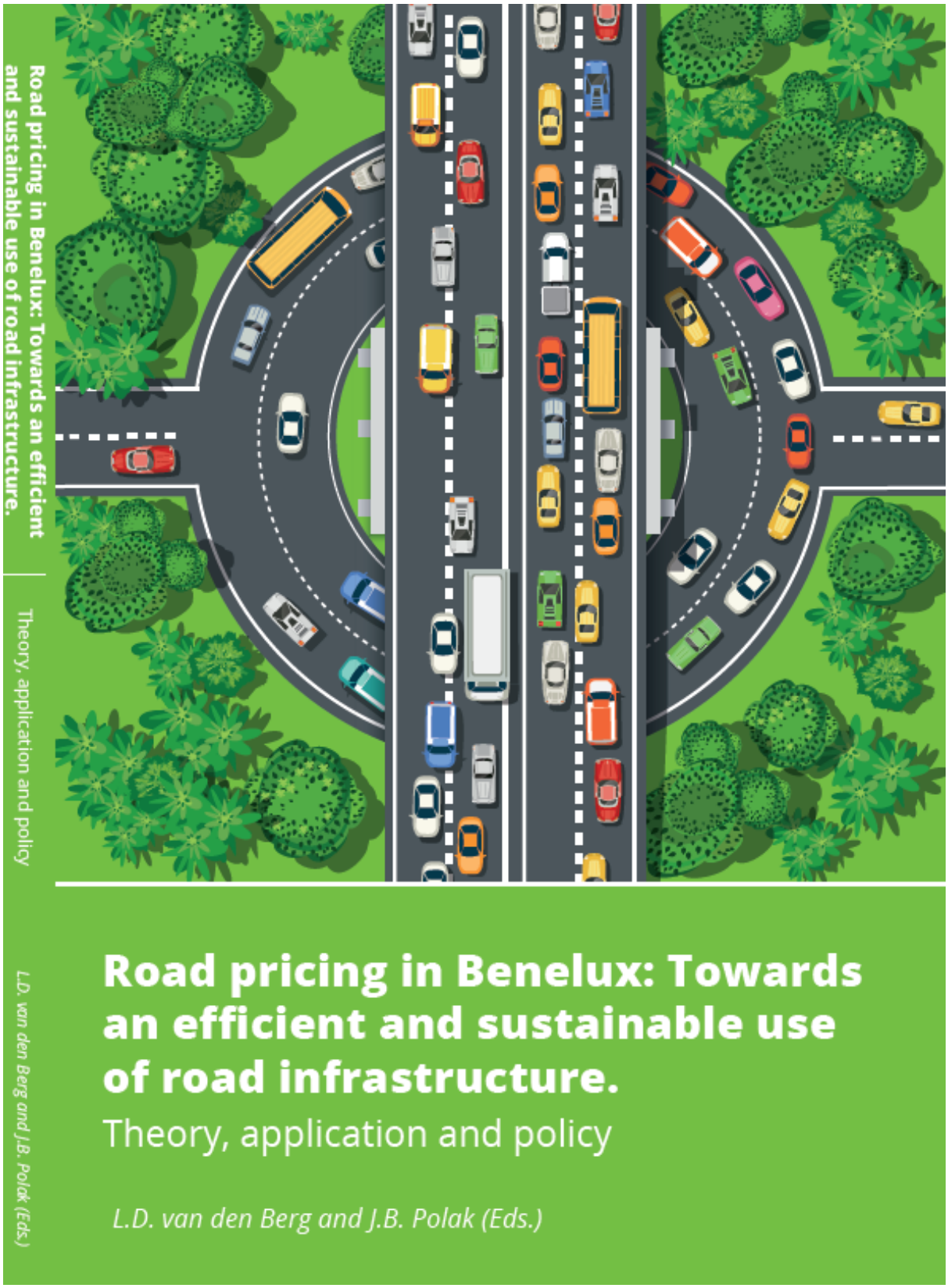

second edition, May 2020

Road pricing in Benelux: Towards an efficient and sustainable use of road infrastructure. Theory, application and policy

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Theory, application and policy
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BIVEC-GIBET

Benelux Interuniversity Association of Transport Researchers

Road pricing in Benelux: Towards an efficient and sustainable use of road infrastructure. Theory, application, and policy

TABLE OF CONTENTS

4

FOREWORD

Mobility, at the right price. Mobility at any price? 6
F. WITLOX

PART I: INTRODUCTION

Chapter 1. Purpose of the book 10
J.B. POLAK

Chapter 2. Reading Guide 16
J.B. POLAK AND L.D. VAN DEN BERG

Chapter 3. Mobility: a priceless global issue to be “priced” correctly 24
W. WINKELMANS

Part II: THEORY

Chapter 4. Economic theory of road pricing – an introduction 30
E.T. VERHOEF

Chapter 5. Review of policy instruments: beyond price instruments 39
S. PROOST AND B. DE BORGER

Chapter 6. Challenge for the near future: Instruments for a climate friendly use of road infrastructure 46
C. MACHARIS, N. BRUSSELAERS AND K. MOMMENS

PART III: A COMMON ROAD PRICING POLICY?

Chapter 7. Road pricing in Belgium 69
TH. VANOUTRIVE

Chapter 8. Road pricing in the Netherlands 78
G.P. VAN WEE

Chapter 9. Benelux cooperation and mobility management 82
B.M.J. HENNEKAM AND L.D. VAN DEN BERG

Chapter 10. The European Union road pricing approach 87
J.G.W. SIMONS

Chapter 11. International cooperation in freight transport pricing and investment 99
B. DE BORGER AND S. PROOST

Part IV: PRACTICE

Chapter 12. Practical applications of road pricing and associated technology 107
M. COOLS

Chapter 13. Road pricing for bus and coach 116
S. LANNOO AND J. DE VOS

Part V: CONCLUSION

Chapter 14. City mobility in 2019 – sustainable and smart? 127
D. BANISTER

Chapter 15. What lessons can be learned both from theory and from practice of the management of road pricing? 131
F. WITLOX

ANNEX

Annex1: Forty years of BIVEC-GIBET 137
L.D. VAN DEN BERG AND J.B. POLAK

Annex 2: Referees 149

Annex 3: Author index 148

FOREWORD

Mobility, at the right price. Mobility, at any price?

F. WITLOX (1)

BIVEC-GIBET is celebrating its 40th birthday. This Benelux cooperation of higher education institutions and research institutions, active in the broad field of the transport economics, seizes this anniversary to publish in Benelux a book on the topic road pricing.

The key building blocks of any economic system are transport, mobility, and logistics. Therefore, they are essential for creating welfare, growth, and regional development. This is particularly true for the Benelux countries. When the neighbouring countries of Belgium, the Netherlands, and Luxembourg decided to establish the Benelux Economic Union in 1958 (entering into force in 1960), the notion of transport, mobility, and logistics was already incorporated in the promotion of free movement of workers, capital, services, and goods to increase prosperity in this area. The focus was clearly on the co-operation of economic, financial, and social policies. It has brought the three nations closer together, as they stood united when common economic and transport-related interests were at stake. Even today, when important responsibilities have been transferred to the level of the European Union, cross-border cooperation between the Benelux countries remains essential to the joint application of supranational legislation, the management of ever-increasing traffic flows with their congestion problems and the development and financing of common transport policies (Witlox *et al*., 2007).

This Treaty between the Benelux countries was limited to a period of fifty years. By the end of that period, in 2008, the three countries decided to renew the agreement, which was to enter into force in 2010. No time limit for the Treaty was set anymore. At the same time, the name "Benelux Economic Union" was changed to "Benelux Union", to better reflect the broader scope of the Union. Also, three key themes were put forward: (i) the economy and the internal market, (ii) security and society, and (iii) sustainable and digital cooperation. www.benelux.int

Today, the Benelux functions as an open economy, heavily dependent on its quality and on the efficient use of its transport infrastructure. This quality *and* efficiency have huge positive impacts on the competitive position of the industrial and services sectors located in the hinterland of the Benelux gateways. This performance is also related to the strategic location of the Benelux countries at the heart of the European Union area, which also hosts the most competitive cities, the most important European production and consumption centres, in the heart of the so-called 'Blue Banana' of Europe[1]. It is also combined with a very dense transport infrastructure including ports, airports, roads, railways, waterways, and pipelines.

In recent years, however, the mobility in Belgium, the Netherlands, and Luxembourg is increasingly at risk of coming to a complete standstill. This will worsen the area's accessibility and degenerate the quality of the environment and everyday life. Short-term solutions cannot help to turn the tide.

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[1] Concept developed by Brunet and Boyer (1989). Outlines a multinational European megalopolis, which includes different metropolises from different (Western) European states.

Instead, structural**,** and innovative changes to the mobility system are required to support welfare in a sustainable manner.

Road pricing – a method for charging for the use of roads – is one of the primary themes of transport economics. Already Adam Smith - generally considered as the father of modern economics - in 1776, mentioned the principles of efficient (equity) provision of 'public works' ("high roads") when he stated that "when the carriages which pass over a highway or a bridge ... pay toll in proportion to their weight … they pay for the maintenance of those public works exactly in proportion to the wear and tear which they occasion of them. A more equitable way to maintain such works seems to be expensive"[2].

Road pricing is widely accepted as an effective tool for alleviating urban traffic congestion, reducing environmental impacts, avoiding escalating car ownership, and generating revenue to finance transport improvements, *but* there are also certain barriers to implementation, particularly outside urban areas as well. Usual questions are: what system to install, how should it be operated, who should be the operator and, what should be the level of charges?

Clearly, a substantial amount of knowledge about this very topic has already been built up over time. The topic, which was already a research object when BIVEC-GIBET was founded in 1978, is still current. Moreover, it is put on the political agenda – *or not* - as we speak… In this way, producing a jubilee book on the topic of *Road pricing in Benelux: Towards an efficient and sustainable use of road infrastructure. Theory, Application, and Policy* seems very justified.
From a political and a societal point of view, decision-making regarding road pricing seems to be very difficult, demanding, and sometimes impossible (for this, see further: Chapter 4, *The Economics of Road Pricing*).

Past experience tells us that one does not simply impose financial restrictions on someone's use of a car without a struggle ("my car, my freedom" - remember). It is clear science and scientific research are needed in such situations to put the debate into the right, objective direction, and to look for proper solutions that are widely supported - by governments, by public and private organizations, by you-and-me.

This book provides an overview of insights about road pricing developed at Benelux universities and other research institutions. As such, the book can also serve to encourage stakeholders from transport practice to actively make use of the extensive scientific knowledge on road pricing and its effects. We are convinced that this is indeed very desirable.

The current book explains some of road pricing's most important transport-economic and institutional aspects. It has different perspectives, and disciplines of economics, geography, engineering, spatial planning, business management, legal and technology approaches. The different contributions are based on both theory and practice, taking road pricing their scope in Benelux. There are good reasons to do so: BIVEC-GIBET has a special relationship with the Benelux. The General Secretariat of the Benelux was active in supporting the creation of BIVEC-GIBET in the late 1970s. This support has paid off as, over the past forty years, more than a hundred scientific meetings, colloquia, and seminars have been organized by the ' oldest ' Benelux cooperation at the higher education level.

We are, therefore, very happy to be able to celebrate this fortieth anniversary of BIVEC-GIBET!

[2] Smith, A., Book V, Ch. I, Part III, Article I, p. 212.

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PART I: INTRODUCTION

Chapter 1. Purpose of the book
J.B. POLAK

Chapter 2. Reading Guide
J.B. POLAK AND L.D. VAN DEN BERG

Chapter 3. Mobility: a priceless global issue to be “priced” correctly
W. WINKELMANS

1 Purpose of the book

J. B. POLAK (1)

1 Why this book?

Behind the simple question that forms the title of this Section figure four more detailed questions:

Question 1.: Why a book?
For BIVEC-GIBET, as an association and not a publisher, it is not self-evident - at times - still taking upon itself that latter role. Doing so, however, has been judged to follow directly from BIVEC-GIBETS's principal task: promoting research in transport economics and related fields, in Benelux. From this, it is only one step to also taking care of the accessibility of the results of such research. For a detailed history of BIVEC-GIBET in its role as publisher the reader may be referred to the Annex 1. Here, just some highlights in the fulfilling of this role may be mentioned. Such was, in the first place, the Jubilee book published at the occasion of the 25th anniversary of BIVEC-GIBET. Further, the Proceedings of the Transport Research Days, organized regularly by BIVEC-GIBET since the year 2007.

Question 2.: Why a book just now?
Towards the end of 2018, BIVEC-GIBET celebrated its fortieth anniversary/eighth Lustrum. Definitely, attention was to be paid to this circumstance. There is no law - or something similar - to whether or not publishing a book at the occasion of a BIVEC-GIBET jubilee. Still, there were a number of factors that came together and that made the organization's Board feel that the outside world could once more be reminded of BIVEC-GIBET's existence - and that the publishing of a book would again be an excellent means to this end.

Question 3.: Why, this book, particularly about "road pricing"?
The immediate reason for choosing road pricing as the central theme of this jubilee publication has been the renewed interest in this subject in two of the three Benelux countries, i.e. in Belgium and in the Netherlands.

There is, however, an answer to the above question – Question 3. – that is of a more substantive nature than the topicality of the subject. This answer, in fact, is of a twofold nature. Partly it has to do with economic theory, partly with practical matters.

(1) Professor emeritus of Transport Economics, University of Groningen, former Lecturer University of Amsterdam, (both the Netherlands)

First and foremost, “road pricing” for a long time already has been one of the important themes in transport economics and still is receiving much attention in literature. To this, the following consideration with regard to the putting into practice of road pricing may be added.
Given that political decision-making about road pricing often is difficult, theoretical knowledge of the subject and research relating to it can be of help to decision-making. The present publication is to be seen in this light. An implication of this is, it is worth mentioning, that it has been attempted to focus the whole of the subjects of the book on a broad readership.
Finally, the problem of sustainability aspect offers a completely new perspective to the instrument of road pricing, as such being a further reason for devoting a publication to this subject.

Question 4.: Why, in particular, road pricing in Benelux?
This is a question that is not difficult to answer. The answer can be found in letter “B” in “BIVEC-GIBET”. The connectedness of BIVEC-GIBET with the Benelux Union has its roots in the past, but - fortunately – it equally applies to today. More about this bond can be found in the Annex 1.

What is to follow, next, in this introductory Chapter? Firstly, the title of this book speaks of both an efficient and a sustainable use of road infrastructure as the aims of road pricing. Some explanation of why these two aims is given in Section 3. Section 4, finally, present some general comments on each of the Chapters.

2 Relevance of this topic

2.1 Procedure

As is well-known, it is good practice, before entering on any research project, to first answer, depending on the character of the research project, either one or both of the following two questions:
- is the project scientifically relevant?
- is it socially relevant?
Now, it will be clear, that great differences exist between the situation of entering upon a research project and that of the reading of a collection of essays.
Nevertheless, for the collection of essays it may be attractive to borrow from the case of a research project and, by analogy, also to apply either or both of the two criteria of relevance.
What would be the purpose of such an exercise, one might well ask. The answer is that, the same as in the case of a research project, the exercise would function as an aid in decision-making. That decision would be either to accept or to reject, that the choice of the subject for the collection of essays has been a useful one. This, of course, only is an intermediary step, leading to the final decision to read the book or not.
It will be noted that, at this point, still one question has been left open. That is the question whether, for the present book, just one or both of the criteria for assessing its relevance will have to be employed. The answer to this question will be given in the briefest manner possible, here. Most members of BIVEC-GIBET working at universities, it is in the nature of their work that this will have to satisfy any test of scientific relevance. To this it has to be added that BIVEC-GIBET has in its genes an interest in the interaction between theory and practice of transport economics and related fields – and that, for this reason, also assessing the societal relevance of its work is very obvious.

2.2 Scientific relevance

For answering the question whether this book can be deemed to be scientifically relevant this question can best be split up in a number of sub-questions. These are the following:

1. What is the scientific relevance of the subject of road pricing generally speaking?
2. Would the fact that this book is about road pricing specifically in Benelux, in any sense add to its scientific relevance?
3. Would the fact that this book is in the form of a collection of essays in any way have a meaning as regards its scientific relevance?

Ad 1.: This question (scientific relevance of the subject of road pricing generally speaking) may be answered in two separate steps, i.e. by first, briefly, looking backwards and then looking forward. Looking backwards, first: for this, it is apt to quote, here, what already BIVEC-GIBET Chairman Frank Witlox wrote in his Foreword to this book. These were his words:
"Road pricing is one of the primary themes of transport economics. Even Adam Smith…mentioned the principles of efficient provision of 'public works' ("high roads")…". Moreover: "a substantial amount of knowledge has already been built up over time to discuss this very topic.".
From the above, one may well conclude that in the past road pricing indeed has been an important subject in transport economics.

But how is this today? For an answer to the question of the scientific relevance of dealing with the subject of road pricing one may turn to welfare theory, part of the theory of economic policy. To begin with, welfare theory is about the conditions for the optimum use of scarce resources. In traditional welfare theory, at least in that of its variants developed by Pareto (Pareto, 1906) - or any modern textbook about welfare theory, in the first instance it is assumed that in all markets there is perfect competition. This ensures that in all markets in the end will be in equilibrium. In practice, however, such a course of events in many cases will not occur. This is because there, apparently, is what is commonly referred to as "market failure". Welfare economics has found that, in the case of market failures, an equilibrium can still be reached, notably by corrective pricing. Literature has made clear that the use of roads is a typical example of the occurrence of market failures. By finding solutions for arriving at an optimum use of roads it thus will be possible to make a contribution to welfare theory, the part of economics where, in the main, the subject of this book – road pricing – is situated.[3]
Ad *2.:* (relevance of a book about road pricing specifically in Benelux) With this book being about the case of road pricing in countries that together form an international organization – the Benelux Union – one enters the field of the theory of international economic relations. It may be said that, in a manner analogous to the case of welfare theory, studying road pricing in Benelux can contribute to the theory of international economic relations and in this respect too can be said to be scientifically relevant.

Ad 3.: (scientific relevance of a collection of essays) This book, being a collection of essays, puts together a number of different sides of the problem of road pricing. This amounts to giving a broad view of the subject. Because of this, the book could well promote a better understanding of the subject of road pricing in general. In a sense maybe somewhat different from the usual one, one might take this as an aspect of the scientific relevance of the book too.

[3] One may find a parallel, here, with what famous economist Schumpeter once wrote about a quite different part of transport economics, i.e. railway ("railroad") economics - witness the following quotation:
"Any decent theory of cost and price ought to be able to make valuable contributions to railroad economics, *and railroad economics ought to be able to repay the service by offering to general theory interesting special patterns and problems*." (Schumpeter,1972; author of this Chapter).
To the opinion one sometimes comes across that specialized fields within economics like transport economics merely are in the nature of being applications of "general (economic) theory", one may reply that such an opinion presupposes that there are no more "blanks" to be filled in general theory, which, evidently, is not true.

2.3 Societal relevance

2.3.1 "What?"

"Societal relevance", firstly, may be translated as: "being of use to the solution of problems existing in society". The question whether there are problems for society in connection with the use of roads is not hard to answer: congestion, traffic safety, various problems of the environment and climate change all are problems of present-day society. In densely populated areas like the countries of Benelux these problems in particular weigh heavily. Road pricing, so much is clear from literature – and already in some cases from practice too - can be of significant help in reducing the size of this problems (see, e.g. Vrijburg and Geilenkirchen (2019))

2.3.2 "Where?"

First, in his closing Chapter (Chapter 15) - as the reader will still see - BIVEC-GIBET Chairman Frank Witlox states: "The Benelux Union is supported by the three countries' advanced scientific research, in transport economics as well as in other, related, fields."
Also, what was the opinion of the late Secretary General of Benelux, Mr. E.D.J. Kruytbosch, here is of great interest. As stated elsewhere in this book (see Annex 1) he (Kruytbosch) "saw the great importance of actively using science and scientific research as a basis for policy-making…".

Though these two quotations only refer to the activity of BIVEC-GIBET in general, they may still underline that BIVEC-GIBET, in studying road pricing in Benelux, may well be of use to the countries together forming the Benelux Union too. This would be the more so if, at any future date, these countries were to give thought to coming to a policy on road pricing that would be common to the three of them.[4]

3 Why towards "efficient and sustainable" use?

In economic theory, the subject of "road pricing" is something in the domain of welfare theory, this being part of the Theory of Economic Policy. In welfare theory, "efficiency" is the one and only criterion for all economic action. If, as expressed by its title, road pricing is to serve not only the aim of efficiency, but still another one – that of "sustainability" – is not that too much of a good thing?
For answering this question, it may be helpful first to recall that in early welfare theory, the concept of "welfare" was conceived of as being identical with "national product" – or, in terms of money, "national income". Such, e.g., was the view of famous British economist Arthur Pigou, who defined "(economic) welfare" as "that part of social (general) welfare that can be brought directly or indirectly into relation with the measuring rod of money." (Pigou, 1932).
In later years, one of the most prominent Dutch economists, Pieter Hennipman, basing himself on what is known as the Austrian School of economists, put forward a view greatly differing from that held before (see, e.g., Hennipman, 1995). According to Hennipman, the concept of welfare rests on the notion of the existence of a fundamental scarcity of resources in relation to human wants. "Fundamental": "of all times". In this view, maximum welfare, is obtained when there is an optimum use of scarce resources. This situation is called "efficient" in economic theory.
Same as "welfare", in the above sense, "efficient" refers to all purposes whatsoever for which scarce resources are being used, more specifically here too including: "sustainability".

At this point, an answer may be given to the question raised at the beginning of this Section, i.e.: "why mentioning 'sustainability' as an aim of road pricing too", i.e. next to the aim of efficiency.

[4] Cf. what is written in Chapter 9 "currently, there is no active collaboration in the field of road pricing.". For some suggestions as to how this problem might be tackled see same Chapter.

The simple answer to this question is that, while there is not any doubt that in present-day economics "sustainability" forms part of the concept of efficiency – and would, therefore, by definition be something a policy of road pricing would be aiming at - perhaps not every reader of this book will be aware of this fact. The *"and sustainable (use)",* in the title of this book, thus may be seen as a case of "better safe than sorry".

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2 Reading Guide

J. B. POLAK (1) AND L.D. VAN DEN BERG (2)

This Reading Guide contains brief introductions to the various Chapters in this book. These introductions, it should be noted, are not summaries of the Chapters. The latter can be found at the beginning of each of the Chapters. The purpose of this Reading Guide firstly is to make clear why the different subjects of the Chapters have been given a place in this book. Further, to indicate what passages deserve special attention. Where this is thought to be helpful, comments are made on what is written. Also, relevant cross-connections between Chapters are identified.

In order to reach a broad international readership, BIVEC-GIBET has decided to publish this book in English. A brave move given that apart from one, none of the other authors are native English speakers. The authors and the editors have made their best efforts in English.
English is however a language of subtleties, so we would be grateful that you excuse our likely grammatical errors and suchlike when reading this book. We trust that this does not affect your enjoyment of this book.

1 Structure of the book

The book is divided into five parts:

Part I (Foreword , Chapters 1-3), next to the Foreword by the Chairman of BIVEC-GIBET, contains an explanation of the purpose and the structure of the book and a general sketch of the background of road pricing.
Part II (Chapters 4-6) focuses on the theory of road pricing. It first states the principles of this. It then supplements this analysis by also examining the potential of non-pricing measures. Finally, in line with the great importance that is currently attached to climate problems, it pays ample attention to what road pricing may mean for climate policy.
Part III (focuses on policy developments concerning road pricing relevant to Benelux, both in national (Chapters 7 and 8) and international (Chapters 9-11) settings.
and goes on to give a critical appraisal of solutions to problems that have accompanied these changes.

(1) Professor emeritus of Transport Economics, University of Groningen, former Lecturer University of Amsterdam (both the Netherlands)
(2) Former Director at the General Secretariat of Benelux Union in Brussels (Belgium)

Part IV (Chapters 12-13) contains two contributions dealing with the practical application of road pricing within the confines of Benelux. The first of these in part consists of an overview of various financial instruments for managing mobility and further deals with the implementation of these instruments in a Belgian context. The second contribution in this Part examines what would be the effects of the introduction of road pricing in Belgium on the use of bus and of coach in that country.
In Part V (Chapters 14-15) there are two contributions, both in the nature of a synthesis of preceding matter in the book. The first of these two considers changes in mobility in cities over the past decade The second contribution presents recommendations on how to work best in the Benelux in order to arrive at a smart and sustainability-oriented mobility approach. Finally, in an Annex, the many activities undertaken by BIVEC-GIBET in the course of its existence are listed.

Each Chapter describes an aspect in the broad field of road pricing. It is useful but certainly not necessary to read all Chapters in the order in which they appear in the book. The reader can, if desired, make a selection from these topics.

2 Survey of Chapters

In his foreword, then BIVEC-GIBET chairman Frank Witlox explains why this international association of transport economists is celebrating its 40th anniversary with a publication about road pricing in the Benelux. A publication that has as one of its aims making findings of science known also outside the circle of researchers, and by this also to function as a guide to a Benelux cooperation with regard to road pricing, if so desired. “Road pricing”, in past years, and the world over, has attracted much attention, both in economic theory and, be it still to a lesser degree, in policy-making.

Chapter 1 - *"Purpose of the book"* (Jacob Polak) - sets out the main reasons why this topic has been found a suitable one for a Jubilee book of BIVEC-GIBET. The argument is put in the form of a test as is commonly applied to research projects, that is, when it has to be decided whether it is worth undertaking a particular project - or not.
Such a test comes down to making clear what is the relevance of the project in question. “Relevance” may either mean, it is set out: “being of use to theory” or: “of use to society”. In this Chapter it is argued that the subject of the present book – “Road pricing in Benelux” - largely scores both on the criterion of theoretical and of that of social relevance.

Chapter 2 is the present "*Reading Guide"* (Jaap Polak en Leen van den Berg).

Chapter 3 - *"Mobility: a priceless global issue to be “priced” correctly"* (Willy Winkelmans) - evokes the thought of a painting - in dark colours. It depicts how a decent human life will become impossible, if both mobility and the environment will come under permanent pressure. That something like this will occur is seen as a far from unlikely scenario.
The Chapter further notes that, in past years and the world over, investment in transport infrastructure has been lagging behind. This may be taken as a warning that road pricing can only be a partial solution to mobility problems. From a certain point onwards, is the message of this Chapter, it will only be possible to meet mobility demand by expanding infrastructure capacity. More about the question whether the instruments of road pricing and of investment in infrastructure are to be seen as mutually exclusive or not – a question evidently of great importance for decision-making - can be found in Chapter 4. (Section 4, "Road pricing or capacity expansion") and in Chapter 11. (International cooperation on freight transport pricing and investment).

In an introductory Chapter like Chapter 3 there is not much need to go beyond indicating in global terms the importance of transport and the extent of the problems associated with it – like, here, with the words: "without transport, everything stands still". It may be noted that for a particular category of the external effects of transport, i.e. effects on climate change, a calculation of the cost of these can be found in Chapter 6 (“Challenge for the near future: Instruments for a climate friendly use of road

infrastructure"). In line with this, it can be concluded that it is the integral social costs of road traffic that are to be seen as a compass for policy-makers. These will, therefore, benefit greatly from a more comprehensive quantification thereof.

Towards the end, Chapter 3 brings the reader down from ideal to reality. Road pricing? Very fine in theory. But what about its practicalities? How to design, e.g., a system of pricing that takes account of the many differences in externalities among modes of transport – and among different modes of road transport too, one might add. Questions like these point to matters one will find further in the book.

Chapter 4 - *"Economic theory of road pricing, an introduction*" (Erik Verhoef) - provides the major features of the theory of road pricing. It also links this theory to practical questions such as:

- why is there so much resistance to road pricing among road users?
- do revenues from road pricing have to be used for expanding road capacity?
- when does pricing and when extra capacity come into consideration?
- what are the merits of a scheme for rewarding off-peak travelling?

From a practical point of view, tradable rights as an instrument for managing mobility (par. 6 - "Positive and budget-neutral price incentives") appear as an interesting alternative to classical - "Pigovian" - road pricing. The associated incentives can reduce the unmistakably present broad social resistance to road pricing - or even turn it into active support. As such, this Chapter is more than a theoretical consideration and is definitely to be recommended to readers who in practical circumstances have to do with road pricing, be it in the context of policy-making or otherwise.
Still, given the above, the question remains open whether one would find it acceptable that the number of peak permits is determined by a political decision – as opposed to, which one would prefer, being based on a criterion derived from economic theory.

Chapter 5 - *"Review of policy instruments: beyond price instruments"* (Stef Proost and Bruno De Borger) - takes as its starting point that today, mobility problems are mostly tackled through instruments other than road pricing. The text here points to tolling, noise-reducing devices, traffic lights, bypasses and low emission zones. This Chapter stresses the need for coordination for situations where, in the use of instruments like these, conflicts of interest arise between various levels of government and between local governments.
For this approach to have optimum effect, the use of these instruments must be coordinated in a broad manner, i.e. both geographically and between levels of government. Such coordination then would preferably be at an early stage in the process of planning for mobility. This other than often is the case in present practice, where coordination and integration of different approaches to the management of mobility are only thought of at an advanced stage and sometimes even after implementation, which then results in often much unmanageable problems.
It may be remarked that conflicts like these also manifest themselves between national governments. More than once a country will avoid looking for an international approach where certain measures will raise major controversies within that country, but rather seeks the solution in national customization. As a result of this, international coordination will only receive attention at a later moment. Often it then is too late to arrive at an integrated cross-border approach. As indicated in various places in the book, the Benelux countries as an European transport hub have great interests to defend in the field of transport and logistics. A coherent mobility policy, however, with regard to external effects too and in connection with climate policy, so far is a missing link in the Benelux cooperation.

Chapter 6 - *"Challenge for the near future: instruments for a climate friendly use of road infrastructure"* (Cathy Macharis, Nicolas Brusselaers and Koen Mommens) - focuses on the use of road pricing for supporting climate policy. This Chapter, one may note, by far is the longest of all, in the book. This justifies the question: why so much attention for this particular topic?

In Chapter 1 (Section 3), one may remember, it was asked why the title of the book, next to efficiency, also indicated "sustainability" as a goal of a policy of road pricing. The answer to this question was, to quote the relevant passage, that "today, by many, sustainability is considered as a major objective of economic policy". It is this same observation, in combination with the relatively recent attention for sustainability problems, that may make clear why, in this book, so much space has been devoted to creating a link between sustainability and road pricing. Indeed, certain external effects of road traffic - for example, effects on public health, on nature or on climate - appear to be much more far-reaching than previously estimated.

Chapter 6 deals extensively with the climate effects of traffic. Road traffic is becoming increasingly cleaner, but this reduction is being exceeded by the growth of traffic, so that on balance emissions are still growing. Road pricing noticeably supports climate policy, but that will not be enough to fully meet the climate objectives. And also, the message is that delaying in taking appropriate measures will seriously hamper the recovery of sustainability.
With regard to the latter: the costs of too slow a decision-making process, not only as regards climate policy, but also in a more general sense, are often unknown. Calculating – in terms of costs and benefits - the optimum moment for decision-making, nevertheless, can be very relevant and can speed up decision-making, as appeared, for example, in the negotiations between the Netherlands and Flanders on deepening the river Western Scheldt at the beginning of this century.

Restrictions on mobility are often very sensitive in society - and therefore also in politics. In this situation, it is difficult to arrive at a widely supported introduction of road pricing. Chapters 7, 8, 9, 10 and 11 describe how decision-making on road pricing developed in the Benelux countries and in the context of the EU.

In Belgium, a kilometre charge for heavy lorries has been introduced. Chapter 7 - *"Road pricing in Belgium"* (Thomas Vanoutrive) - not only explains the history of this measure, but also - in a detailed manner - why this approach was chosen.
It may be noted that the decision-making process about a kilometre charge for heavy lorries in Belgium has been a lengthy one. This is partly due to social resistance to such a measure and partly to the complex political structure of the country – which is that of a federation. The latter entails that there not only is a federal – "national" – government, but, in addition to this, three regional governments, these being of the regions of Brussels, of Flanders and of Wallonia, respectively. What is of importance here, is that all these governments are competent in matters of transport policy, road pricing included.
In the year 2016, an agreement between the various governments was reached with regard to a vehicle charge for lorries weighing more than 3.5 tonnes. As regards introducing road pricing for passenger cars too, nothing has been decided yet. This again is because of existing social resistance, but also because of disagreements between the various governments regarding the particular type of pricing instrument to be used.

Chapter 8 - *"Road pricing in the Netherlands"* (Bert van Wee) - mainly deals with the implementation problems due to social and political resistance in the Netherlands. It describes the situation where road pricing has been discussed for decades without any concrete implementation. This chapter provides a description of a long, difficult, political decision-making process. This Chapter is a case study of the failure factors surrounding the introduction of road pricing.

Comparing the road pricing situations in Belgium and the Netherlands, the lesson is that, from the point of view of public support, implementation through a step-by-step approach with priority for heavy vehicles offers the greatest chance of success. A second lesson is that it is advisable not to refine the charges too far. As long ago as 1998, G. Blauwens warned that there is a psychological limit to the refinement of charges that cannot be crossed. Beyond a certain limit, when electronic charges are highly differentiated according to location and time, they may become insufficiently transparent to road users. They will then no longer respond to the charges or in an incorrect manner. As soon as this happens, all theoretical calculations will collapse. If the market loses its transparency,

it is difficult to say to what extent it will reach its optimum. In the Netherlands in particular, there is a tendency to want to arrive at very sophisticated forms of pricing. The resulting additional studies and uncertainty not only takes time, but also are not without risk in view of the above-mentioned need for transparency.

Chapter 9 - *"Benelux cooperation and mobility management"* (Ben Hennekam and Leen van den Berg) - focuses on the state of Benelux cooperation with respect to road pricing. With several sea- and airports within Benelux functioning as hubs for transport in Europe, the three countries have an interest in developing a coherent mobility policy, not only among themselves but also within the EU. It may be found rather astonishing that, while the Benelux over the years has played a pioneering role for the EU in many areas of policy, this is not so in the field of mobility. Benelux cooperation with regard to mobility requires unanimity in approach. In Chapter 9 it is set out that, in fact, such is not the case.

In 1988 the EU investigated the costs of imperfections in the internal market. The outcome of what become known as the "Cecchini report" woke up politicians. By this, it formed a contribution to the realization of the internal market. The three Benelux-countries could very well, similar to this, take the initiative for research into the effects of a greater coherence in decisions with regard to road pricing, both in the Benelux and in the EU. In this context, it is useful to recall the motive of then Benelux Secretary General Kruijtbosch for actively supporting BIVEC-GIBET, when this was founded, in 1978. He recognized that scientific research is an important tool that should support policy-making. Doing this together, in the Benelux area, could not only raise the quality of research, but could also create a solid basis for a joint Benelux approach towards transport policy.

Chapter 10 - *"The European Union road pricing approach"* (Jan Simons) - elaborates on the legal and institutional aspects of EU transport policy. This contribution shows that, in the early years of the EU, a legal procedure was necessary for achieving a more coherent European transport market. Following this, powers in the field of transport were gradually transferred from the individual Member States to the EU. Nevertheless, it appears, this did not suffice for achieving an overall common transport policy. What has been achieved, in the course of time, is a common policy for the internalization of external costs of road haulage. The aim of this was that individual Member States would be able to recover the external costs caused by heavy goods vehicles from other Member States.
A policy similar to that for goods transport has appeared to be still a step too far for private cars. EU Member States so far have been developing their own policies in this area. With non-discriminatory provisions also with regard to the use of private cars, residents and non-residents would - in line with the principles of the EU – also in this case be treated on an equal basis. It would then make it difficult for individual Member States, it may be noted, to offset the costs of road pricing to residents by lowering the fixed tax burden, as is often intended for receiving national support for road pricing.

Protection of nature, the environment and climate interests are areas in which legal proceedings aimed against too slow a decision-making process have resulted in more coherent and, above all, more vigorous policy. This is so at regional, national as well as international levels. The instrument of road pricing - considering its sustainability aspects - might therefore well be given a higher place on the political agenda in the near future.

Chapter 11 - *"International cooperation in freight transport pricing and investment"* (Bruno De Borger and Stef Proost) - focuses on two interesting aspects of international cooperation with regard to transport. This, one finds both from a theoretical and a practical point of view. The two aspects of international cooperation in this Chapter are pricing the use of roads by international freight transport and the way in which investment decisions for the European infrastructure networks are substantiated. For both aspects, a European approach is obvious. For road pricing for heavy good vehicles, in practice this more or less is the case. When it comes to substantiating the usefulness and necessity of infrastructure, the Chapter stresses that factors other than efficiency (the latter concept in the sense of economic theory) often play an important role. This leads the authors to the conclusion that

investments in (parts of) the Trans-European Network often are insufficiently coordinated, resulting in shortcomings in this network.

A publication on road pricing should, of course, also include a contribution on how such a measure is implemented in practice and what its effects are. Chapters 4 and 5 on the development of theories have already briefly addressed this issue. Practice -viewed in more detail - is the central theme in Chapters 12 and 13.

Chapter 12 - *"Practical applications of road pricing and associated technology*" (Mario Cools) - discusses a number of techniques that can be used for pricing road traffic. Three applications of these techniques are compared. Finally, the author gives some reflections on the use of road pricing in Belgium.
It may be useful to note, at this place, that while the present book, in principle, deals with the issue of charging for the use of roads on the basis of distance travelled, Chapter 12. draws a wider circle for its analysis. That is in that it also considers situations where there is no direct relationship between charges and distance travelled.

Chapter 13 - *"Road pricing for bus and coach"* (Steven Lannoo en Johan De Vos) - deals with this sector of transport in particular in Belgium. This being given, there are two aspects in which this Chapter is different from all others in this book.
Firstly, this is because it looks at a category of road users other than the private car, that is, as shown by its title, bus and coach. The authors – rightly – are of the opinion that bus and coach are an essential part of a sustainable transport system. They make clear, that is difficult to say something definite about the share of this sector within the whole of passenger movements by road – that is, including those by private car. On the one hand, when road pricing will be introduced, part of present car users may be expected to switch to using bus or coach transport. On the other hand, road pricing would lead to the latter being confronted with higher operating costs, which, in principle, would make it lose part of its present users.
A second particular aspect of this Chapter is, that it is the only one in this book, that, for its analysis, employs an econometric model. This is a powerful tool, that would deserve also to be applied to cases other than in Belgium – be it elsewhere in Benelux or, for that matter, also outside this.

Chapter 14 - *"City Mobility in 2019 – Sustainable and Smart?"* (David Banister) - is a general reflection on the price instrument - as its title shows - within cities.
The Chapter first points to what are termed two new dimensions that have emerged for policy: global and local environmental pollution and inequality. This serves to make clear that the problems of the optimum use of roads "road pricing" as well as the related problem of the use of renewable energy are part of a much wider problem. As such, the author sees the issues of what types of cities to choose for and of the availability of space in cities.
New thinking on these issues, the author cannot but conclude, has been limited in recent years. Rather gloomy as this conclusion may be, it might, at the same time, act as a stimulus to do just that what the author has found lacking.
The reader may note, it can be added, that in this Chapter the instrument of road pricing does not hold the central place it has in all other Chapters. This might well be due to the fact that the author is accustomed to approach problems from the point of view of geography - this being his disciplinary background - while all other authors either themselves are economists or still approach the subject of road pricing from the point of view of economics.[5]
However this may be, this Chapter gives the reader much food for thought. In this, it fully meets with its place in the concluding part of the book. It could, perhaps, also set some readers on the path of

[5]Cf. Vanoutrive, in this book (Chapter 7), pointing - among others - to Banister too: "Nevertheless, some geographers and planners remained critical of congestion pricing…".
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examining whether the thoughts developed here in particular for cities could be of use too when considering wider entities, such as a region or an entire country.

Chapter 15 - *"What lessons can be learned both from theory and from practice of the management of road pricing"* (Frank Witlox) - links the various Chapters of the book with each other. In doing so, it creates a very instructive synthesis of the advantages and disadvantages of road pricing in the Benelux. Road pricing as an instrument for the optimum use of road infrastructure may be a very obvious thing from the point of view of economic theory. It, nevertheless, is far from easy to put it into practice. The alternative of expanding the supply of infrastructure: this too often is controversial - quite apart from the problem of finding sufficient finance for this.
Would the foregoing mean that only a standstill is possible in policy regarding road use? Is this going be the trend in mobility policy? Or will the political courage be there that is needed for the untangling of this Gordian knot? In addition to this, a maximum cooperation among nations would be required. The author's plea is for such cooperation among the Benelux countries – in the sense of governmental authorities as well as the research communities in these countries joining forces.

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3 Mobility, a priceless global issue to be "priced" correctly

W. WINKELMANS [1]

Abstract

The Chapter first expresses its doubts about the future possibilities of economic development. These doubts stem from the observation that there is an imminent shortage of infrastructure.
As a result, traffic is faced with congestion. This congestion is very expensive not only in terms of waiting time and due to increased fuel costs, but also because it makes transport unsustainable: drivers become nervous, the number of accidents increases, citizens get a reason to think more negatively about their society and, last but not least, long queues harm our health and nature.

What could be solutions to these problems? It is found that "road pricing" here could very well play a role. It is thought only natural, that also external costs should be part of prices for road use.
After having pointed out that public authorities often are not able, anymore, to take the lead in the development of transport infrastructure, the Chapter concludes by stating that the public financing of transport services needs a revival.

1 Introduction: Why, when, where, how, what needs to be done, about transport, to make it *smart* transport?

Generally, it is assumed that the economic development of a country or region, as well as of cities, ultimately depends on the existence of high-quality transport infrastructures. This is not an exaggeration: the degree and quality of mobility of passengers, freight and data have become an increasingly important economic good worldwide. Hence, it would be wise to understand and to put into practice, that "mobility" concerns much more than just "transport"! For the sake of a wise understanding of the issue of mobility, it is useful to agree upon the following definitions.

Mobility – "being mobile": being "able to move or be moved freely or easily…" (Concise Oxford Dictionary, 1999) - is a prerequisite for production and consumption.

Transport concerns the moving of goods, persons, documents and data - for which it needs rules, techniques and technologies. This function of transport makes that is a tradable commodity too.

Modal split is the distribution of traffic among modes – modalities - of transport.

Modal shift may be a policy goal – with, in its turn, serving to increase welfare. This concept to be taken in a broad sense, i.e. as consisting of everything that may be considered economically scarce.

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Transport policy concerns the behaviour of governments both with respect to transport activity and to investment in transport infrastructure

Sustainable mobility is the ultimate goal of a sound transport policy, and therefore a key element in global welfare generation.

In all, the economic development of countries, regions and cities depends on the quality of the supply of transport infrastructure, which, after all, becomes an important enabler of economic growth. Nevertheless, infrastructure development is no longer so obvious (De Brucker *et al.*, 1996).

Nowadays, various stakeholders have been able to block transport projects long term - and sometimes even definitively. In developed countries, apparently, the current institutional system often is unable to provide a stable legal framework for the implementation of transport projects.

However, transport infrastructures are likely to be remaining important enablers of economic growth. Therefore, it is better to take into account not only that there is a stringent co-relation between transport and welfare, but also that "regions" basically need a sustainable smart transport system. Again, the issue of mobility is more than just a transport issue. This should be realized more than ever. Any comprehensive transport policy must therefore include coherent country and city planning measures, including the environment, safety and, last but not least, accessibility (Winkelmans, 2000).

The concept of "the economy" in a traditional sense is focused upon production, but today one should "know" that value creation is often much higher before and after the pure production or 'make'-phase. If "knowledge" is looked at in this way, i.e. essentially as a crucial raw material, the one and the other implies that the wide process of bringing about a product is becoming more important than the production phase - in a narrow, technical sense – itself. Therefore, in order to master our mobility, it is necessary to face a whole series of old and new challenges in the development of transport infrastructure - including stakeholder management - with a view to fruitful cooperation and change management. One must be aware, however, that, in the industrialized economies, there are numerous lawsuits by stakeholders, by which they "hope" to block the transport projects concerned, while in the emerging economies – perhaps apart from China and some Middle Eastern countries, at least momentarily – infrastructural development cannot keep pace with economic development. Good examples are India, Indonesia and Brazil. Ultimately, the one and the other appear to be difficult to understand, while political and societal doubts regarding the evaluation instruments are considered. There often is much doubt about the usefulness, necessity and the question of whether costs are in line with benefits.

Nevertheless, the current level of public investment in transport infrastructure long has been far too low to ensure longer-term economic growth: "Bridging the Global Infrastructure Gap" was the call, already a decade ago (KPMG, 2008). That this call is still valid, is proved by two very recent publications on the subject (Metcalfe and Valeri, 2018; see also Acca and CPA, 2019).

Finally, one ought to "know" – i.e. wisely understand:

- That the transport industry is an industrial activity growing as a function of population growth, globalization and technology.
- That free space for transport and storage is becoming increasingly short.
- That transport, more than ever before, has negative external effects such as noise and air pollution and congestion, especially in and around (port) cities.
- That the worsening imbalance between the demand for mobility and the supply of transport infrastructure is not an ideal result - on the contrary.

2 The issue of sustainability in transport industry's framework confronted with a global emergence of structural congestions

Although it is generally accepted, that the economic development of regions and cities first and foremost depends on the quantity and quality of their stock of infrastructure, today's mobility for various reasons is under threat, one of these reasons being a shortage of infrastructure (Winkelmans, 2008).

Road congestion in particular sometimes becomes a real nightmare. It is very expensive not only in terms of waiting time and due to increased fuel costs, but also because it makes transport unsustainable: drivers become nervous, the number of accidents increases, citizens get a reason to think more negatively about their society and, last but not least, long queues harm our health and nature.

The growing emergence of structural congestion is an undeniable aspect. In the case of road transport, the increasing imbalance between demand for mobility and supply of infrastructure is one of the main causes. The interrelationship is clear: the more unit production and consumption, the more road traffic … which leads - given its limited possibilities in capacity extension to more road congestion and accidents and negative externalities, such as noise, visual intrusions, etc. due to its limited capacity expansion possibilities. Not only is this kind of congestion cost generating, it also is environmentally unfriendly.

So, one should not underestimate the likelihood of the following sequence of events: "the more production and consumption in today's societies, the more traffic (and accidents), the more noise, the less air, water, and space quality … and finally the less wellbeing"! One should be aware that the increase in welfare (indices) is not reflected in the index of well-being (Dutch: "welvaart" and "welzijn" / French: "prospérité" and "bien-être"). As such, it becomes necessary to understand that the almost daily confrontation with mobility syndromes is severely contra-productive: "without transport everything stands still". In other words, the issues around "mobility" need a totally novel approach. Besides, it is true that Albert Einstein's wise saying, "*If you always do what you have done, you will always get what you always got. So we can't solve problems by using the same kind of thinking we used when we created them*" seems perfectly applicable to this type of transport issue (Winkelmans, 2009).

Many solutions have already been suggested. What about "road pricing" – the central subject of this book? Unfortunately, like some other instruments, this is regularly confronted both with plenty of friends and enemies. The demand side of mobility is indeed profoundly divided: for some, it is the solution, for others it is almost heretical.

Nevertheless, instruments that could influence the demand side of transport are most logical and desirable from a socio-economic point of view. In that case, of course is not just a matter of price levelling, but of restructuring the supply and demand prices; think of the fact that the environmental costs are largely different by mode of transport. As such, the cost price by mode of transport differs indeed enormously as a function of differences in congestion, air pollution and noise pollution. Implementation of such external costs into final freight prices is called the "Royal Way", given that free transfer, silence, and healthy air are scarce "goods", which deserve to be paid for in terms of the cost price to maintain them.

Last but not least, ever-growing global demand for transport – both in terms of freight and passengers – is proceeding with a non-sustainable exponential growth of a whole series of "productions". The fact that worldwide transport supply and/or transport capacity often represents a much smaller expansion could be considered a benefactor, at least those who are convinced that our planet has only a limited capacity in all that.

The fact that public authorities are no longer able to take the lead in the necessary development of transport infrastructure in most countries is a serious drawback to achieving future sustainability. Although transport remains a serious source of income for the public administration, public financing of basic transport infrastructure is no longer part of the government's primary task. This will jeopardize the necessary future extensions of transport supply in terms of infrastructure. Public financing of transport services therefore needs a revival in both concept and action.

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Part II: THEORY

Chapter 4. Economic theory of road pricing – an introduction
E.T. VERHOEF

Chapter 5. Review of policy instruments: beyond price instruments
S. PROOST AND B. DE BORGER

Chapter 6. Challenge for the near future. instruments for a climate friendly use of road infrastructure
C. MACHARIS, N. BRUSSELAERS AND K. MOMMENS

4 The economics of “road pricing”

E. T. VERHOEF [1]

Abstract

This Chapter focuses on the question why, from the perspective of economic theory, road pricing is the appropriate tool for achieving the optimum use of road infrastructure. This is first set out for an “ideal” world, i.e. a world in which all road users would agree to the introduction of this instrument. Then it is explained that such is not the case in the real world, where there is often social and political resistance to road pricing. Finally, it is shown that, under such circumstances, less strict versions of the principle of road pricing can be followed, leading to what are usually called *second-best* solutions to the problem of optimum use.

1 Introduction

In 1920 Arthur Pigou put down his theory of "road congestion pricing” and explained why, from the perspective of economics, this is such a logical policy. That he was a visionary, can already be seen from the fact that at that time traffic congestion had by no means reached the scale and urgency that it has in present-day cities - worldwide. It has been reported that the biggest challenge in urban transport policy at the time was the question of what to do with the huge stocks of horse manure if mobility continued to grow as feared. In the meantime, this problem has solved itself, but traffic congestion is high on the urgency list in most major cities. Pigou’s explanation is equally applicable to other “external costs” of mobility, such as damage from emissions, risks in traffic safety as well as noise nuisance. This makes the theory all the more relevant for current traffic and transport policy.

What Pigou has shown is that where markets are missing, prices no longer provide incentives to limit consumption. Over-consumption is lurking due to unpriced scarcity. We see this reflected in excessive congestion and emissions in road traffic in and around contemporary cities. Pigou's remedy was as simple as it was ingenious: enter a price - a “toll” or in modern terminology and technology: a kilometre price - which after all charges the originator for the unpriced scarcity. Then, the optimum as we know it from economic textbooks still comes into the picture.

Although Pigou’s analysis of the problem covered no more than one paragraph, it has had enormous follow-up literature. It is impossible to do full justice to this within the limits of an introductory Chapter like the present one. This Chapter will, therefore, be confined to a number of important insights from this literature that have two things in common: they made an essential contribution to transport economics, and they have direct and important implications for government policy.
The structure of this Chapter is as follows. In the next section, Section 2, Pigou's basic economic analysis of external effects in road traffic is discussed and it is explained why it is so obvious from the

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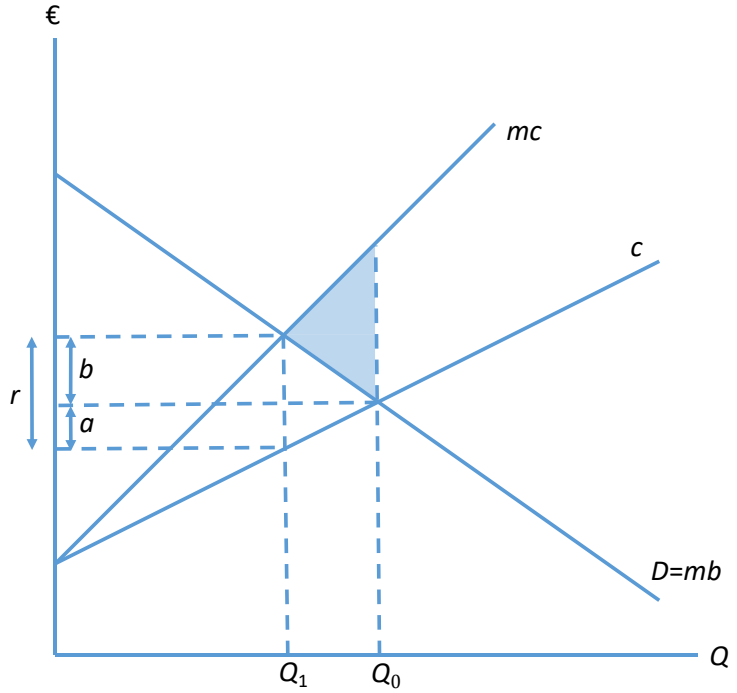
point of view of economics to address these externalities through regulatory levies. It will further be discussed why social acceptance of this type of policy is so low. In addition, in Section 3, it will be seen that a smart design of dynamic charges, according to principles set out by Vickrey (1969), could increase social acceptance of pricing policy. Following this, in Section 4, it will be discussed how this pricing policy relates to a supply-oriented policy, in particular the one that offers extra road capacity in response to increasing congestion. Central to this section is the contribution by Mohring and Harwitz (1962), who ingeniously demonstrated that the yields of optimal congestion charges under certain technical conditions are just enough to finance the supply of optimum road capacity. Then, in Section 5, the "textbook world" is left behind and it is set out how all kinds of restrictions ensure that the "first-best" policy discussed above is not feasible in reality, and what lessons can be learned from the now extensive literature on more realistic "second-best" policies. Finally, in Section 6, a number of possible second-best instruments are discussed from a practical point of view, focusing on instruments designed to bridge the resistance to traditional pricing policies by providing incentives as rewards ("Spitsmijden", or: "Avoiding the peak") or as a budget-neutral mix of rewarding and pricing (tradable mobility rights).

2 The basics – back to Pigou (1920)

Although textbooks sometimes suggest otherwise, in his 1920 book, Pigou never drew the standard graphic exhibition of road pricing. However, the standard diagram summarizes his theory very well, and it will therefore be used for the present discussion as shown in Figure 1.

FIGURE 1 Optimal road pricing



Along the horizontal axis, the level of road use, *Q*, is displayed; the vertical axis represents costs, benefits and prices. The falling inverse demand function *D* gives the number of road users (horizontally) for each price (vertically) and is therefore equal to the marginal benefit function *mb*: only users who attribute benefits to their mobility that are at least equal to the price will use the road. The relevant "price" also takes the value of travel time into account.

Congestion increases this price with road use, as shown by the rising function *c*. It is found by multiplying average travel time by the value of time resulting in average costs *c*. Without further

policy, equilibrium Q_0 comes into being, where the benefits that the last added traveller attributes to making the trip are high enough to find costs *c* just acceptable to him.

It was Pigou's insight that the rising *c* line indicates that marginal costs *mc* are above average costs *c*, and that the difference between these two is given by marginal external costs: the costs that one road user - due to his or her effect on travel time - causes to all other road users.

Because of the difference between *c* and *mc*, equilibrium Q_0 is not the efficient level, where social surplus - or total benefits minus total costs - is maximized. The latter requires an equality of *mb* and *mc* and is therefore at Q_1.

If road use could be reduced from Q_0 to Q_1, costs would decrease with the area under *mc*, and benefits with the area below *mb*. The positive difference between the two is the welfare gain, expressed as an increase in the social surplus as given by the shaded triangle.

Pigou also showed how to achieve the optimum. By introducing a toll *r* equal to marginal external costs in the optimum, i.e. the difference between *mc* and *c*, road users between Q_1 and Q_0 will no longer want to go on the road, and the optimum is achieved. This is Pigou's contribution in a nutshell. The theory can also be used for the analysis of other external costs, and is an important pillar of economics, particularly in environmental economics - where, naturally, the relevant external costs usually consist of various forms of non-priced environmental pollution.

There are at least two important reasons why economists find pricing policy such an attractive option for the reducing of external costs, in addition to what is immediately visible in Figure 1, i.e. that the optimum volume of the external effect is achieved.

The first of these is that the levy ensures that sacrificed consumption concerns those units that represent the lowest benefits. These are, in the Figure, those trips that are located between Q_1 and Q_0. This effect makes the instrument inherently more efficient than non-price solutions. An example of the latter is the number plate policy as pursued in Athens. A certain fraction of motorists are denied access to the road on certain days by rotation. In principle, it would be possible with this policy to achieve, in the world of Figure 1, a total use of Q_1 every day. The government, then, could conclude that the optimum has been achieved but that would be a serious miscalculation. It ignores that the lost benefits are higher than under pricing, because all values of *mb*, between 0 and Q_0, are lost on some days. In addition, lower congestion would actually attract trips with even lower benefits to the right of Q_0. On balance, the overall net welfare effect could even be negative, depending on how demand and cost curves run.

The second reason for finding "pricing" an attractive policy for the reduction of external costs is that, in reality, multiple behavioural margins are relevant when adjusting behaviour in order to obtain a reduction in external costs. For example, drivers could adjust their choice of travel moment, residential location, work location, mode of transport, route, vehicle type, driving style - and no doubt, there are more options. The price instrument gives the road user the incentive to choose from such a menu of options those that cause him or her least trouble. This also translates into minimal social costs to achieve a certain decrease in external costs.

Both reasons remain somewhat underexposed in policy discussions, partly because they are not visible in the often-used network models. That, however, does not make them any less important.

With so many economic arguments in favour of using the price instrument, one would expect it to be widely used - worldwide. There is nothing less true. The actual applications of congestion charges that are in accordance with economic theory only consist of a very limited number of - well-known - examples. Among these, Singapore is historically important as the first large-scale application. London and Stockholm are the well-known examples in Europe. There have been many examples of preparations for implementation that died prematurely. The Netherlands probably take the lead here,

with a rich history of failed plans that came and went, in particular in the '90s and '00s: "Tolpleinen", "Spitsvignetten", "Tolpoorten", "Mobimiles", "Anders Betalen voor Mobiliteit"… it is a rich arsenal.[6] Nevertheless, the Netherlands is not alone in this failure to implement: road pricing has also experienced considerable political and social resistance elsewhere. Figure 1 in fact shows why: without a return in toll revenues, the generalized price – i.e. price including both all internal and all external costs - rises: charge *r* is higher than the decrease in costs *a*. Therefore, the net result *b* is negative. This is independent of the exact drawing of the curves. The situation always occurs when moving to the left along a demand line. The result is that people between 0 and Q_1 will not easily support the proposal, because they see the price rise, while people between Q_1 and Q_0 will not be enthusiastic because they have to find an alternative to the behaviour they had before. Of course, the world is not as simple as in Figure 1: if there are differences in time valuation, for example, there may be high-value-of-time people who can benefit from road pricing even before they receive any revenues that are returned to road users (Arnott *et al*., 1994). Distributional effects then come into the picture (Mayeres and Proost, 1991). The essence of the problem will remain unchanged, however, for a substantial proportion of road users, even if heterogeneity of travellers is allowed for.

3 Optimal dynamic tolls according to Vickrey (1969)

Interestingly enough, an important part of the price increase discussed above can be prevented if road pricing is used dynamically, at bottlenecks where otherwise traffic jams occur. Nobel Prize winner William Vickrey (1969) was the first to show this, in the now widely used "bottleneck model", in which departure time choice has been added as an essential margin of behaviour for peak travel. Arnott *et al*. **Fout! Bladwijzer niet gedefinieerd.** (1993a,b) have brought this model back to the attention of economists. Briefly, traffic jams arise in the model as an equilibrium-restoring mechanism, in which the sum of waiting time costs at a bottleneck and so-called schedule delay costs - the costs involved in not arriving at the most desired moment - remains constant over time. This creates a dynamic equilibrium: it pays for no one to unilaterally change departure time from home. During rush hour, the traffic jam first grows, because the flow with which vehicles arrive at the tail of the traffic jam is larger than the flow out of the bottleneck – that equals its capacity. In the second part of the rush hour, the inflow at the tail of the queue drops below capacity, and the queue, therefore, over time becomes shorter, whereas as the outflow from the bottleneck remains equal to its capacity as long as there is a queue. A dynamic toll changes the dynamic departure times from home, making it constant over time and equal to capacity throughout the peak, while times of arrival at work do not change as long as the bottleneck is at its maximum capacity. The optimum dynamic toll exactly replaces the travel time costs from the unpriced balance, and the generalized price does not increase (Arnott *et al.*, 1993a,b). The model is applicable to traffic jams at bottlenecks and removes two common objections to congestion charges.

A first objection is that commuters are not flexible, because at some point in time they simply have to be at work However, the arrival times in the optimum of the model are the same as in the non-priced equilibrium: it is only departure times from home that change.

The second argument is that pricing policy makes no sense because alternative transport is not attractive enough for dedicated car drivers. In the model, however, traffic jams are removed by prices without changing the total road use over the entire peak. This, combined with the aforementioned characteristic that the price in the optimum does not rise relative to the unpriced equilibrium, makes it very attractive to opt for dynamic pricing at bottlenecks when introducing road pricing policies.

The particular set of ends for which revenues will be used all the same remains an important instrument for increasing the acceptance of road pricing (Small, 1992). It goes without saying that types of use that are closer to the interests of those who pay the levy will increase their acceptance. In

[6] "Toll plazas", "Peak vignettes", "Toll gates", "Mobimiles", "Paying differently for Mobility"…

1997 already, this was confirmed in a survey among peak travellers in the Western, densely populated part of the Netherlands (the "Randstad"; Verhoef *et al.*, 1997a).

Replacing existing fixed vehicle taxes - such as the annual motor vehicle tax or the purchase tax for new vehicles - by variable road pricing is a good example of this. So is the use of revenues for financing infrastructure.

4 Road pricing or capacity expansion?

In the social and political debate about congestion charges, it often seems as if only two tastes are conceivable: either one is in favour of road pricing and sees nothing in further construction or widening of roads, or vice versa. From an economic point of view, the contradiction suggested is rather absurd: after all, it is wise to optimize capacity and prices in mutual cohesion. The two instruments are complementary, not substitutes. That insight was formally elaborated already in the early 1960s, by Mohring and Harwitz (1962). These authors came to a conclusion equally fascinating and important: if certain technical conditions are met, the revenues from optimal congestion charges are just enough to cover the costs of financing the optimum supply of infrastructure. Subsequent contributions have shown that the theorem remains intact when the setting is broadened (Small *et al*., 2007, provide an overview): for networks as well as for a single road; with dynamic instead of static congestion; for heterogeneous road users; if we take into account growing demand over the years; if we consider wear and tear; and also if not only width but also thickness (so: "wear resistance") of the road surface can be chosen.[7]

The aforementioned technical conditions include, among other things, that there are neutral scale effects in road construction and congestion technology: to handle a flow of vehicles twice as large at the same speed, road capacity twice as expensive is required. In addition, we will have to be able to treat road capacity as a continuous variable, for (mathematical) derivation. Although these assumptions will not be met literally and precisely, on average they seem to be close enough to reality over a network, to allow the theorem to be more than a theoretical curio (Krauss; 1981; Small *et al*., 2007). It opens the way to self-financing road infrastructure in the long run. Efficient, because the result comes from optimization of tolls and road capacity; transparent because it is clear what toll revenues are used for; and fair to the extent that it is considered fair that users ultimately pay for the costs of road construction, but also pay no more than these costs. Certainly where acceptance of a pricing policy depends on what happens to tax revenues, all this makes the application of the theorem an attractive avenue. revenues, all this makes the application of the theorem an attractive avenue.

The theorem is sometimes misinterpreted, and a warning seems appropriate. The fact that toll revenues cover capital costs definitely does not mean that all toll revenues should be converted into new investments. Capital costs include interest foregone due to previous investment. The confusion referred to would lead to large-scale over-investment in road infrastructure. Secondly, where kilometre prices would also have an environmental component, the revenue from that tax component has no relationship with the investment budgets. The theorem is purely about the congestion component in the charges.

[7] See, among others, Newberry (1989); Arnott and Krauss (1998); Berechman and Pines (1991); and Small (1999).

5 Second-best tolls

What the above explanations have in common is that they are based on "first-best" analyses. That means that there are two important underlying assumptions. The first of these is, that there are no restrictions on the policy instruments. For example, in Vickrey's analysis, the charge may vary continuously over time. Or, if that would be necessary because different types of road users cause different marginal external costs, the charge can be perfectly differentiated between road users. Also, for a given road user, prices can be varied perfectly over time and place of road use, and even driving style. This assumption will not be met in practice. Even if it were technically possible, it would encounter problems of ability to explain, feasibility, measurability, and privacy.

The second assumption is, if possible, even more unrealistic. Apart from the marginal external costs one wants to internalize through the levy, there is no relevant market failure in any market directly or indirectly connected to the market under consideration (for example, the market in Figure 1). That is not the case in any economy. To give an example: morning and evening rush hour congestion is strongly linked to commuter traffic, while the labour markets that give rise to that traffic do not work efficiently - if only because of the income tax. The latter, in the Netherlands for example, creates a wedge of up to 52% between net and gross wages. Another example is that a close substitute for road traffic is public transport, where pricing is not efficient, and rates do not generally reflect marginal costs. Also: road freight traffic often concerns goods that themselves are traded in inefficient markets, and for which, for example, marginal environmental costs in production are not reflected in prices.

In such cases, the most efficient choice for the level of the charge is no longer to equate it with marginal external costs. A classic example of this (Lévy-Lambert, 1968; Verhoef *et al*., 1996; Braid, 1996) concerns the pay-lane, i.e. the case of a few lanes on a highway where a charge applies, in addition to unpriced lanes. When applied, it is often motivated by considerations of acceptance: to many people, the availability of a toll-free alternative makes the introduction of a toll more acceptable. Because the charge then leads to a shift of traffic to the non-priced lanes, where congestion will increase, it is efficient to set the charge lower than the marginal external costs on the pay-lane. This partially avoids the negative side-effect on the untolled lanes.

Also, in second-best situations, the use of tax revenues becomes more than "just" a means to increase acceptance. For example, Parry and Bento (2001) show that where a congestion charge is introduced for commuter traffic that is already economically distorted due to a labour tax, final welfare gains can be twice as high if proceeds are used to lower the labour tax. These gains may actually disappear, or even become negative, when "lump-sum" recycling of revenues is used, that discourages labour supply. These examples show that for adequate policy advice on road pricing policy, thorough modelling work is often required, which usually also requires looking beyond effects within transport markets.

6 Positive and budget-neutral price incentives

A special form of second-best price incentives, that has already been used several times in the Netherlands, concerns rewards for avoiding the rush hour. Experience has been gained with this in various "Spitsmijden" experiments (see, for example, Knockaert *et al*., 2012), both in road traffic and in public transport. Although the experiments differ in their design, they have a number of characteristics in common: there is automatic detection of mobility behaviour, for example via license plate recognition or via an app; participation is voluntary; and for avoiding the rush hour, rewards are awarded that usually are in the range of € 2 - € 5. The behavioural effects are usually considerable and can amount to a halving of the number of rush-hour trips by the participants. It is important to bear in mind that there is strong self-selection, because of voluntary participation: flexible travellers in particular expect to be rewarded relatively often and will therefore be more inclined to participate.

The big advantage of such reward arrangements is that acceptance among travellers often is not a problem. This, of course, is related to the fact that being rewarded is more pleasant than having to pay, and that, as already mentioned, participation is voluntary. Rewarding, however, also has its shadow sides. A practical drawback is that budgets are generally finite, so that this type of project can only be carried out temporarily and on a limited spatial scale. Roadworks are a good example.
An economic objection is that introducing a reward where there is market failure that, bearing in mind Figure 1, actually requires a levy, leads to distortions. Specifically, rewarding could induce latent demand: on balance, the road system becomes cheaper rather than more expensive, and this attracts extra traffic, certainly in the longer term - just as usually seen in response to road widening.
We therefore have, on the one hand, the theoretically optimum pricing instrument which, however, has major acceptance problems, and, on the other the more acceptable rewarding instrument that is, however, applicable only to a limited extent, due to the finiteness of rewarding budgets. The question then arises whether it is not possible to envisage a budget-neutral intermediate variant that combines the best of both worlds. Such an instrument would be a system of tradable mobility rights (Verhoef *et al*., 1997b). For regulating rush hour traffic, this could take the form of tradable peak permits Road users are then given a limited number of peak permits that are used when they are driving during the rush hour. If they succeed in avoiding peak traffic more often than necessary, given the number of permits they have received, they can sell permits and will thus be rewarded on balance. If avoiding the peak is not possible, they will have to buy extra permits, but pay less than with a traditional toll, because they do not have to pay for the days for which they had received permits. Similar systems of tradable permits can be used, for example, to allocate scarce parking space, or - via so-called "Tradable Green Days" - to encourage greener mobility behaviour within companies. A first lab experiment showed that such a system is technically implementable and is indeed understood and used by participants as intended in theory (Brands *et al*., 2019).

7 Conclusion

The economic theory behind the use of price incentives for regulating road traffic is strong and now a century old. The same theory can very well explain why social and political resistance to it is so strong. Advantage can be taken of this in policy-making - among other things when designing the price incentive itself, when designing forms of use of tax revenue, or when designing budget-neutral price instruments. With the predicted increase in congestion in the real world, the subject remains prominently on the political agenda. The question that can only be answered with a crystal ball is whether, and in what form, in practice this will lead to the introduction of the principles outlined. For the time being, Belgium seems to be well on track, and The Netherlands seems to be cautiously thinking of new experiments (see further Chapters 7 and 8 in this volume, *Road Pricing in Belgium* and *idem in The Netherlands* respectively). However, all this may have changed again already in the brief time between this contribution, and the day this book appeared in print.

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5 Review of policy instruments: beyond price instruments

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Abstract

Road traffic creates various types of externalities, including congestion, noise, local air pollution, accidents, and climate change. To control externalities, economists have mainly been focusing on the use of pricing instruments. In practice, however, pricing has not often been used. Instead, quite different types of policy instruments have been implemented including Low Emission Zones, speed bumps, traffic lights, pedestrian bridges, and restricted access for through traffic and trucks. In this Chapter, we explain why local governments using non-price measures will often make decisions that are inefficient. We further explain the inefficiencies arising from the conflict between central and local governments when local governments use non-price measures and the central government introduces road pricing on main roads. This is not implausible in the future: the development of cheap ANPR cameras could both lead to road pricing developments and generalized implementation of restricted access zones. We review the problems that follow from the use of both pricing and non-pricing instruments. The use of non-price instruments to regulate traffic has received relatively less attention from economists, although instruments like road bumps, traffic lights, pedestrian overpasses, and access restrictions for non-locals are heavily used as a policy instrument. These instruments may become even more important when road pricing is introduced on the main roads.

1 Introduction

Economists love pricing solutions to address the external costs of road transport (congestion, air pollution, accidents, and noise). Pricing is efficient when prices are well-targeted to external costs and managed with care. Of course, we have pricing instruments in place: high fuel excises, purchase and ownership taxes differentiated by the level of emission and fuel type, parking levies, and experience-rated insurance charges. However, these instruments are not what economists dream about because they are not well targeted to the level of the external cost they try to deal with.

This raises the question why we do not have better price instruments. First, it is difficult to design pricing instruments closely reflecting marginal external costs when these are time-and-place-specific. A tailored approach is needed, but this requires detailed information on external cost variability, and it requires new pricing instruments that can capture this variation in time and space.
The appropriate instruments (electronic road pricing) exist, but it is well known that they have high implementation costs. Second, the implementation of road pricing proves to be politically difficult.

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For example, it has been argued that several types of uncertainty (on the effects of road pricing, on the use of the revenues) cause major obstacles to the introduction of road pricing (De Borger and Proost, 2012).
Another handicap of sophisticated pricing solutions is that conflicts between central and local governments may arise (De Borger and Proost, 2016).

On the one hand, it is difficult for a central government to impose locally differentiated fares and prices because this may easily lead to spatial favouritism. On the other hand, leaving pricing solutions to the local government level may give rise to exploitation of non-locals. It is possible to decentralize pricing decisions, but this requires complicated safeguards against the issues just mentioned.

The two implementation problems raised above made governments look for non-price instruments that can easily be locally differentiated according to local conditions. These include speed bumps, low emission zones, pedestrian overpasses, traffic lights and bypass roads. This is the main topic of this Chapter. In Section 1.1, we develop a taxonomy of such measures. We then argue that the use of these measures may lead to conflicts between different governments. In Section 1.2, we emphasize that central and local governments will make much different decisions on the use of non-pricing measures; in most cases, local government decisions will be inefficient. Section 1.3 looks at possible conflicts between local governments. In Section 1.4, we focus on the implications of the competition between the central and the local governments when local governments use non-price measures, and the central government introduces road pricing on main roads. The main conclusions from the Chapter are presented in Section 2.

1.1 A taxonomy of measures

To analyze the wide variety of measures, we need to classify their impacts, costs, and benefits. This is done in Table 1 (also see De Borger and Proost, 2013; 2018). The table starts with the traditional economists' solution to impose "tolls"; however, they are virtually non-existent in the Benelux. The other measures commonly used are non-price measures addressing a variety of external costs, ranging from noise (noise walls) to congestion (restricted entry and bypass capacity). Reducing external costs may involve a combination of a volume reduction, a change in vehicle use, and the use of restrictive or protective measures. To evaluate the efficiency of different measures - not allowing certain types of traffic (low emission zones, limited access), passing traffic along a different route (bypass capacity) or increasing generalized costs (speed restrictions, road bumps) - it needs to be known how these affect total traffic volume
Moreover, we need to have information on how much they reduce the external cost per kilometer and on the implementation cost. Some measures are very costly to implement but are very effective (pedestrian overpass), while other measures are less costly but still can have some desirable effect (changes in the control of traffic lights). All these characteristics are needed to make a formal cost-benefit analysis[8].

[8] The information needed to make cost-benefit evaluations of the use of different instruments can also help in monitoring the conflicts between governments studied further in this chapter.

TABLE 1 Taxonomy of policy measures that address external costs and benefits of traffic (Legend: 0= no (or negative) effect; +: positive effect)

Benefits of different measures	Reduces traffic volume in city	Speed reducing effect	Requires large public investment	Reduction of external cost per car kilometer	Impact on urban traffic by the local population
Tolls	+	0	0	+	+
Noise walls, investment in quiet asphalt	0	0	+	+	0
Speed restriction, increasing the red phase of traffic lights	+	+	0	+	+
New traffic lights, road bumps, etc.	+	+	+	0	+
Restricted entry	+	0	0		+
Emission standards for cars	+	0	0	+	+
Low emission zones	+	0	0	+	+
Bypass capacity	+	0	+	0	+

1.2 Conflicts between government levels

Consider a policy measure (placing speed bumps, traffic lights, etc.) implemented at the local level. The local level can be a large city, but also a small municipality. To evaluate the effects of this policy, the local governments will take into account the benefits for local traffic (more precisely, the benefits of the improvement in traffic conditions for the local population), as well as the costs for the local taxpayers. The central government should care about the costs and benefits of the policy measure for all traffic, local as well as non-local (through traffic from other communities). De Borger and Proost (2013, 2018) use this framework to show the origin of various conflicts between local and central governments. They offer a number of results that we briefly discuss.

Result 1. Compared to the federal social optimum, the local government over-invests in externality-reducing infrastructure whenever this infrastructure increases the generalized cost of through traffic. The local government invests optimally when policies do not affect generalized costs.

To illustrate what this result means, road traffic is focused on and a local road is considered that is also intensively used by through traffic. Then, the welfare implications of speed bumps and pedestrian overpasses compared, two types of measures that can be used to reduce transport externalities. Pedestrian overpasses will not affect the volume of car traffic. To evaluate this policy measure, the local government will compare traffic safety benefits with construction costs. As all safety benefits

accrue to the local population, and construction costs are captured by the local community, there is no systematic bias in the level of investment: the central government would make exactly the same comparison when evaluating the policy (there are neither benefits nor costs outside the local community).

However, next consider speed bumps. They will obstruct both local and through traffic, raising their generalized costs of using the road. As before, there are traffic safety benefits, in the form of lower accident risks for the pedestrians from the local community. The main difference with pedestrian bridges is that the local government will not care (or care less) about the increase in generalized costs for through traffic, and will, therefore, underestimate the full cost of the measure implemented. As a consequence, it will over-invest in speed bumps compared with what would be the best solution for the country as a whole (of course, the central government does take into account the effect on through traffic).

Result 2. Local governments will favor restricted access to local communities, even when this is socially undesirable.

The availability of cheap ANPR cameras allows restricting the use of a local road to the inhabitants or to visitors of the local community and keep through traffic out. This offers advantages for the local community. For example, on the local road, there will be less congestion, less noise, less pollution, and there may be fewer traffic accidents. Note that restricted access can also be specific for trucks only; this is already a widespread technique adopted to shield local communities from noise, vibrations, and congestion.

However, especially if this applies both to passenger cars and to trucks, restricted access for through traffic transport is not necessarily beneficial for the country as a whole. Through traffic that can no longer use the local road has to make a detour. If this traffic is diverted towards a heavily congested main road, the increase in generalized costs may be so large that, from a social perspective, the benefits do not compensate for these high costs. In that case, it would be better not to restrict access.

Given the advantages for local communities, restricted access techniques could become quite common throughout Flanders. Although in many cases this can be justified, our point is that not all such restrictions will be beneficial for the country as a whole.

Result 3. In a low emission zone, the urban government has incentives to impose too stringent standards and too high fees for non-compliance compared to the federal optimum.
Low emission zones (LEZ's) exist in several EU countries, including Belgium (Antwerp Brussels, Mechelen, Ghent, etc.). In addition, they have been studied for several Dutch cities.
As always, we need to compare the benefits and costs of the policy. The benefits of the LEZ are mainly local. It puts a restriction on the type of car that can be used, leading to higher costs for both inhabitants and outsiders. However, the extra costs for non-inhabitants are not taken into account by the urban government. This results in too severe standards and too high fees for non-compliance compared to what a central government would impose[9]. The reason is again that the central level would take into account the implications for non-inhabitants in their decisions.

Result 4. The city government will underinvest in bypass capacity.

A bypass around the city keeps through traffic away from the most vulnerable roads in the city center, where external costs are highest. A bypass allows faster traffic for both the inhabitants using the local road, and for through traffic using the bypass. In its investment decision, the local government will take into account the traffic benefits and external cost reductions for local users but will not consider

[9] A second reason for the local government's tendency towards high fees is that they serve as a transfer of income from non-inhabitants to inhabitants.

the benefits for through traffic. The central government would do so when considering welfare for all users. As a result, local governments will underinvest in bypass capacity.

1.3 Conflicts between local governments: the race to the top

The use of non-price traffic calming instruments by municipalities can also lead to conflicts between the different local governments. Consider two municipalities A and B that are located on a route between two important cities. The two cities generate a lot of bilateral traffic. This traffic can opt to take the route either via A or via B. It generates a lot of externalities in both the communities A and B.

Result 5. The non-cooperative game between two parallel communities leads to excessive use of instruments that increase the generalized costs for through traffic.

Municipality A would prefer that through traffic chooses the route via B, and it has instruments to achieve this. The obvious way is to install non-price measures – such as traffic lights and speed bumps - that increase the generalized cost of passing through A. This shifts through traffic to some extent to B. But, of course, B itself prefers that through traffic passes via A. It will act the same as A and start to use non-price measures to stimulate through traffic to go via A. This is a non-cooperative game between the communities; it leads to excessive use of the non-price measures to keep through traffic out of the own community (Proost and Westin, 2017).

Result 6. It is optimal to concentrate through traffic on only one of the two parallel roads.

As there are economies of scale in investing in non-price measures, the best solution is to equip only one of the two roads for through traffic, and direct all through traffic to pass via one of the two communities. For this solution to be acceptable for the community that receives all the through traffic, it needs to be compensated by the central government.

1.4 Road pricing on the main roads and local non-price measures

In this section, we discuss some results that arise when the central and the local governments both use different instruments on various parts of the network. This will become more relevant in the future when a move towards road pricing can be expected. However, it is unlikely that road pricing will immediately apply to the whole network. More plausibly, the central government may introduce tolls on the main roads, whereas local governments will implement traffic calming measures - such as speed bumps - on the local roads through their local communities.

More specifically, we consider the traffic problems of a small local town or community that is located parallel to a heavily congested main road, such as a motorway. A frequent problem in such situations is that traffic uses a local road through the community as an alternative for the congested motorway[10]. Of course, this generates accident risks and other inconveniences for the local population. Now suppose that the federal government can impose tolls on the main road[11]; the local government controls local accident risks and local congestion using non-price measures such as speed bumps, traffic lights, and formal access restrictions (i.e., restrictions on who is allowed to use the local road).

Result 7. For any given toll on the main road, the use of non-price measures by the local governments will be excessive.

[10] This is a well-studied second-best problem in the economics of transportation. See Small et al., 2007 (Ch 4.2).
[11] This is not unrealistic in the future. The technology to introduce road pricing is available. However, implementation is costly. Therefore, it is probably worthwhile to introduce it just on the main corridors or around the main agglomerations.

This is easy to explain. The users of the main road are tempted to divert towards the local road so as to avoid the congestion tolls[12]. However, this raises congestion on the local road and leads to higher accident risks for the local population. Therefore, local authorities will react and make the use of the local roads more difficult. This can be done, among others, by speed bumps and introducing traffic lights. This, in fact, raises generalized costs for all traffic through the local community, both local traffic and through traffic. More drastically, they can use number plate detection technologies to restrict access to local traffic and keep through traffic out. The higher the charges on the main road, the more traffic will divert to the local road, and the more stringent will be the local response. Importantly, however, the local government's use of non-price measures will be excessive (too many speed bumps, too many traffic lights, etc.) because it does not care for the implications of its policies on through traffic that no longer can pass through the local community.

Result 8. Competition between central and local governments will lead to tolls that are too high and too much traffic calming.

This result follows by extending the previous discussion. The use of tolls on the main road and traffic calming by the local government on the local road gives rise to a rat race. The toll leads to more speed bumps, but this obviously raises the generalized costs for through traffic. By strongly restricting through traffic from using the local road, traffic and therefore congestion on the main road increases, and this induces the central government to set higher tolls on the main road to reduce external congestion costs. The result of this competition is that we end up with tolls that exceed the social optimum and too excessive use of traffic calming measures by the local authorities.

Result 9. Given the use of traffic calming measures by local governments, it may be better not to impose tolls on the main road at all.

The rat race described above may lead to a very inefficient outcome with extremely high tolls on the main road and many obstacles of using the local road through the small town. In those cases, welfare may actually be higher if one only uses traffic calming on the local road and no tolls on the main road.

2 Conclusion

This Chapter has summarized the use of non-price instruments to regulate traffic. This has received relatively less attention from economists, although This has received relatively less attention from economists, although matters like speed bumps, traffic lights, pedestrian overpasses and access restrictions for non-local residents are heavily used as policy tools.
Such tools may become even more important when road pricing is introduced on the main roads. All non-price instruments that also affect non-local traffic users will tend to be used too intensively by local authorities. This is one of the main economic reasons why many countries have a hierarchy of roads. Local governments cannot take policy measures on roads of national importance as these policy measures may be suboptimal. On the other hand, national policy makers may be poorly informed about local traffic problems created by national roads. Finding the right division of power between local and national levels of policy-making remains a tricky question.

[12] This was already a problem when distance charging for trucks was introduced in Belgium. Distance charges were only to be paid on the main roads to limit the monitoring and collection costs. The idea was that traffic conditions on the main roads were so much better than on local roads that trucks would only use the local roads when they had to be there. This proved not to be correct as truck traffic massively switched towards using local roads to avoid the charges.

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6 Challenge for the near future: Instruments for a climate friendly use of road infrastructure

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Abstract

While transport is inevitable in our economy and daily lives, it also engenders many negative effects - on the economy, society, and environment. Though a large share of the external costs associated with climate change is attributable to transport, this is only partly carried by it. The transport sector still lags behind with regard to emitted greenhouse gases and faces difficulties in achieving the emission reduction goals. In line with the 'polluter pays' principle, an instrument for internalizing the external costs of transport is a road pricing scheme. Not only would it stimulate the use of more environmentally friendly vehicles, this concept could also prove its use in pursuing a level playing field across different transport modes. Implementation of a pricing system should be well thought of, as perverse effects can easily arise. Road pricing will also incentivize the switch to zero-emission vehicles. A pricing scheme should be implemented coherently on a European level to avoid additional kilometres due to detour and related externalities.

1 Introduction

While transport is of great importance in our daily lives and economic system, it also creates negative effects, like climate change, local emissions, congestion, and accidents. All these come with a cost for society, i.e. for the economy, and environment. Climate change and its effects have recently been put high on the public and political agenda in many European countries, in view of the impact that greenhouse gas emissions have and will have (European Environment Agency, 2016; ECA, 2018; Intergovernmental Panel on Climate Change, 2018). In Belgium, as in several other EU member states, many bottom-up actions such as Youth for Climate are organized to increase awareness on climate change and to urge governments to take adequate actions to limit the global warming. Figure 1 shows the evolution of global temperature and rising CO2 levels the world over between 1959 and 2016 (WEF, 2018), and highlights the clear correlation between the two. If the current rate persists, the probability for global warming to reach the 1.5°C threshold - i.e. global warming of 1.5 °C above pre-industrial levels - between 2030 and 2052 is extremely high (Intergovernmental Panel on Climate Change, 2018).
To avoid, reduce, and delay greenhouse gas emission levels, recent policies focus on mitigating actions.

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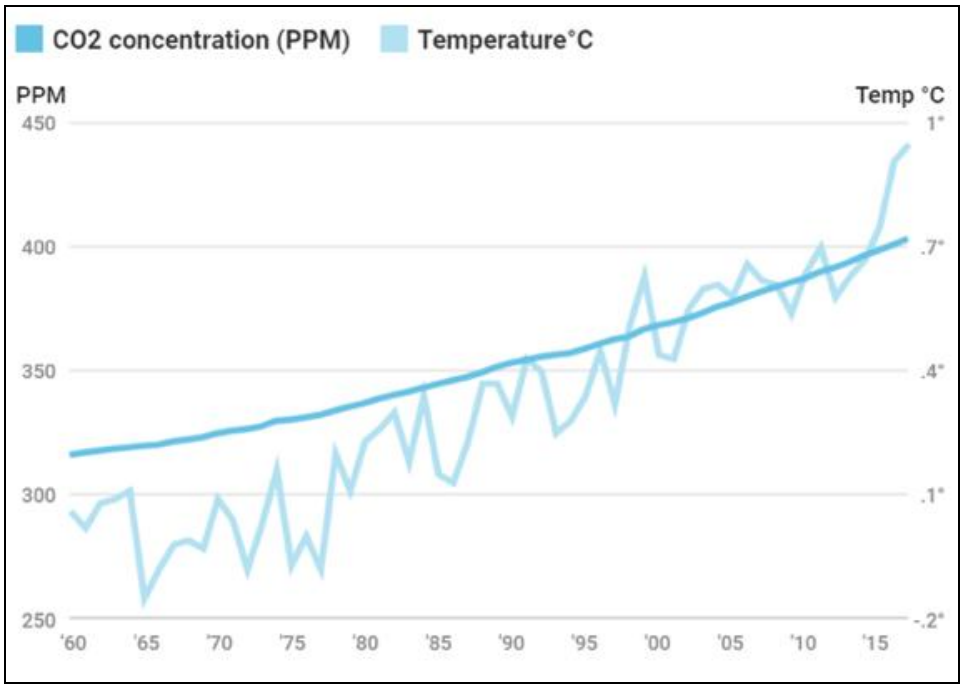
Indeed, the European Commission (2018) envisions net-zero greenhouse gas emissions by 2050, coherent with the global temperature objective of maximum 2°C (in comparison with pre-industrial levels).Although mitigating actions are necessary to reach the targets put forward, these need to be complemented with adaptive actions to constrain the damages caused by inevitable impacts of climate change (NCC, 2016).

FIGURE 1 Annual global temperature and CO_2 levels between 1959 and 2016 (WEF, 2018)



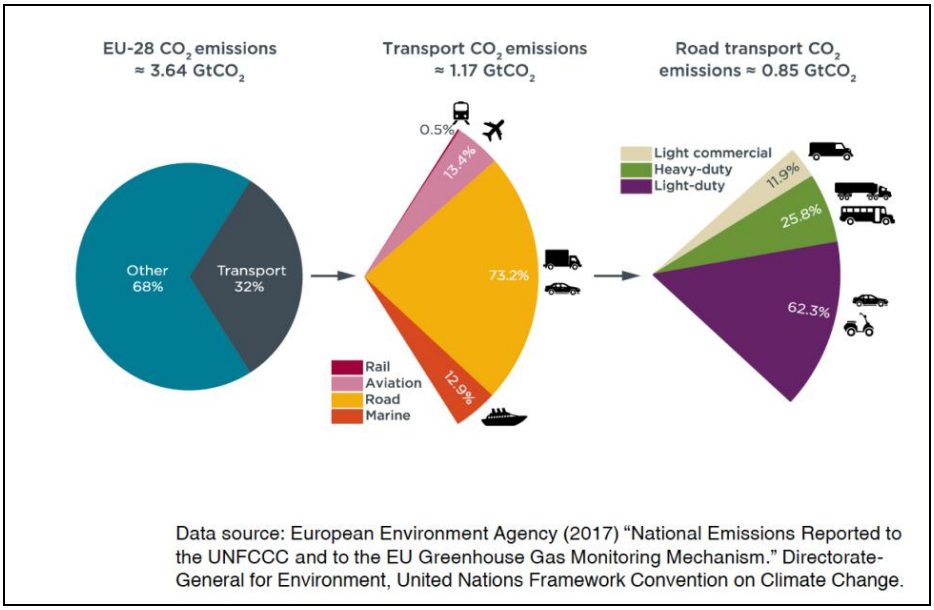
Next to climate change, the impact of the transport sector on air quality is also very worrisome. World Health Organization standards on air quality are far from being met, especially when zooming in on busy roads. Known as PM (Particulate Matter), O_3 (Ozone), and NO_x (Nitric Oxide), the local effects of air pollution on human health are responsible for approximately 555,000 premature deaths in Europe annually (European Environment Agency, 2016; ECA, 2018). A large share of these emissions is attributable to freight transport. While only representing 14% of total traffic in the Brussels Capital Region, freight transport is responsible for 33% of traffic related PM emissions (Lebeau and Macharis, 2014).

Next to these global and local emissions effects, also accidents, congestion, and up-and downstream processes have an important negative impact on society. The associated costs - for the greater part – are not reflected in the price of transport activities. I.e., they are not borne by those who have caused them. These costs - commonly referred to as “externalities” - are equivalent to changes in welfare (about externalities, see further 3.2. below; see also Chapters 1, 3 and 4 in this book).
Next, the following will be explained: (1) the challenge to reduce the greenhouse gases for the transport sector, (2) the theoretical background on how to monetarize external costs (in other words, how to assign a money value to them), and then (3) show how a policy oriented towards the internalization of external costs could look like by the means of a road pricing scheme.

2 External effects

2.1 Climate change in numbers

FIGURE 2 Distribution of total direct CO_2-emissions (ETS & non-ETS sectors combined) in the EU, 2015 (European Environment Agency, 2017)

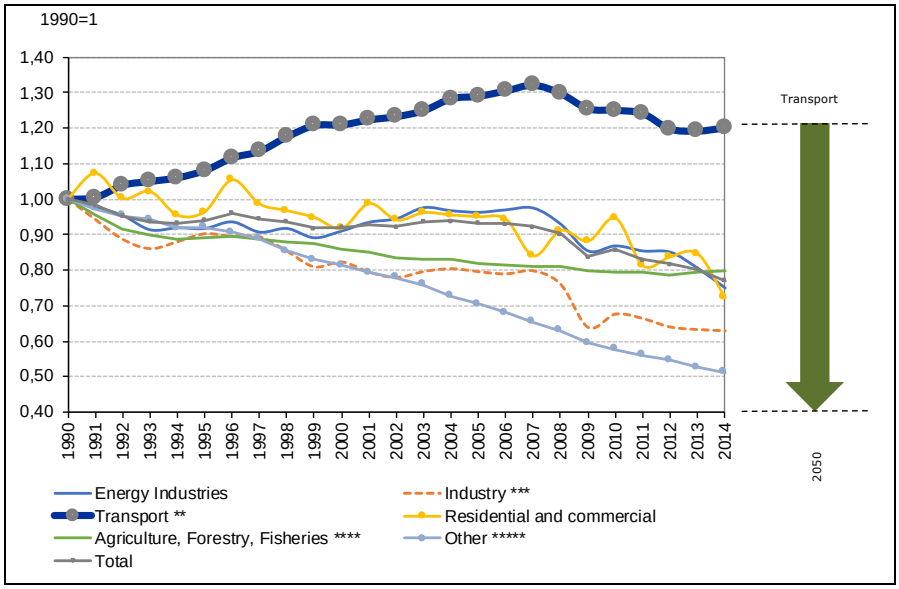


ETS/non-ETS sectors: sectors of the economy to which the EU Emissions Trading System applies either or not.[13]

As may be seen in FIGURE 2**,** transport accounts for 32% of total direct CO_2 emissions (both ETS and non-ETS sectors) in the European Union (EC, 2015). What is striking, however, is that the European transport sector is the only sector that did not manage to lower its CO_2 emissions as compared to 1990 levels (EC, 2016; European Environment Agency, 2016).

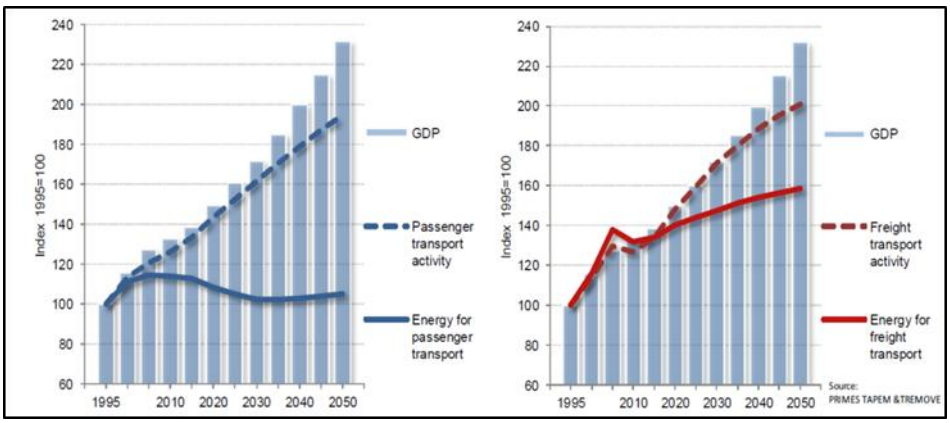
[13] The EU Emissions Trading System (EU ETS) is a 'cap-and-trade' mechanism to achieve emission reductions by putting in place incentives. Sectors covered are mainly civil aviation, energy sector and energy-intensive industry sectors (such as oil refineries and steel works). ETS-sectors account for approximately 40% of the EU's GHG emissions (EC, 2015; 2017). The non-ETS sectors mainly include transport, buildings, agricultural sector, waste and non-ETS industry, and cover around 60% of the EU's total domestic emissions (EC, 2018). By 2020, the non-ETS sector should have lowered its emissions by 15% and in 2030 by 35% CO_2 compared to the reference year of 2005.

FIGURE 3 CO_2 emissions, EU, by economic sector, 1990-2014 (European Commission, 2017b; European Environment Agency, 2016)



It is also important to stress the non-declining trend of the share of the transport sector as a whole and its associated emitted greenhouse gases in Flanders (MIRA, 2018). This is due to the increased demand for transport (both passenger and freight), influenced by trends of globalization, e-commerce, further economic and population growth, and the like. The technological advances could not alter this trend. This growth in demand is expected to continue (see Figure 4).

FIGURE 4 Growth figures for the EU (European Commission, 2016)



The Federal Planning Agency of Belgium and the Federal Public Service for Mobility and Transport of Belgium prepared long-term forecasts for transport demand in Belgium. Over the period 2012-2030, the FPB estimates that the demand for passenger transport trips would increase by 10% or an average annual growth of 0.5%. The number of passenger-kilometres would increase by 11% between 2012 and 2030, or on average, a 0.6% yearly growth. For freight transport, the number of tonne-kilometres for road, rail, and inland waterways would increase from 65.4 billion in 2012 to 94.5 billion in 2030. This equals an increase of 45% (an annual growth rate of 2.1%). For the modal distribution of the freight transport tonne-kilometres in Belgium, road transport remains the dominant mode. By 2030 (with reference year 2012), the total number of vehicle-kilometres (both freight and passenger) on Belgian roads is expected to increase by 22%. This increase is greater for freight

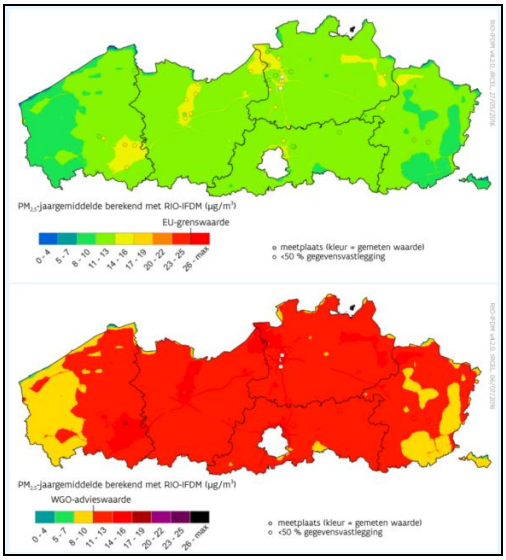
transport (30% for trucks and 43% for vans) than for cars (19%) (Federaal Planbureau, 2015). In their more recent calculations, the forecast has been adjusted to a growth of still 25% between 2015 and 2040 (Federaal Planbureau, 2019).
It is clear from this overview that a huge challenge is being faced, and that the implementation of multiple measures will be necessary to reach the CO_2 reduction goals. Road pricing (kilometre charging) can be one of the instruments.

2.2 Evolution of local emission levels (air pollution)

Reports highlight the importance of the transport sector (both passenger and freight) for a number of air pollutants in Flanders. The most striking is that 55% of all NO_x emissions find their origin in transport (2014). The majority is attributable to road transport (both passenger and freight), and its relative share systematically stagnates (or even increases).

The main causes of worsening air pollution levels are the inefficient use of energy and the strong reliance on fossil fuels. The WHO attributed 3.7 million deaths to outdoor air pollution in 2012 (for people younger than 60), and states that air pollution (indoor and outdoor) is the major threat to human health globally (mainly due to high PM concentrations) (2014).

FIGURE 5 Spatial spread of $PM_{2.5}$ average annual concentration at (1) Upper EU Limit Value and (2) Lower WHO Advisory Value for Flanders in 2015 (IRCEL, 2017; MIRA, 2017; Emissie Inventaris Lucht, 2016a, 2016b)



The first graph in Figure 6 has been rendered, taking account of the EU-limit for $PM_{2.5}$ and shows that this limit was not exceeded in any part of Flanders in 2015. Using the moderately stricter WHO advisory value, the second graph reveals that a large part of Flanders' citizens is exposed to exceeding concentrations (94% population density) (MIRA, 2017). This was further confirmed by local measurements held in the CurieuzeNeuzen citizen science project, during which data from 20,000 citizens were used to build a detailed air quality map of Flanders (CurieuzeNeuzen, 2018).

3 The internalization of external costs

Externalities arise when the associated costs of nuisances are not carried by the causer, as these changes in wealth are not included in the prices of transport activities. Hence, the impact of air pollution on human health is generally not included in the price of the vehicle use (Weinreich *et al.*, 2000). Highlighting the important concepts of external cost calculation, this part will focus specifically on climate change and air pollution for road transport (Macharis and van Lier, 2017).

Societal welfare principles aim to oversee that prices include the total cost of an activity, hence incorporating the cost of the caused nuisances. After estimating and monetizing socio-environmental damages, external costs can be internalized by implementing economic instruments such as road pricing.

3.1 External costs: a theoretical overview

An economic exchange can cause additional consequences to a third party. This is referred to as an externality (or transaction spillover) and is defined as a cost or benefit incurred by a party who did not agree to the action causing the cost or benefit, and this cost or benefit is not reflected in the price of the good or service (Laffont, 2008, Macharis and van Lier, 2017).

As explained in more detail in Part II: Theory (Chapter 4), in classical economics, under theoretical conditions, the competitive price mechanism leads to a Pareto optimal allocation of resources. Welfare economics, however, has shown that these externalities lead to a non-optimal situation, hence causing a market failure because the market price does not equal the societal price (Schmidtchen *et al.*, 2009). Applied to the transport industry, the many nuisances caused by transport activities (negative externalities) to society are generally not reflected in the market price of these activities. Market driven approaches aim to recover the market/social equilibrium by internalizing external costs.

3.2 Environmental damage costs generated by road transport

When determining external costs, one needs to first measure the effects of the associated externalities, and then, correctly monetize these effects. This can be done in a straightforward way for marketed goods and services by means of willingness to pay (WTP). However, this is rarely the case for non-marketed goods and services, where some welfare components are not reflected in their market price (such as the impact of air pollution on human health due to freight transport activities) (Bickel *et al.*, 2005). These welfare changes (referred to as the total economic value of the change) can be monetized by means of non-market valuation techniques.

Over the course of the past decades, extensive literature can be found on valuation techniques. Two major concepts are emphasized (Pearce and Howarth, 2000): revealed preference techniques (preferences based on actual, observed, market-based information) and stated preference techniques (a more generic term to include contingent valuation and choice experiments).

Transport brings along many kinds of negative externalities. The best known are climate change and air pollution (consequences of emissions), accidents noise, soil contamination, interference in the ecological system, damage to infrastructure, visual nuisance, and congestion (van Lier *et al.*, 2017). The European Commission estimates the total size of external costs for transport in the EU at around 1,000 billion euro annually, or, as a size estimation, approximately 7% of the EU28 GDP (EC, 2018).

This Chapter focusses on the consequences of emissions, namely climate change and air pollution. Climate change and the impact of air pollution are parts of the environmental damage costs and are highly dependent on the energy use of transport modes. Some emissions/pollutants are evaluated more expensive than others, given their different impact on human health and the environment.

3.3 Climate change (global emissions)

Nowadays, global greenhouse gas and its impact on climate change are major topics of research output, which continuously improves economic impact assessment models. A major aspect of the calculation of the external cost of climate change is the realistic evaluation of the carbon price (Ricardo-AEA, 2014).
In scientific as well as in popular literature, social costs of climate change are often associated with impacts on health, ecosystems and biodiversity, rising sea levels, energy use and demand. The most

important emissions generated by transport having an impact on climate change are CO_2, N_2O, and CH_4 (van Lier *et al.,* 2010). While being extremely complex to estimate due to their unpredictable risk patterns, long-term effects, and their global geographical scale (Maibach *et al.,* 2008), these require an approach combining both a damage costs approach (Impact Pathway Approach) and a mitigation cost approach (reduction objectives).

As for transport-generated emissions, two distinct types can be distinguished: direct emissions (happening while using a vehicle and consisting of both exhaust and non-exhaust emissions) and indirect emissions (related to up-and downstream processes) (Delhaye *et al.,* 2010; van Lier and Macharis, 2009).

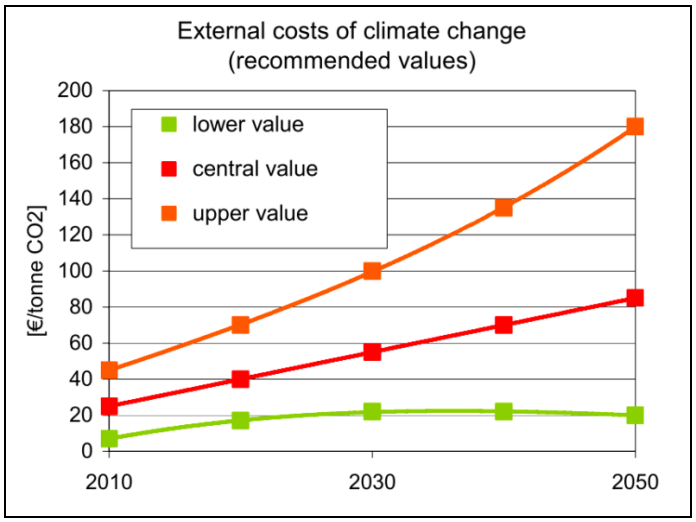
The transport mode and fuel types thus play a crucial role in the generated emissions. External costs output values for climate change can, for example, be retrieved from Ricardo-AEA's Update of the Handbook on External Costs of Transport (2014). As explained in this study, the estimation of the unit cost for different transport modes envelops different steps, combining (1) the quantification of GHG emission factors for a range of vehicle types (in tonnes CO_2-equivalent per vkm) and (2) the valuation of climate change (per tonne of CO_2-equivalent) to finally calculate (3) the marginal climate change costs for a range of different types of vehicles and fuels. In this process, the cost valuation of climate change is thus important.

For this GHG emissions cost evaluation, literature suggests two main techniques: the damage-cost approach and the abatement cost approach. The latter stresses the willingness-to-pay (WTP) for less pollution expressed in €-values per kg of pollutant (e.g., tonne CO_2). The first includes all total costs assuming a business as usual scenario in which no attempts are made to decrease the pace of global warming, which inhibits global warming effects in rising sea levels, vegetation, and the like. Although this method can capture all external costs related to climate change, its complexity in terms of uncertainty, geographical spread, and extended time periods makes it next to impossible to measure in a simple and accurate way. Moreover, it is widely accepted that many climate change-related threats are still unknown and thus difficult to evaluate. Therefore, the abatement cost approach, based on a set emission reduction target upon which the cost is calculated to meet the target, offers a sound alternative if these reduction targets correctly translate the societal preferences, in this, facilitating the calculation of the willingness to pay for different abatement levels (Ricardo-AEA, 2014). Furthermore, comparing the spread of results in studies using the damage costs approach or the avoidance cost approach, it is importantly lower in the latter. When reduction targets have been put forward, CO_2 external costs based on avoidance costs are thus preferred. Consequently, these costs will vary strongly based on the set target levels (Maibach *et al.,* 2008).

Every GHG influences the phenomenon of global warming. Its impact can thus be expressed in the amount it contributes to climate change. The potential impact of a greenhouse gas is used to calculate the corresponding CO_2-equivalent (CO_2e), a standardized unit and aggregated indicator to measure the carbon footprint (Ecolife, 2016).

The valuation of the external cost of climate change, measured as €/tonne (against a base year), varies from study to study and evolves over time. The Handbook on Estimation of External Costs in the Transport Sector conducted by CE Delft (Maibach *et al*., 2008) proposed a € 25/tonne CO_2-equivalent (2005 base prices) with incremental increases over time (as shown in Figure 6).

FIGURE 6 Values for the calculation of external costs of climate change as proposed by Maibach *et al.* (2008)



It is worth noting that more recent studies estimate this cost to be higher than earlier ones. This is mainly attributable to an increasing knowledge on the topic and to sensitivity risks, which is in its turn translated in more fine-grained modelling. However, a large spread is still noticeable in damage costs evaluations, highlighting the uncertainty associated with these approaches. Kuik *et al*. (2009), in a study which is strongly based on the United Nations Framework Convention on Climate Change (UNFCCC), proposes a range of € 69-241/tonne CO_2-equivalent to a central value of € 129 for the year 2025 and € 128-396/tonne CO_2-equivalent with central value of € 225 for 2050 (base year 2005).

The Ricardo-AEA study (2014) offers an updated handbook of Maibach *et al.* (2008) with a central value for carbon price at € 90/tonne CO_2-equivalent (€ 48-168 range, 2010 prices), which is comparable to other studies. For example, UBA (2012), as guidelines for Germany, recommends a central value of € 80/tonne CO_2-equivalent (with a range of € 40-120), and Watkiss and Downing (2008) recommend £ 80/tonne CO_2-equivalent for the UK (for 2010). The latest update on the Handbook on the External Costs of Transport (van Essen *et al*., 2019) presents a central value of € 100/tonne CO_2-equivalent ($€_{2016\ prices}$).

3.4 Carbon offsetting

Another way of evaluating the costs linked to CO_2 is the carbon offsetting mechanism, following the principle of CO_2-neutrality. Using a transparent measurement system, the latter foresees that the net calculated CO_2 emissions equal zero. The mechanism of carbon offsetting states that an organization indemnifies - part of - the GHG emissions it produces by paying for a CO_2 equivalent reduction in another region of the world. For example, a company indirectly invests in wind farms and hence compensates for a CO_2 saving equivalent to its coal-fired steel manufacturing emissions. A company's activity is carbon neutral when all the non-avoidable emissions are offset. Carbon offsetting is different from the EU ETS scheme because the latter only allows a maximum GHG emission allowance for heavy energy-consuming activities under a 'cap-and-trade' scheme (ECA, 2014; CO_2logic, 2014).

To enable correct measurements for additional emission reductions and avoid double counting, offsets should be validated using accepted schemes. Indeed, it is worth stressing that offsetting is not widely in the EU. One reason for this is that EU institutions have different approaches to deal with offsetting; in other words, no common carbon footprint calculation approach exists for EU institutions and bodies. Another reason is that carbon offsetting is not mandatory for EU institutions. Although some companies have been using the mechanism to a limited extent, audits reveal that companies paid, on average, between € 3.45 and € 24.5 per tonne CO_2-equivalent. These are lower than the maximum

cost put forward by the European Parliament (€ 40; 2007 prices) (ECA, 2014) and drastically lower when compared to the damage cost evaluation in the previous segment. It, thus, must be borne in mind that this discrepancy can be explained by, for example, the fluctuating market price of carbon offsetting credits and economic variables associated with the region where the compensating measures are taken.

3.5 Air pollution (local emissions)

An approved way of measuring external costs related to air pollution is the Impact Pathway Approach (IPA). This technique enables the estimation of external costs based on dose-response functions (Maibach *et al.*, 2008), hence taking account of the number of receptors, people in the near vicinity of the emission source (generally the moving vehicle). The number of receptors is thus directly related to the magnitude of the external costs caused by air pollution.

An example of output values of air pollution for recommended external costs, both for freight transport and passenger cars, can be retrieved from the Update of the Handbook on External Costs of Transport (Ricardo-AEA, 2014). By analogy, other transport modes are also accounted for in the same study.

Barring some exceptions, air pollution costs for heavy goods vehicles are generally higher for vehicles having a larger engine and lower EURO norm. In addition, the costs are typically higher in urban zones compared to rural ones. Key takeaways for passenger cars from this table are the lower costs of petrol cars compared to diesel ones, the impact of the EURO norm, and the considerably higher marginal costs in urban areas due to higher receptor densities compared to interurban or rural areas. In this regard, diesel passenger cars are the greatest wrongdoers when it comes to marginal environmental damage costs. The reason for this is their relatively high PM emissions, having a high impact on human health. Hybrid and electric cars, with their relatively low air pollution costs, bear the most moderate environmental external costs. However, one needs to take into account the up-and downstream processes needed to generate electricity (well-to-tank emissions) for these activities.

3.6 Methods for internalizing external costs of transport

Vehicle purchase and ownership usually involve several taxes, such as registration (once upon registration), circulation (annually and based on, i.a. engine power), and value added taxes (once upon purchase). These are examples of fixed and periodical taxes or pricing measures. While potentially having an influence on the initial purchase of the vehicle, these do not take into account the use of the vehicle and its related impact on the environment or congestion and are thus not suitable to internalize external costs. A more suitable and correct way to reflect external costs generated by transport is to implement variable taxes, stressing car usage rather than car ownership, i.e., reducing the importance of a fixed tax in favour of variable taxes (Immers and Stada, 2004). Examples of this variabilization include congestion pricing and kilometre charging. In accordance with the subject of this book, here the wider notion of the latter will be focused on[14].

While reducing the share of fixed taxes, the kilometre tax (or road pricing) is likely to influence traffic volume. Recording the number of kilometres driven (De Borger *et al.*, 1997), it has the probability to differentiate fuel type, EURO norm, vehicle size, location, road type and time, and potentially also the pollution level of the concerned vehicle. Hence, it could prove to be an efficient pricing concept for the internalization of external costs (such as air pollution) of transport. A potential hurdle in terms of its implementation is, among others, the public acceptability, which is generally very low and often based on misconceptions (De Borger *et al.*, 1997; see also p. 90 in this book). If its implementation is

[14] Although variable taxes encompass excise duties, these do not fall under the road pricing scheme.

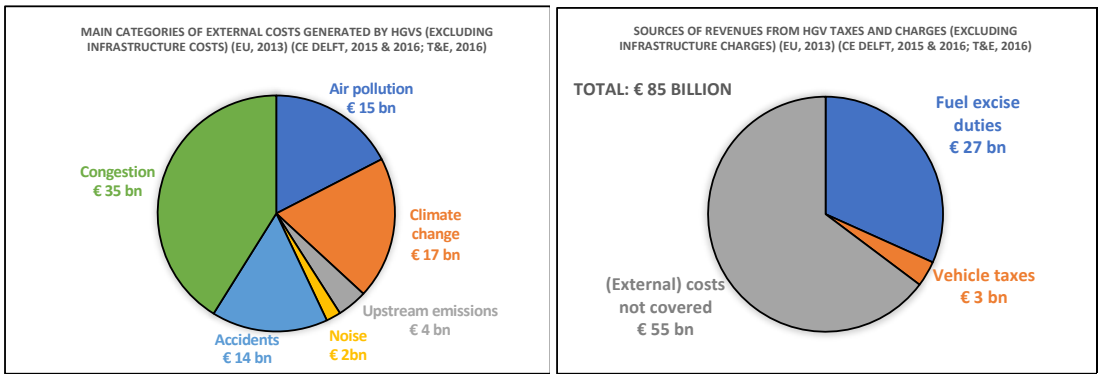
being hindered, second-best solutions - such as parking charges or public transport subsidies - can be relied on[15].

At present, still, a great part of the external costs caused by the transport sector is not being internalized, meaning the damage costs are carried by society and are not reflected in the price of the use of transport. In other words, the current taxes and charges on transport only recover the external costs partially.

Within the passenger transport segment, the internalization rate is generally the highest for road transport, especially personal petrol cars (80% of its external costs) and motorcycles (more taxes than its external costs). In contrast, the external costs of diesel cars are only internalized for a share of 42%. For company cars, this figure drops to 66% for petrol and a mere 21% for diesel. The freight transport segment knows lower internalization rates. Light commercial vehicles internalize (depending on fuel type) between 27% and 50% of their external costs, while the percentage for heavy goods vehicles is 15% and 26%, respectively (Delhaye *et al.*, 2017). For road transport, it is worth noting that time (off-peak) and place (road type) variables also render different internalization rates. Generally, heavy goods vehicles do not pay enough to compensate for their external costs, but this stressed even more during peak times and in urban environments.

In absolute figures, 75% of all transport-related external costs come from road transport. Within total external costs from transport in the EU-28 in 2016 (EC, 2018), environmental costs (air pollution and climate change) have a share of 28%. The transport sector is also responsible for other types of external costs, such as congestion and accidents costs, respectively accounting for 27% and 29% of total external costs (EC, 2018). Figure 7 shows external costs in €-values generated by heavy goods vehicles per category for the EU in 2013 (T&E, 2016), and its share that is not covered by current schemes (except infrastructure costs and charges).

FIGURE 7 External costs generated by heavy goods vehicles (HGVs) in the EU in 2013 (adaptation[16] from Transport & Environment, 2016). Left: Main categories of external costs generated by HGVs. Right: Sources of revenues from HGV taxes and charges (excluding infrastructure charges)



By increasing the internalization rate, users are encouraged to choose less damaging transport modes; hence, rendering the transport sector more efficient economically, environmentally, and socially. The deadweight loss caused by external costs (not carried by the causer) should thus be minimized. The current discrepancy between the market price for the use of road transport and its external costs also engenders a 'competitive disadvantage' towards other transport modes, discriminating mainly rail transport. Widely accepted and currently endorsed by the European Commission, the 'polluter pays'

[15] Fine-grained spatiotemporal observations need to be taken into account when assessing the external cost of congestion.

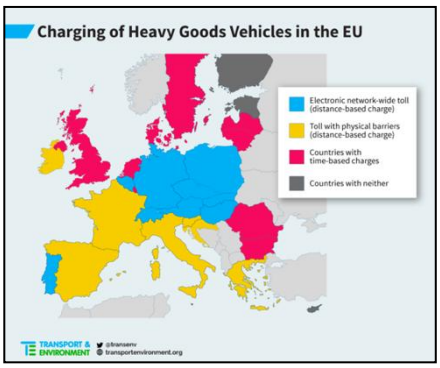
[16] In their original version, these graphs also took into account infrastructure costs and charges. For the purpose of this chapter, however, it was decided to leave out this category.

principle would potentially fill this gap by means of, amongst others, road pricing or kilometre charges (TEN-T, 2019).

4 Road pricing measures

Road pricing schemes or kilometre charges have been extensively analysed for both passenger and freight transport during the past decades (Mommens *et al.*, 2016). These schemes have numerous goals, such as reducing congestion levels, recouping the infrastructure or maintenance costs, or internalizing - part of - external costs of climate change or other, and involve the user of the infrastructure to pay directly for its use (Mommens *et al.*, 2016).

FIGURE 8 Charging of heavy goods vehicles in the EU (T&E, 2016)



Previous legislative measures from the European Commission include the 'Eurovignette Directive' (1999/62/EC) and set out a list of guidelines (the directive is largely opt-in based) on how member states can charge trucks for their road infrastructure use. The benefits to the member states are obvious: a reduction in external costs, public budget revenue growth, and more efficient transport. A proposal to review the Directive stresses the concepts of the 'polluter pays' and 'user pays', hence putting forward socially equitable transport (European Parliament, 2017). The goal is to extend the Directive wider than Heavy Goods Vehicles (HGV) to also cover Light Duty Vehicles (LDV) such as passenger cars, buses, and vans (especially for freight carriage).

This dynamic pricing scheme would increase the variable cost and decrease its fixed cost, thereby stimulating the 'polluter pays' principle. A differentiated toll scheme (by air pollutant and CO_2 emissions) and the incentivization of zero-emission vehicles are key aspects to stimulate this dynamic kilometre charge and thus reduce emissions. While road pricing on its own is not the sole element for solving climate change, air pollution concentrations, and paving the way towards decarbonization, the concept can prove itself useful if implemented in such a fashion that it promotes green and sustainable transport behaviour (T&E, 2017).

4.1 Passenger transport

The Flemish government has been working towards the so-called 'green tax shift', following the 'polluter pays' principle. Current tax schemes (other than excise duties) do not take into account actual vehicle usage (the number of kilometres driven). These static tax schemes are thus bound to miss their desired effect when it comes to calculating the external cost. In other words, the conventional static vehicle tax schemes do not internalize the total external costs of vehicle usage and emitted pollutants. At the same time, implementing such a road pricing scheme might require public acceptance. That is why it also must be studied in combination with a possible tax shift. Transport & Mobility Leuven (TML, 2019) together with KU Leuven were commissioned for this study, in order to analyse the feasibility of implementing a green tax shift based on kilometre charge (road pricing)

and how the latter can stimulate the economy whilst keeping close attention to the environment and social aspects.

Road pricing is a concept where road users directly pay for their use, hence offering a dynamic approach to the conventional one-off tax at the time of purchase (the tax on entry into service) or a periodic tax on car ownership (annual traffic tax). This road pricing scheme thus increases the car usage's variable cost and therefore offers a more accurate approach to internalize the external costs, such as climate change and air pollution. For this reason, sometimes the term 'smart' kilometre charge is used – i.e., because the level of the charges also depends on where and when one drives[17] [18].

A dynamic road pricing scheme would encourage car users to reduce their car use, possibly to shift towards other means of transport, and discourage users from driving during peak hours (Vlaamse Overheid, 2019a).

TML (2019) differentiated multiple road pricing scenarios, considering the governments' regulatory and budgetary constraints and its expected end results. Hence, these scenarios enabled the calculation of the effects on traffic volumes, congestion, and environment and were completed with a social cost-benefit analysis. The results of the study highlight the fact that the kilometre charge would enable the green tax shift from labour to road taxing. Taking account of the internalization of external costs of transport, the charge would yield € 5.6 billion annually with an average tax of € 0.125 per kilometre (with or without a higher rate during rush hour). Subtracting this figure from system costs and the current income from traffic taxes (which would be abolished), the government would still have a budgetary surplus of € 3.8 billion in this scenario. TML also forecasts an additional 700 million in expected payback effects, associated with the positive impact of the charge reduction on the economy and labour market, as such expecting Flanders to gain € 4.5 billion in this green tax shift. Consequently, an 8% decrease in the amount of vehicle kilometres would be noticeable and would reduce the external costs of congestion, emissions, noise, and accidents by € 830 million per year[19]. The green tax shift would thus entail an increase in price for using a car but could be compensated by lowering the tax on personal income (labour). As predicted by Breemersch *et al.*, CO_2 levels could also fall by 8% and an even larger amount in terms of NO_2 and PM if low-emission vehicles are favoured. When implementing the kilometre charge, a decrease in car usage (in total passenger kilometres) is also noticeable. Partially shifting to other transport modes such as train and bike would lead to relatively increase the green tax (TML, 2019).

4.2 Freight transport

In Belgium, a kilometre charge for trucks has already been introduced in April 2016 (Mommens *et al.*, 2016; Vlaamse Overheid, 2019b). This includes a kilometre charge for the use of motorways and certain regional roads in Belgium and must be paid by owners of freight vehicles with a gross vehicle weight of over 3.5t and for vehicles of class N1/BC[20] [21]. A price distinction is made in terms of different roads, gross vehicle weight, and their EURO-norm and is applicable for Belgian as well as foreign vehicles. However, no time variations are taken into account. This 'smart' kilometre charge is calculated via an On-Board Unit ("OBU") using GPS technology to track the number of kilometres driven. In other words, this variable kilometre charge is based on the distance covered, and how environmentally friendly the vehicle is.

[17] Next to other variable cost items such as fuel costs (including excise duties and VAT), maintenance costs, and sometimes insurance costs based on kilometres.
[18] Compared to the static tax scheme increasing the fixed costs of car usage.
[19] The double dividend of environmental tax schemes implies an improvement from both an economic and an environmental point of view (Goulder, 1995).
[20] The kilometre charging includes all roads in the Brussels Metropolitan Region.
[21] Excluded from this kilometre charge are machine-vehicles (such as cranes, bulldozers, and lifts) and other types of vehicles such as test drive license plated vehicles, old-timers, etc.

Thus far, the effects of this road pricing scheme have been limited in terms of modal shift or bundling. The kilometre charge had a perverse effect mainly due to the emergence of avoidance traffic, hence partially shifting traffic from motorways to the secondary road network to avoid the charge. This resulted in an extension of 6 road segments in the road pricing network at the beginning of 2018, and further analyses are conducted to extend the network even further (Departement Mobiliteit en Openbare Werken, MOW 2018).

4.3 Road pricing for freight transport in Belgium

The common use of GPS devices and traffic monitoring techniques allow the implementation of road pricing systems which differentiate their price settings according to the vehicle, location, and potentially also time. This is illustrated by the current road pricing system in Belgium, described above. While this system has been communicated and justified as a tool to internalize transport-related external costs, it is just part of the case in terms of the prices used, variables considered, and related externalities. Therefore, the question of what the impact of a correct and holistic internalization of transport-related externalities would be remains unanswered.

In a study for the Flemish Government (Departement Mobiliteit en Openbare werken, MOW), VUB-MOBI calculated the impact of such an internalization, both in terms of modal split, vehicle-kilometres, and CO_2 reduction (van Lier *et al.*, 2019). The presented research is part of a broader study, conducted by a consortium of VUB-MOBI, Sweco Belgium, and VIL, on the reduction of climate and air emissions generated by freight transport. The aim was to scientifically underpin the debate on a strategy for the reduction of greenhouse gas and air pollutant emissions from freight transport (van Lier *et al.*, 2019). In total, nineteen different measures were identified through literature and stakeholder assessment (Macharis *et al.*, 2019). Thereafter, all 19 measures were simulated towards horizon 2030 with two freight transport models; the Strategic Freight Model of Flanders (Borremans *et al.*, 2015) and TRABAM (Mommens *et al.*, 2018). The most promising ones were combined in multiple preferred scenarios.

The introduction of pricing was one of the simulated measures. It has been simulated using the Strategic Freight Model. This is a classic FOUR step model, which simulates freight transport flows between 615 zones subdividing Europe, nevertheless, with a strong focus on Flanders (518 zones). The model offers the opportunity to include passenger transport. Three types of road vehicles (vans, light duty vehicles, and heavy-duty vehicles), one type of train, and six types of barges (CETM class I to VI) are considered. Pricing has been introduced as an additional cost, taking account of vehicle type, road type, and peak and off-hours. The external cost factors are based on the Delhaye *et al.* (2017) study.

Six pricing scenarios using these costs were individually analysed, as they differentiate from geographical scope (Belgium or European Union), transport modes (road only or rail, road, and inland waterway transport), and the variable of whether road taxes and excise duties could be considered as an internalization of external costs (yes or no).

The first scenario consists of a pricing system which applies to road transport only and is performed on Belgian territory. Excise duties are not considered as internalization, and passenger road transport is confronted with a flat pricing of € 0.05 per kilometre and a start fee of € 0.25. Those passenger tariffs are used throughout all scenarios. The second scenario is equal to the first, except that it is applied to all transport modes, i.e., road, rail, and inland waterways.

TABLE 1 Total external costs per vehicle type, time, and road type, without considering excise duties as internalization (van Lier *et al.*, 2019)

	Off -peak						**Peak**					
€/vkm	Highways		Regional roads		Local roads		Highways		Regional roads		Local roads	
	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban
Vans (1 - 3.5 tonnes)	0.176	0.228	0.171	0.193	0.171	0.193	0.360	0.404	0.201	0.254	0.201	0.254
LDV (3.5 - 12 tonnes)	0.326	0.402	0.280	0.347	0.280	0.347	0.693	0.769	0.339	0.469	0.339	0.469
HDV (12,5 – 40 tonnes)	0.405	0.485	0.359	0.430	0.359	0.430	0.772	0.852	0.418	0.552	0.418	0.552
IWT - small	2.820											
IWT – medium	6.645											
IWT – big	10.617											
Rail	3.359											

Both scenarios show relatively large reductions in CO_2 emitted by transport operations in Flanders. Respectively, reductions of 11.7% and 11.9% are obtained in 2030 compared to business as usual ("bau") in 2030. Yet by analysing these results, they are not caused by a large modal shift or bundling strategies. Unfortunately, the reductions are explained by transport flows that avoid the additional charge by making a detour through the neighbouring countries. Therefore, the overall European CO_2 emissions are higher than business as usual.

This is also underpinned by the third scenario, which is on its turn equal to the first one, except that the pricing system applies to the whole of Europe. The implementation of a European road pricing system, applying the values presented in Table 1, results in a 0.1% reduction in CO_2 emissions. This limited reduction is obtained by a modal shift from the road (-1.72% of volume) to rail (+0.74%) and barge (+0.98%). However, a closer look at the results illustrated that many heavy-duty vehicles were pushed from the main roads (highways) towards local, smaller roads. The reason for this undesired effect is the relatively high congestion cost on highways with respect to the values that are applicable to congestion on local roads.

Given the negative effects of heavy-duty vehicles on local roads such as infrastructural damage, safety issues and noise nuisance, two additional scenarios were constructed with adapted costs. The used costs were set on -20% on highways and +25% on local roads, as they stop the perverse effect and result in similar income of the pricing system, thus leading to a correct internalization. Additionally, both scenarios (4 and 5) consider excise duties as an internalization of external costs and exclude the external costs of CO_2 emissions (set on € 100/tonne). Therefore, the following costs were applied to the pricing system in scenarios 4 and 5.

TABLE 2 External costs used in scenarios 4 and 5 (van Lier *et al*., 2019)

	Off -peak						**Peak**					
€/vkm	Highways		Regional roads		Local roads		Highways		Regional roads		Local roads	
	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban	Rural & suburban	urban
Vans (1 - 3.5 tonnes)	0.052	0.085	0.116	0.136	0.116	0.136	0.148	0.182	0.274	0.291	0.271	0.291
LDV (3.5 - 12 tonnes)	0.079	0.136	0.150	0.217	0.150	0.217	0.272	0.329	0.460	0.527	0.460	0.527
HDV (12,5 – 40 tonnes)	0.035	0.095	0.080	0.152	0.800	0.152	0.229	0.289	0.390	0.462	0.390	0.462
IWT - small	2.100											
IWT – medium	4.227											
IWT – big	6.311											
Rail	0.0 (-0.23)											

Both scenarios 4 and 5 apply on the European scale, yet in 4 all transport modes are considered, while in 5 only road transport is confronted with the pricing system. The results of both scenarios are negative, with a respective rise of 2% and 1.3% compared to business as usual in 2030. The reason for this result is twofold. First, transport flows are pushed towards the highways, resulting in higher vehicle-kilometres and related CO_2. Second, transport operations are optimized to reduce air pollution and avoid congestion, and not to consider CO_2. Although CO_2 is mostly correlated with congestion and air pollution at the first thought, it can be explained that transport flows take longer routes to avoid congestion or drive to less populated areas to avoid air pollution costs. Yet, both result in higher CO_2 emissions. This argument is underpinned with scenario six that considers an internalization of CO_2 costs only (€ 100/tonne). This scenario results in a reduction of 3.2% compared to business as usual in 2030.

FIGURE 9 Results of pricing scheme scenarios for freight transport in Flanders compared to business as usual (bau) in 2030 (index = 1) (source: VUB MOBI)

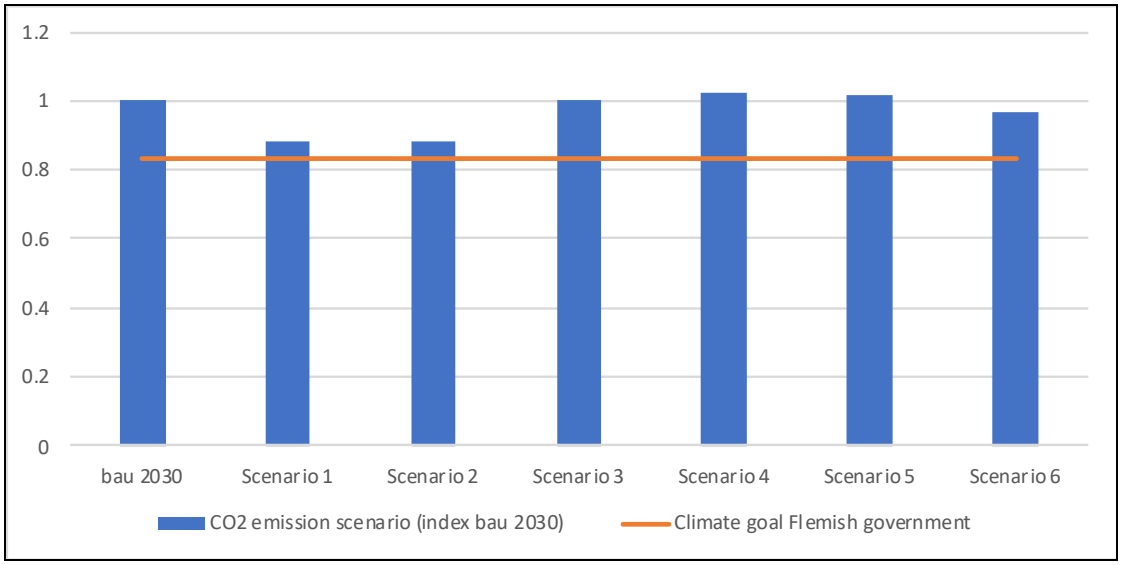


Figure 9 gives an overview of the CO_2 reductions for all six scenarios compared to one another and compared to the reduction goals set by the Flemish government for 2030. The government is allowing the freight transport sector to still have rising CO_2 emissions, up to 3% compared to 2005. Therefore, it considers the expectancy of the freight sector to grow in the coming years, its related dependence on economic growth, and lastly, its challenges to become sustainable, as technologies (like electric trucks) will be commercially available in a later stage than passenger cars. Still, this 3% goal will not be reached with solely an internalization of external costs. Therefore, many other measures inducing a system change will be necessary to reach the climate goals.

5 Conclusions: possibilities and hurdles of the road pricing instrument

While transport is inevitable in our economy and daily lives, it also engenders many negative effects on the economy, society, and environment. A great share of the external costs associated with climate change is attributable to transport. In 2015, an almost 9% share of all CO_2 emissions across all sectors in the EU was particularly attributable to road freight transport (both light commercial and heavy duty). However, most sorts of damage costs are not entirely borne by the causer of the nuisances, hence not internalized in the pricing system.

The alarming pace at which global warming and climate change are escalating cannot be denied. Mitigating actions have been put forward to avoid, reduce, and delay greenhouse gas emissions and to grow towards a low-carbon economy. However, the transport sector still lags with regards to emitted greenhouse gases and faces difficulties to achieve the emission reduction goals. In fact, it is the sole sector that has not been able to lower its CO_2 emissions compared to 1990 levels.

To meet the targets set for 2030 and 2050, and tackle this urgent challenge, the implementation of multiple measures will be required. In line with the ‘polluter pays’ principle, a possible instrument to reduce greenhouse gas emissions and increase the internalization rate of road freight transport is the implementation of a road pricing scheme. Not only would it stimulate the use of more environmentally friendly vehicles; this concept could also prove its use in pursuing a level playing field across different transport modes.

Regarding passenger road transport in Belgium, implementing a dynamic road pricing scheme could offer a more accurate approach to internalize external costs which are linked to driven vehicle

kilometres, such as climate change and air pollution. Indeed, results highlight a potential CO_2 reduction of up to 8% and a double dividend (over all external costs) of up to € 830 million per year. While vehicle usage would then become more expensive, the additionally generated public revenue could compensate for the cost by lowering the labour tax, referred to as the green tax shift.

When it comes to road freight transport, Belgium implemented a kilometre charge in early 2016. Although the scheme has been put forward to justify the internalization of external costs generated by transport activities, it is only partially the case, as can be deducted from the prices used, variables, and associated externalities. The study by VUB-MOBI for the Flemish Government (Departement Mobiliteit en Openbare Werken) referred to above (Van Lier *et al*., 2019) calculates the impact of this internalization in terms of CO_2 reduction potential, vehicle-kilometres, and modal split, based on six different scenarios. Although the largest reductions in CO_2 reach up to -11.9% in 2030 (compared to business as usual when implemented on Belgian soil only), this drop is mainly attributable to avoidance traffic, shifting routes to neighbouring countries (rather than modal shift or bundling). A slight modal shift from road to rail and barge is noticeable when the kilometre charge is applied to Europe as a whole. However, also a shift from motorways to the secondary road network is noticeable because of the relatively high congestion costs on highways. A desirable internalization can be obtained when lowering the congestion cost on highways and increasing the one on local roads, hence pushing traffic volumes towards the highways.

As explained above, the implementation of a pricing system should be well thought of, as perverse effects can easily arise. Secondly, governments should go for pricing systems that internalize all transport-related externalities. The direct effect may be limited for freight transport; however, it creates an environment where more sustainable concepts, operations, and technologies can be applied more easily and with greater economic success. While an important aspect remains to properly frame and communicate the goal and impact of such a differentiated pricing system to users, a differentiated toll has the potential to generate stakeholder awareness on the external effects the transport industry is generating. It could provide insights as to how companies can enhance their logistics activities in a more sustainable way, as such lowering the external damages caused. In this way, unnecessary kilometres can be avoided, and empty journeys can be reduced by bundling trips to pay fewer taxes. Depending on the implementation level, pricing could also -partially- stimulate a modal shift. This modal shift will obviously be greater if a road pricing scheme is being implemented solely on road transport, as opposed to simultaneously applying a charge to rail and inland shipping. Analogous to this, the road pricing scheme will also incentivize the switch to zero-emission vehicles (ZEV) (more quickly), given the lower charge for more environmentally friendly vehicles. Lastly, a pricing scheme should be implemented coherently on a European level, to avoid additional kilometres due to detour and related externalities.

It is also worth pointing out that the instrument of road pricing is just one in many tools in meeting the long-term 2030 and 2050 decarbonization targets, and these will also have to be implemented to reach the goals.

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PART III: A COMMON ROAD PRICING POLICY?

Chapter 7. Road pricing in Belgium
TH. VANOUTRIVE

Chapter 8. Road pricing in the Netherlands
G.P. VAN WEE

Chapter 9. Benelux cooperation and mobility management
B.M.J. HENNEKAM AND L.D. VAN DEN BERG

Chapter 10. The European Union road pricing approach
J.G.W. SIMONS

Chapter 11. International cooperation in freight transport pricing and investment
B. DE BORGER AND S. PROOST

7 Road pricing policy in Belgium

TH. VANOUTRIVE [(1)]

Abstract

This contribution describes how road pricing in Belgium has become a viable policy option. Since the 1990s, transport economists and other actors have been able to put a version of road pricing on the agenda that comes close to the idea of marginal social cost pricing. After some initial protest, a large group of actors seems to accept the implementation of a kilometre charge for trucks over 3.5 tons in 2016. Several Flemish politicians as well as employer organizations and environmentalist groups support the introduction of a similar road charging scheme for passenger cars and vans, but it remains unclear whether the coalition will succeed.

1 Introduction

On Thursday 31July, 1958, the Belgian ministers of Public Works and of Communications meet a number of other prominent figures during a ceremony in the town hall of Sint-Niklaas, and then travel to Antwerp for a reception at the City Hall. During these festivities, the most symbolic event took place when the minister of transport ('*Verkeerswezen*') cut the tape at the Waasland tunnel. These ceremonies were not organized to celebrate the opening of the tunnel, but to commemorate the end of 'anachronistic' road tolls, as the toll levied at the Waasland tunnel was the last toll present in Belgium (Gazet van Antwerpen, 1958). Tolls would only reappear in Belgium in 1991, when the Liefkenshoek tunnel between Antwerp and Beveren was opened, but this can be considered an isolated case.

Today, road tolls are back on the political agenda in Belgium. However, there is a major conceptual difference between the old-style 'funding tolls' discussed above, and more recent calls for a 'smart kilometre charge'. Traditionally, new infrastructure has been appointed to finance the building (and maintenance) costs. In contrast, the aim of a 'smart kilometre charge' is the optimum use of infrastructure, irrespective of how old a particular road segment is. The latter corresponds to the idea of marginal social cost pricing for roads as was developed by transport economists in the second half of the twentieth century (Lindsey, 2006; McDonald, 2013; Vanoutrive, 2017), and which has been labelled 'decongestion toll' or 'congestion pricing' (Derycke, 1998).

The growing popularity of congestion pricing among transport professionals, policy makers and some other actors in Belgium, follows an international trend. Over the years, what was once a deviant idea has convinced a growing number of economists, and - especially since the 1980s and 1990s - engineers, urban planners, and environmentalists (Vanoutrive and Zijlstra, 2017).

International and supranational institutions such as the World Bank, OECD and the European Commission have become ardent promoters of congestion pricing, while the general public seems less enthusiastic about road pricing (Schade and Schlag, 2003; Jensen, 2013; Vanoutrive and Zijlstra, 2018).

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As a consequence, introducing pricing measures is a risky business for politicians.
This Chapter discusses road pricing policy in Belgium using academic sources as well as press articles, policy documents and election programmes. The next section describes how, in the context of changing transport policy paradigms, experts were able to introduce congestion pricing in the debate, and have, over time, awakened an interest among key policy actors. Subsequently, it is shown that the consensus on charging is not complete, and this is followed by a section on the implementation of a kilometre charge for heavy goods vehicles, which is seen by some as a first step towards road charging for cars and vans. The overview presented in this Chapter indicates that the sustained efforts of transport economists to promote the idea of congestion pricing have been successful in shaping the debate on transport policy in Belgium.

1.1 Changing policy paradigms and the rise of road pricing as a policy option in Belgium

The acceptability of a measure such as congestion pricing correlates with the popularity and dominance of policy paradigms. Since the 1970s, the dominant focus in transport policy on the provision of infrastructure with motorway expansion as its hallmark has been replaced by a vision that emphases the management of traffic and transport. This shift from 'predict and provide' to 'predict and prevent' (Owens, 1995) or transport demand management (Meyer, 1999; Lyons and Urry, 2005) was accompanied by the sustainable mobility wave in transport research and policy (Vanoutrive, 2015). In recent years, pricing has been integrated in the smart mobility paradigm.

Congestion pricing was certainly discussed by transport experts and policy makers in Belgium, particularly in the Flanders region, from the 1990s onwards (Baeten *et al.*, 1997). The Belgian Minister of Communications' 1988 policy note (Dehaene, 1988) clearly illustrates the declining belief in infrastructure expansion and the rise of the idea that the government must regulate traffic to deal with congestion and related issues. Road pricing is mentioned as one of the options for influencing variable costs, but this was seen as a theoretical possibility rather than a realistic policy option. Following the devolution of large parts of transport policy to the regional level, we observe a similar approach in the 'traffic and transport plan Flanders' (Sauwens, 1991). Road pricing is mentioned as one of the options available to policy makers, but more emphasis is placed on telematics and other measures. In the mid-1990s Flemish political landscape, road pricing became a solution put forward by experts, but was not publicly supported by politicians. Academics promoted congestion pricing in numerous publications (e.g. Blauwens, 1997; De Borger and Proost, 1997), and in 1997, the Flemish secretary-general responsible for infrastructure stated that there was a consensus among experts that a system of road pricing could influence demand and he referred to the then decision in the Netherlands to implement road pricing in the Western part of the country, the "Randstad" (Vlaams Parlement, 1998). At the political level, by the end of the decade, a majority of members of the Flemish Parliamentary Committee on Mobility recommended road pricing as a policy measure (Commissie Mobiliteit, 1999).

After the turn of the millennium, the draft 2001 Flanders Mobility Plan expected that road pricing would be introduced first for trucks, and in a later stage for passenger cars, but this was not expected at short notice (Departement Mobiliteit en Openbare Werken, 2001). Overall, the 2000s witnessed a growing acceptance of road pricing among political parties, and several of them included road pricing in their programme for regional elections in 2009. Charging truck traffic was the least contested - maybe since a relatively large part of this traffic is due to foreign trucks - and in 2011 the three Belgian regions reached an agreement to implement a 'kilometre charge' for trucks over 3.5 tons in 2016. The 2013 draft mobility plan Flanders refers to this decision and to a pilot project to be applied to passenger cars, but notes that the social acceptability is rather low (Departement Mobiliteit en Openbare Werken, 2013). During the 2014 pilot project, a research consortium installed 820 on-board units in the cars of respondents living in the commuting area around Brussels (including parts of the regions of Wallonia and Flanders) to monitor the behavioural changes caused by the charging experiment (De Vos, 2016). The mixed results were cast in the press as a failure since two thirds of the participants rejected road pricing and did not change their behaviour (VTM, 2014). Despite the

negative framing in the press, the Flemish coalition agreement for the period 2014-2019 cautiously introduces road pricing as a defensible policy option (Vlaamse Regering, 2014). The Flemish minister of Mobility has become less cautious and has repeatedly expressed his preference for the introduction of congestion pricing for cars (HLN, 2016). To this end, a 'social acceptability' study was commissioned to design a plan to increase the popularity of road pricing among the public (PwC *et al.*, 2017), and some politicians foresee that the next government will implement congestion charging (HLN, 2018a). However, establishing cooperation between the three regions comparable to the agreement on heavy goods vehicles could be challenging given the low popularity of pricing, especially in the Walloon region, and since a number of Walloon politicians seem to prefer a vignette over so-called smart technologies.

1.2 Diversity of opinions on pricing

Although a considerable number of policy-makers favour the introduction of road pricing in Belgium, a closer look at the opinions of some relevant actors reveals the variety of positions. A first group of actors are academics, and as mentioned in the introduction, the idea of decongestion tolls has its origins in academic economics. Transport economists in Belgium refer to the principle of marginal social cost pricing, and the internalisation of external costs. They consider crude, imperfect applications such as cordon charges inferior to dynamic location-specific, network-wide pricing mechanisms. While the emphasis of transport economics at Belgian universities has been on logistics and freight, including passenger cars is promoted in pricing schemes, not least because freight and passenger traffic share roads. Applying marginal social cost pricing in another, related, market - public transport - has also been promoted. Over the years, researchers from related field such as transport geography, urban planning and traffic engineering have joined transport economists in their struggle to put congestion pricing on the policy agenda (see also Witlox *et al.*, 2013). Nevertheless, some geographers and planners remained critical of congestion pricing and its potential equity impacts (Baeten *et al.*, 1997; Vanoutrive and Zijlstra, 2018; Banister, 2018).

While theory might be the main source of inspiration for transport economists, critical accounts of the auto-mobility system are probably the main source of inspiration for environmental scholars and environmentalists when they include road pricing in their set of policy recommendations (Giuliano, 1992). The main Flemish environmental NGO, Bond Beter Leefmilieu (BBL) is clearly in favour of a 'smart kilometre charge' which should be based on vehicle characteristics, and the place and time of a trip (Lambregs, 2016). A similar position can be found in the mobility manifesto of the Flemish Council of Spatial Planners (VRP, 2015). Even with road pricing in place, BBL would maintain a green vehicle registration tax to promote the purchase of cleaner vehicles. In contrast, the Walloon counterpart of BBL, the Fédération Inter-Environnement Wallonie is more critical of congestion pricing and the conceptualisation of pollution as an external cost, and proposes, among other things, maximizing use of existing instruments such as VAT and excise duties (Courbe, 2015).

Similarly, the Flemish green party openly advocates the implementation of a smart kilometre charge (Groen, 2009, 2014), while the French-speaking greens of Ecolo do not (Ecolo, 2017). The Flemish Christian Democratic party uses the conditional tense to discuss road pricing but gives the impression that it is in favour of the idea (CD&V, 2009, 2014). In response to the pilot project, the French-speaking cdH rejected congestion pricing for passenger cars (Le Vif, 2014). The Flemish Nationalist N-VA was an outspoken proponent of a congestion charge (N-VA, 2009, 2014), while the Flemish liberal democrats had remained somewhat undecided (OpenVLD, 2009, 2014). But they seem to have joined the coalition that advocates replacing of the vehicle registration tax and the annual car tax with a variable smart kilometre charge (De Standaard, 2018). In general, both the French-speaking and the Flemish social democrats, respectively PS and sp.a do not promote congestion pricing for cars in their official election programmes (sp.a, 2009, 2014), although it is negotiable for the Flemish sp.a, while the French-speaking PS has proposed together with cdH the introduction of a vignette in the Walloon region (L'Echo, 2017). Members of the French-speaking political parties PS, Ecolo and FDF (now DéFI) from Brussels have indicated that it might be interesting to investigate some form of road pricing (VMX, 2013). Finally, discussions among French-speaking liberal democrats indicate that the

political divide does not coincide with the language border, as the more urban section in Brussels differs in opinion from other sections (de Saint Martin, 2015). Finally, the leading employer organizations in Belgium, the Walloon UWE, the Flemish VOKA and the Belgian VBO-FEB are all in favour of the extending the kilometre charge for trucks to passenger cars and vans (UWE, 2018; VBO, 2016; VOKA, 2018).

1.3 Pricing trucks paves the way for pricing cars

While large employer organizations have become proponents of congestion pricing in general, individual companies are sometimes ardent opponents, especially in the transport sector. The start of the kilometre charge for heavy goods vehicles in April 2016 was accompanied by demonstrations and roadblocks by truck drivers and farmers. Nearly a hundred companies joined forces and went to court, but without success (Transportmedia, 2016). The main complaints were problems with the timely installation and use of On-Board Units, but also more fundamental issues related to privacy were raised (Maus, 2016). Uncertainty about the effects was a potential obstacle during the preparation phase. Port authorities, for example, were concerned about their position vis-à-vis Rotterdam and some other foreign ports, and a study seems to have helped to reduce their concern (Blauwens *et al.*, 2011).

Apart from some difficulties during the first phase, the implementation was considered successful (Van Apeldoorn, 2018). The tolled network has been extended to discourage rat running since the start in 2016, and its length is now 6,492 km. In 2017, 6.13 billion truck kilometres were travelled on this network, and vehicles registered outside Belgium account for 54% of this traffic, and the regions receiving € 424.4 million (Flanders), € 241.5 million (Wallonia) and € 10.1 million (Brussels Capital Region). Viapass, the organization set up by the three regions to manage road pricing for heavy goods vehicles, states that the Belgian approach is a leading example of the application of Global Navigation Satellite System (GNSS)-based tolling as envisaged by European policy (Viapass, 2018). However, despite the introduction of road pricing for trucks, congestion has risen and even the number of trucks has increased (HLN, 2018b).

Congestion is arguably the most frequently cited reason to include passenger cars and vans in the road pricing scheme. In addition, air quality is a popular topic in the media and some proponents of road pricing refer to the results of citizen science projects such as ‘curieuzeneuzen’ (www.curieuzeneuzen.be/) and ‘airbezen’ (www.airbezen.be/), which indicate that levels of NO_2 and particulate matter regularly exceed health standards. Representatives of the private sector in particular add that limiting tolls to trucks is not efficient and fair. The fact that a system is in place makes an extension more realistic, just like the existence of the German (and Austrian) LKW-Maut example made it easier to introduce truck tolling in Belgium. However, the feasibility of installing OBUs in all passenger cars and vans is not clear, and alternative technologies are also considered. Nevertheless, road pricing for cars is regularly framed as an extension rather than an entirely new system.

2 Conclusion

Road pricing has emerged as a policy option in Belgium since the 1990s, and the three Belgian regions introduced a ‘kilometre charge’ for trucks over 3.5 tons on major roads in 2016. Despite some difficulties and protests at the start of the project, most actors seem to accept this system as a *fait accompli*. Employers’ organizations, many environmentalists and several Flemish political parties are promoting the extension of this system to passenger cars and vans. The Flanders region has developed a strategy to increase the social acceptability of the measure. But road pricing remains a notoriously unpopular measure, and the example of the Netherlands illustrates the instability of pro-pricing coalitions, even after formal agreements have been concluded (Smaal, 2012). It remains to be seen what will happen with the proposal to introduce a smart kilometre charge for cars in the Flanders region. The implementation of road pricing for cars is also a challenging political issue in the Brussels

Capital Region and, on the basis of opinions expressed by politicians, we do not expect the introduction in the Walloon region in the short term.
With regard to the role of transport economics, the proposals in Belgium come close to the theoretical model of marginal social cost pricing. While cordon charges have been discussed, the emphasis is on place-specific and time-dependent tolls that also take into account vehicle characteristics in order to internalise most external costs. Thus, transport economists in Belgium were able to put their view of road pricing on the political agenda in tandem with international organizations. This illustrates that, in addition to factors such as fuel prices and actual air quality and congestion levels, ideas and their promoters play a decisive role in the shaping of transport policy.

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8 Road pricing in the Netherlands

G. P. VAN WEE [(1)]

Abstract

This Chapter presents an overview of policy intentions in the Netherlands related to road pricing during the period 1988 - 2019 . Although the Netherlands were the first country where, already in those years, a wide support for a national road pricing system was found, nevertheless, its real-world implementation so far failed.

The Chapter discusses dominant factors that have led to not implementing any road pricing policy over of all those years. These factors mainly were a lack of political, social and actor support. Uncertainty about ICT (costs, reliability) also played a role. What does this state of affairs imply for the future of road pricing, in the Netherlands? An evolutionary - 'step by step' - implementation would have most chance of being accepted. If neighbouring countries – like Belgium - were to impose a kilometre charge, this, most probably, would increase the likeliness that the Netherlands were to do this, too.

1 Introduction

As Chapter 4 explains, the welfare effects of road pricing have been recognized for about a century, but real-world implementation has so far been limited, examples being London, Stockholm, Singapore, and Malta. Most real-world implementations are at the urban scale, the German Maut system for lorries, on a selection of motorways and a comparable system later implemented in Belgium being the exceptions. Almost certainly, the Netherlands have been the first country to propose a national system of road pricing for all motorized vehicles, the first proposal being launched in 1988/1990 (Tweede Structuurschema Verkeer en Vervoer ["Second Transport Structure Plan"], Tweede Kamer). But the Netherlands have hardly implemented any policy on road pricing so far. This Chapter will give an overview of policy intentions related to road pricing in this country since 1988/1990 (for a longer-term overview see Smaal, 2012), and will discuss dominant factors for not having implemented a road pricing policy, so far.

The methodology in this Chapter is a hybrid one, combining reading (policy) documents, engaging in various discussions, conducting research and supervising PhD students doing research in this area.

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2 An overview of policies since 1988

As explained above, the first national wide road pricing scheme was announced in the Second Transport Structure Plan ("Tweede Structuurschema Verkeer en Vervoer", 1990, policy intentions: 1988, decision by government: 1990 [Ministerie van VROM; Ministerie van V&W]), but implementation failed (see next section). In the following decade, follow-up proposals included: a toll system for major urban areas , a rush hour permit , and road pricing again but in a 'reduced form' compared to the proposal of 1998/1990. All proposals were initiated by the policymakers. At the turn of the century, the debate shifted towards an 'advanced ICT based' system of paying per kilometre: the Mobimiles proposal, initiated by Roel Pieper, an ICT entrepreneur, and adopted by the Minister of Transport and Public works (Pieper, 2001).

Not all of these proposals have been implemented. In 2003, the new Minister of Transport and Public Works, Karla Peijs, realized that she too would not be able to implement any policy, unless she organized support for this in an early stage. She asked the former director of The Royal Dutch Touring Club (ANWB) -often seen as the Dutch motorist union, which in the past strongly opposed road pricing policies - to chair a committee to explore the topic of paying for mobility: the so-called Platform Anders Betalen voor Mobiliteit ("Platform Paying Differently for Mobility"). The committee included, amongst others, the dominant interest groups, such as the ANWB, Natuur en Milieu (environmental interest group), TLN (transport companies interest group), the Ministries of Finance and of Transport and Public Works, and a scientist. The committee recommended converting taxes on new cars and annual taxes (at least partly) into a system of paying per kilometre (Platform Anders Betalen voor Mobiliteit, 2005). The proposal survived relatively long in the debates: also, the next government supported the policy, and even announced the implementation of the first version in 2011 for lorries only, followed by cars in 2012. Kilometre charges would depend on vehicles' environmental characteristics, time of day and location. The Christian Democrats (CDA) and the right-wing liberals (VVD) stopped supporting the policy shortly before the upcoming elections in 2010, and the next governments did not propose a comparable policy. The only real-world implementation of any form of road pricing were some local experiments of awarding people to not use their car during rush hours. Data bases on cars travelling in specific periods were set up, and the owners were invited to participate in experiments to not travel during rush hours and receive financial compensation. The first experiment dates from 2008. A review of the first five experiments reveals that rush hour avoidances vary between 16-58%, time of day being the most important response (Meurs et al., 2015; see also Chapter 4, Section 6).

3 Success and failure factors

How did the Netherlands not implement any of the proposals? Without a doubt, a lack of political and (related) societal support played a key role. At least until 2003, the Ministry of Transport and Public Works' top-down approach was not helpful for real-world implementation. Support has increased since 2004, due to the involvement of many actors. But the decision, in 2010, to stop supporting the policy of paying per kilometre was partly the result of a lack of support from the actors involved, and a lack of political support (Vonk Noordegraaf, 2015). This lack of support was partly fuelled by – in some cases – negative media attention (Ardiç, 2015).

Besides a general lack in political support, there are also two more specific factors. First, system costs will likely be high (CPB and PBL, 2015) but also, probably, quite uncertain. Secondly, welfare effects could be positive if prices depend on time and location, but not if a flat rate would replace annual taxes. In that case, marginal costs of road use could easily exceed marginal benefits (CPB and PBL, 2015).

4 Conclusion

The main conclusion is that, although the Netherlands were the first to support a national road pricing system, real world implementation failed, about three decades ago, mainly because of the lack of political, social and actor support.

The principal factor was that CDA and VVD were afraid of losing votes if they continued to support the implementation of the kilometre charge. Probably, uncertainty about ICT (costs, reliability) also played a role.

What does this imply for the future of road pricing policies in the Netherlands? If the system would be of the nature of a revolutionary change - like a “big bang” - this would make implementation difficult. A more evolutionary - ‘step by step’ - implementation would have a greater chance of survival. For example, first convert annual taxes to a flat rate per kilometre. This step should be properly motivated, because, then, many people will consider it “fair”: who drives more, pays more, and, conversely, who drives less pays less. Then, as explained above, “fairness” comes at the expense of welfare. A next step, perhaps combined with the first, can be to differentiate by vehicle characteristics (e.g. CO_2-emission). The following step could be to convert part of the new car taxes to a kilometre charge. The ultimate step, then, could be to differentiate by location and by time of day.

If Germany and/or Belgium (and perhaps Luxemburg) were to impose a kilometre charge, it would increase the likeliness of the Netherlands to do that as well.

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9 Benelux cooperation and mobility management

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Abstract

The Benelux Union (BU) plays an important - pioneering - role in the field of international collaboration. Given the significant role of the Benelux countries as a hub for transport and trade, transport collaboration on the whole receives much attention from the side of the BU. As may be well-known, the latter was a precursor in many areas of transport. However, currently, there is no formal collaboration in the field of road pricing. The cause of this lies in major differences of approach in the three countries. In this Chapter, these differences are explained. In addition, a number of suggestions are made for collaboration which could be promising, despite the identified differences in approach.

1 Introduction: Benelux

In 1944, the Governments of Belgium, the Netherlands, and Luxemburg decided to establish the Benelux Customs Union, in order to make a joint contribution to the restoration of the countries plagued by the Second World War. In 1958, this cooperation was deepened, leading to the transformation of the Customs Union into an Economic Union[22].

Salient detail: The Benelux Economic Union Treaty was signed one year after the European Community Treaty of Rome. Article 233 of the latter Treaty contains the provision that, anticipating European integration, the Benelux Union can continue its activities as a European laboratory for integration[23]. This provision still applies today. It provides an answer to the frequently asked question, in the present time, about the usefulness and necessity of the Benelux alongside the European Union. The opportunity of giving an impetus to European countries, in the EU Treaty, has always been actively used by the Benelux. Notably, Benelux, over time, has been a forerunner in traffic and transport issues, simplifying, and wherever possible, completely abolishing transport and border formalities.

Common technical requirements for road vehicles were also introduced. Passenger and goods transport by road were largely liberalized.

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[22] Treaty establishing the Benelux Economic Union of 3 February 1958.
[23] Treaty establishing the European Economic Community of 25 March 1957, Article 233: "The provisions of this Treaty shall not be an obstacle to the existence or completion of regional unions between Belgium and Luxemburg and between Belgium, Luxemburg, and the Netherlands, in so far as the objectives of these regional unions are not achieved by application of this Treaty."

Furthermore, the Benelux Union initiated Pan-European cooperation for road transport enforcement bodies (ECR)[24]. In 1985, a Benelux initiative stood at the basis of the Schengen agreements on the abolition of internal border controls for goods and passenger traffic[25].

Nowadays, Benelux transport cooperation mainly focuses on aspects related to efficient and sustainable transport such as the development of a common strategy concerning digital transport documents deepening the ECR cooperation and exchange of information concerning environmental protection measures in urbanized areas[26].

2 Gateway to Europe

If one looks at the role of the three countries in global and European freight transport, it is needless to say that also here Benelux fosters international cooperation. In 2016, the General Secretariat of the Benelux Union published a study in which flows of goods between the Benelux countries and between these and Neighbouring countries were examined[27]. The study endorses the role played by the Benelux as a hub for international freight and passenger transport within the European Union.
For Benelux seaports, and for the year 2015, the study estimates the total goods transshipment at around 850 million tons. The Top three Benelux seaports Rotterdam, Antwerp, and Amsterdam are the number 1, 2, and 4 seaports of the European Union. Based on cargo weight, these three ports together account for 41% of the transshipment in all EU-28 seaports.

For Benelux airports, the total cargo transshipment was around 3.5 million tons in 2015, a substantial part of the 13,4 million EU-28 cargo transshipment. In 2015, transport in the Benelux, with an area of less than 2% of the EU and with no more than 5% of its inhabitants, represented 78% of the total of tons in EU inland navigation, 24% in EU aviation, 21% in EU maritime navigation, 7% in EU road, and 6% in EU rail transport. It is hardly surprising, therefore, that the three Benelux-countries taken together are in the top ten of world logistic rankings. In this ranking, in 2014, the Netherlands took second, Belgium third, and Luxemburg eighth place.
Finally, the study quoted shows that 1 out of 11 employees in the Benelux holds a job in logistics and 1 out of 20 in the transport and storage sector. The above statistics underline the fact that, for freight transport, Benelux does not merely serve as an area of transit to and from third countries. Freight transport between Benelux-countries themselves has also an intensive character and direct economic importance for these countries.
There is, however, another side to the above coin: transport-related activities put pressure on infrastructure and environmental quality. In addition, in the urbanized areas of Benelux countries, Belgium and Luxemburg especially, considerable congestion problems exist.
With the above data in mind, what follows will focus on the question of whether there are any opportunities for Benelux cooperation in the area of road pricing and, if so, what these would be. Given the position of transport within Benelux, it may seem surprising that this question still has to be

[24] Euro Contrôle route (ECR) is the cooperation among European road transport enforcement bodies including fourteen countries and two countries as observers, working together for safe, fair, social, and sustainable road transport. ECR's activities center around four pillars: 1) coordinated cross border checks, 2) education and training, 3) harmonization, 4) consolidated points of view/common interest and influence decision making process. Member states in 2019 are Belgium, the Netherlands, Luxemburg, France, Germany, Ireland, the United Kingdom, Poland, Austria, Romania, Bulgaria, Hungary, Croatia, and Spain. The observer States are the Czech Republic and Slovenia.
[25] On 14 June 1985, the Heads of Governments of Belgium, the Netherlands, Luxemburg, Germany, and France signed the Schengen Agreement in the Luxemburg border municipality of Schengen. The convention implementing this agreement aimed at abolishing checks on persons and goods at common, internal borders. This created the “Schengen area”, an area without internal borders. In later years, many other European countries joined this initiative.
[26] Each year, the Benelux Committee of Ministers establishes the priorities of Benelux cooperation.
[27] General Secretariat of the Benelux Union, importance and added value of freight transport in the Benelux, Brussels, 2016 (www.benelux.int/files/3414/6607/2335/rapport-EN-DEF_WEB.pdf).

asked. The introduction of road pricing, however, has proved to be a difficult subject in Benelux cooperation. This can be traced back to the circumstance that the three member-countries have diverging interests with respect to this issue, resulting in differing policies.

3 Differences in the approach of the three countries

In April 2016, Belgium introduced a form of road pricing for trucks and coaches on the main road network. Now, in 2019, it is considered an extension to secondary roads. Furthermore, initial signals have been given to apply road pricing to passenger cars in a subsequent legislature. Luxemburg presently has no plans for road pricing. In the Netherlands, road pricing has already been discussed and studied for a fairly long period (the first intention for road pricing was announced in the Second Transport Structure Plan - *Tweede Structuurschema Verkeer en Vervoer* - in 1990; see also Chapter 8). Up till the time of writing, however, its practical application has failed to find sufficient social and political support.

In this divided landscape, it is difficult to arrive at a common Benelux approach. In addition, in the Benelux, unanimity is required for decision-making.
Given these two factors, cooperation with regard to road pricing has mainly remained limited to the exchange of information on policy developments.
It is useful now to take a closer look at the differences between the three Benelux-countries that, so far, have formed an obstacle to the creation of a common road pricing policy.

Luxemburg, being a relatively small country, actively participates in this domain and reaps the benefits of economic international cooperation in general. Here, it not only matters what happens within the Benelux. The Grand Duchy also borders the large countries of France and Germany, each of these has its own system of road pricing. The main road network in the Grand Duchy fulfills an important function for transit traffic. Usually, such traffic does not provide much benefit for the country concerned. In Luxemburg, however, this is different since the policy of low fuel excise duty in this country leads to great deal of transit traffic buying its fuel there[28.] This may well explain that Luxemburg is rather reluctant to introduce road pricing as an instrument for mobility management and gives priority to promoting public transport by making it free for users (2019)

For Belgium, next, transit traffic formed an important argument for introducing a tax on the use of roads by HGVs. In this country, in road freight traffic, there are large transit flows, both on the east-west and the north-south axes. Unlike Luxembourg, Belgium does not have an attractive fuel excise duty that generates income from foreign through traffic. With the argument that, by means of a levy, making transiting foreign HGVs pay for nuisance caused, political and social support for this measure was obtained. It was decided to introduce a levy with technical aspects similar to those in Germany. In other words, vehicle characteristics, distance traveled, and geographical location determine the level of rates. No account is (still) taken of traffic pressure at the time of using the infrastructure. It may be noted that the choice of a system that has been set up elsewhere fits in with the Belgian certainty-oriented culture. Sophisticated systems of road pricing, such as those being considered in the Netherlands, are much less in line with this culture. Finally, for mobility policy in Belgium, a complex

[28] Fuel prices per liter (in €) in the Benelux and in Neighbouring countries, March 2018

	Euro95/E10	Diesel/B7
Belgium	1,426	1,528
Netherlands	1,724	1,457
Luxemburg	1,117	1,101
Germany	1,359	1,289
France	1,498	1,472

Source: VAB.(www.vab.be/nl/info-en-diensten/wegeninfo/brandstofprijzen)

institutional framework exists. That is, important competences lie with the regional governments of Flanders, Brussels, and Wallonia. The levy on HGVs has the support of these partners in decision-making that not only have made investments for the present purpose but also receive a significant income from it. Both the regions and the federal government will, therefore, be more inclined to build on the current system of charging for the use of roads rather than replacing another one, even one that would be more in conformity with economic theory.

The Netherlands has less transit traffic than Belgium and Luxemburg. The argument, therefore, that this traffic does not sufficiently pay for its use of roads holds far less here than in the other two Benelux-countries. Further, the degree of congestion in The Netherlands is less than in the latter ones. This is due to the fact that in the Netherlands, investments in roads have been made almost continuously. This may have contributed to the situation that road pricing has not been a priority for successive governments in the Netherlands.

Furthermore, there is considerable social resistance to this measure. What fits more in Dutch culture is to set trends towards renewed mobility management. Presumably, mobility management has not been studied in any country as extensively as in the Netherlands. The goal is to remain engaged and acquire a leading position in economic and financial activities linked to mobility management.

It may be expected that the above differences between the three countries will not change in the short term. Given the formal requirement for unanimity for common Benelux activities, it will be difficult at the present time to realize a successful common road pricing project in Benelux.

4 Suggestions for greater cohesion

With a view to a somewhat more distant future, it may be useful, all the same, at this place to make a number of suggestions for Benelux cooperation with regard to road pricing.

i. *Organize a Benelux assembly around the theme "level playing field for road pricing"*
Similar to what was undertaken by the Benelux, in the 1980s, with regard to the major seaports in its area, bring stakeholders, governments, and transport and port-related interest groups and researchers together, in order to find out how a level playing could be created for road pricing.

ii. *Work together to encourage the use of clean and safe road vehicles*
The latest Benelux action programme provides for further cooperation on energy transition in road traffic. In the Benelux, ownership and use of electric vehicles are relatively high. A quarter of European hybrid road vehicles in 2017 were registered in the Benelux. Furthermore, a third of electric charging points in Europe were located within Benelux[29]. Benelux cooperation, in 2017, resulted in a common trans-border programme for battery charging facilities. Why not deepen the Benelux cooperation on electric road vehicles and enlarge the focus to the exchange of knowledge and coordination of policies for pricing the use of this type of vehicles? It may be added that road pricing offers opportunities for taking into account vehicle characteristics and thereby encouraging the use of clean vehicles.

iii. *Agreement on how to act with the loss of excise duty on fossil fuels in the event of a transition*
The strategy to be followed when all fuel excise duties will be canceled in the event of an energy transition has a strong political dimension. In addition, such a strategy will have direct links with the issue of road pricing. This is because the latter is an attractive instrument for differentiated taxation of road use.

[29] General Secretariat of the Benelux Union, Political Declaration on Borderless Access to E-Mobility Services within the Benelux, Brussels, 7 July 2017.(ww.benelux.int/files/8215/1274/4037/BENELUX-Political_Declaration_FINAL.pdf).

As already indicated above, fuel excise is an important source of income in the three countries. Coordination of excise policy is one of the unruliest issues of international cooperation. In addition, especially in Benelux-countries, with a coordinated excise policy, much will be at stake.

Direct annual income from excise duty on fossil fuels in road traffic for the three countries together amounts to around € 13 billion. Now that the transition to non-fossil fuels has become a policy aim in these countries, the question arises how to deal with the expected drying up of this substantial source of income. A common Benelux strategy will most certainly be difficult to realize. Undoubtedly, however, it will give great benefits in return.

At the solemn celebration of sixty years of Benelux, in June 2018, Secretary general of the Benelux Union Thomas Antoine pointed out that Benelux cooperation is not a static event, but constantly adapts to new developments and preconditions. In the Benelux Economic Union of 1958, the internal market and the free movement of people were the main themes of cooperation. In the new Benelux Union Treaty of 2008, attention is focused less on market aspects, and more on social cohesion, safety, and sustainability. "Where things were central first, now people are", Antoine said[30].

Benelux cooperation has an important interface with what we would call the two-sided face of mobility. On the one hand, there is mobility as an engine of prosperity, development, well-being, and culture. On the other hand, there is pollution and associated negative health and climate effects.

Mobility management in the three countries will continue to focus on traffic flows. However, limiting emissions in support of climate objectives will become an increasingly key area of attention. The use of the car ("our holy cow") will be judged much more than now in connection with the achievement of these environmental objectives. The latter is a fascinating field of tension for the three countries that are so interwoven with transport. If one wants to achieve something substantial here, cooperation is a must. In this respect, the relationship between mobility management and climate objectives deserves a prominent place on the agenda of Benelux cooperation.

Last but not least, the fact that Benelux acts as a gateway to Europe is also reflected in higher education and in research within this community. With regard to transport and logistics, Benelux may pride itself in having within its area a number of renowned research institutes, the services of which are being provided far beyond the borders of Benelux. In addition, for the two subjects mentioned, there might not be a greater number of institutions of higher education per inhabitant than in Benelux. Therefore, it is entirely understandable why Benelux Secretary general Dick Kruytbosch provided full support for the establishment of BIVEC-GIBET in 1978.

In conclusion, one might ask whether a history of forty years of BIVEC-GIBET may not serve as an inducement for further strengthening Benelux cooperation in transport research. A cooperation with as parties - national and regional - governments, institutions both for higher education and for research as well as the business community.

[30] The Treaty establishing the Benelux Economic Union of 1958 was signed for a period of fifty years. In a constantly changing international context, the focus of Benelux cooperation has shifted to the development of new policy areas. At the end of the fifty-year period, governments of the three Benelux countries decided that it was the time for renewal, considering the new aspects of Benelux cooperation such as safety and sustainability. The new Benelux Treaty was signed on 17 June 2008. On 1 January 2012, it entered into force.

10 The approach to road pricing of the European Union

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Abstract

This Chapter outlines the European Union approach to road pricing. For of a better understanding of the possibilities of the EU regarding road pricing, first what forms the legal context for this is outlined. Then, the origins of the EU-concept of road pricing and the road to decision-making on the subject are described. What follows, is how, presently, the EU deals with the matter.
After a brief excursion to the subject of electronic toll collection, also relevant for EU policy, the Chapter concludes with some words on what remains to be done, for the EU, regarding road pricing.

1 Introduction

The European Union (EU) only became a legal entity with the Lisbon Treaty, which entered into force on 1 December 2009. Neither before nor after that date the EU has been the owner of any kind of transport infrastructure. The question may arise, therefore, why, within the context of the EU, dwelling on the subject of the pricing of roads is necessary.

As opposed to the EU itself, nations – in the present case: Member States of the EU – are the owners of various kinds of transport infrastructure. As such, they are entitled to ask for payment for the use of it by other legal persons, including natural persons.
It is common knowledge that taking action in the areas of coordination, harmonization, and the guarding of subsidiarity and proportionality are tasks of the EU. It is in these areas that the EU has powers and where an approach to "road pricing" can be found. This Chapter intends to present a sketch of the European Union approach to road pricing, mainly concentrating on the transport mode road in line with the other articles in this book[31].

2 Legal context

Formal cooperation between nations is possible in different ways. It may be bilateral or multilateral, each of which is in various forms, i.e., either with an intergovernmental or a supranational character. With the former, sovereignty transfer decisions are being taken in unanimity only. With the latter, it is possible to transfer sovereignty away from individual nations to a supranational organization, without a unanimous decision.

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[31] The EU also acts on road pricing by other modes of transport.

The cooperation between Member States of the EU is obviously of a multilateral nature, but, following the present Treaties (Lisbon, 2007), with elements of supranationality and of intergovernmentality[32]. In combination with other unique issues, such as the exclusive right of the European Commission (hereafter "Commission") to make EU-law proposals, the EU can best be described as an organization "sui generis"[33].

The competence in transport issues is, as article 2 (2) in conjunction with article 4 (2) TFEU says, conferred to the Union shared with the Member States ("the Union and the Member States may legislate and adopt legally binding acts in those areas. The Member States shall exercise their competence to the extent that the Union has not exercised its competence"[34].

Title VI Transport of the TFEU contains eleven articles (art 90 – 100), of which the first two are basic. According to Article 90, "The objectives of the Treaties shall, in matters governed by this Title, be pursued within the framework of a common transport policy".
According to Article 91, "For the purpose of implementing Article 90, the European Parliament and the Council shall … lay down: (d) any other appropriate provisions." The words "Within the framework of a common transport policy", in Article 90, merely state a condition. The substance of a common transport policy, however, has not been defined in the Treaty. This means that it will still have to be formulated. Progress in doing this was very slow until the 1980s, largely because governments were reluctant to give up control over their national transport networks and because of major differences between the regulatory and transport structures in each country. As an example, the following two extremes may be mentioned: (1) France, with its public service policy and (2) the Netherlands, with its primarily market mechanism policy. Either first harmonization or liberalization, or both at the same time, that was the question[35].

Frustrated after at least twenty-five years of patchy legislation, the European Parliament took the unprecedented step of taking the Council to the European Court of Justice for its failure in developing a common transport policy[36]. The Court's judgment of May 1985 (Case 13/83, known as "failure judgment") had the effect of injecting some political impetus and, finally, advances started to be made towards a common policy. The publication of the judgment happened to coincide with a White Paper on promoting the internal market issued by the Commission. It contained specific references to transport and certain goals to be achieved by 1/1/1993.

In addition, the Single European Act of 1986, a new treaty text which introduced qualified majority voting for sea and air transport and matters of harmonization, and the 1992 Commission Communication on the common transport policy were helpful to bring the Council, in 1993, to a legal act, after all its resolutions and declarations about this since the Court judgment[37,38]. By 1992, the foundations of a common transport policy had been laid[39,40].

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[32] The *Treaty on European Union* (TEU*)* and the *Treaty on the Functioning of the European Union* (TFEU), *consolidated versions*, Luxemburg, Publications Office of the European Union, 2010.
[33] See Article 17 (2) TEU for more details.
[34] The shared competences on the internal market, taxation, transport infrastructure as part of the trans-European networks and environment could also be involved with road pricing. Till now, only taxation, particularly article 113 TFEU about harmonization of national indirect taxation is used as a co-basis for legal acts about road pricing.
[35] Jaap de Wit/Henk van Gent, *Economie en Transport* (second printing), Utrecht, Lemma, 2001, p. 414.
[36] The Commission is not to be blamed, here. From 1961 on, the latter tried, with memoranda and other documents, to tempt the Council to take decisions. See J.J.M Tromm, *Juridische aspecten van het communautair vervoerbeleid* ("Legal aspects of Community transport policy"), The Hague, T.M.C. Asser Instituut, 1990 (ISBN 90.6704.055.X), Ch. 5, p. 123 ff. English summary p. 495 ff.
[37] White Paper on the future development of the common transport policy (COM(1992) 0494).
[38] See for the few and lifeless legal acts about infrastructure costs/road pricing before 1985: Tromm (1990), paragraphs 5.6.2.4.3 and 6.2.2.1.
[39] Of importance, here, is article 5 TEU with the principles of conferral, subsidiarity, and proportionality.

3 EU road pricing concept

Main line: With the failure judgment in mind, a proposal on charging different categories of infrastructure costs to heavy goods vehicles was submitted by Commission, but no legal act reaction by the Council. Commission was modified twice, in 1990 and 1992. This time, the deliberations in the Council were successful. An EU policy on road pricing is born. However, it is small and fragile. Confirmed in the White Paper about transport policy in general, from the same year the Commission proceed in road pricing in stages, not excluding private car and stated later on in a White Paper just about infrastructure charging from1998 that in principle includes all modes of transport; all around and in a context of competition while avoiding disruption between transport modes.

In January 1988, i.e., already three years after the "failure judgment", the Commission submitted the "Proposal for a Council Directive on the charging of transport infrastructure costs to heavy goods vehicles"[41]. The proposal was based on articles 75 ("no discrimination of transport contract prices") and 99 ("harmonization of indirect taxes") of the Treaty. The title of the Proposal already gave an indication that "road pricing" as a concept was somewhere in mind. Some elements of it are already there. The keywords below reflect the different categories of costs that would have to be taken into account in pricing the use of infrastructure:

- Traffic-related cost of using the infrastructure;
- Tolls, raised in certain Member States;
- External costs which should be considered with regard to intermodal competition.

There was no legal reaction by the Council. The Commission, therefore, in 1990, modified its proposal[42] .This entails that all 'whereas'-clauses (read: "considerations") have been replaced. One of these clauses implicitly gives the reason the Council did not act: figures for accurate allocation of road infrastructure costs and external costs were not generally available. In this view, a temporary system based on minimum vehicle tax rates was to be introduced. This revised proposal was again changed in November 1992[43]. In the notion of "road pricing", now, the element of the environment has been added[44].This time, the deliberations in the Council were successful. An EU policy on road pricing is born. However, it is still small and fragile[45].
Some keywords from the text with regard to "tolls and charges for the use of certain infrastructures" are as follows:
The Member States shall, if necessary, adjust their systems of vehicle taxes, and for tolls and user charges, in accordance with the provisions of this Directive (article 1);

- Tolls and user charges should not be discriminatory, entail excessive formalities or create obstacles at internal borders;
- The rates of user charges should be based on the duration of the use made of the infrastructure in question; (of importance for an EU road pricing concept) "…rules for determining (the) manner of application [of user charges and tolls] should be laid down, such as characteristics of infrastructure … [and] the maximum rate of user charges…". (Important for Benelux) "Whereas in this context

[40] In practice, during the law-making process the Commission, pursuant to article 293 par 2 TFEU, for political reasons is adapting its original proposal to the result (motto: "some result is better than nothing").
[41] 41 COM(87) 716 final (submitted by the Commission to the Council on 15 January 1988) (*OJ*, 88/C 79/12).
[42] *OJ*, C 75, 20. 3. 1991, p. 1 ff.
[43] *OJ*, C 311, 27.11.1992, p. 63 ff.
[44] "... user charges should take infrastructure and external costs, including environmental costs, into account".
[45] Council Directive 93/89/EEC of 25 October 1993 on the application of taxes on certain vehicles by the Member States, used for the carriage of goods by road and tolls and charges for the use of certain infrastructures, *OJ*, L 279, 12/11/1993, p. 32 ff. Pay attention to the last part of the title ("charges", etc.).
It should be noted that, for formal reasons, the Court of Justice of the European Communities - by the judgment of 5 July 1995, in Case C-21/94 European Parliament v. Council – annulled this Council Directive, while preserving its effects until the Council had adopted a new Directive. It is clear, however, what were the intentions of the Council.

two or more Member States may cooperate for the purpose of introducing a common system of user charges, subject to compliance with some additional conditions."[46].

Around the same time, December 1992, the Commission came forward with its Communication on the future development of transport policy. Knowing already what the Council would approve regarding road pricing, the Commission, of course, in its Communication, laid down what had already been reached ("As a general rule, all transport users should pay the full costs internal and external of the transport services that they consume, …. In particular, internalization of external costs should be a major element of a transport policy integrating the protection of the environment. …")[47]. Later, in this document, it goes into more detail. From this, we here only underline the following[48].

- The development of a Community framework in charging costs of transport can leave scope for national or local authorities to take account of their particular circumstances.
- Compatible technologies are developed so that vehicles from different Member States can be processed with equal facility, and past and current (read: in 1992) Community Research & Development work is assisting the development of common specifications for a pan-European system for charging operations.
- "…road pricing is to use a market mechanism which still leaves operators with choice while ensuring a better utilization in time and space of different transport modes".

Given the complexity of a common approach to the charging of costs, it makes sense to proceed in stages. In the short term, emphasis will be placed on the development of a framework for the imputation of infrastructure costs. Finally, note that in this top political strategy paper, the private car is explicitly mentioned in the EU road pricing context by the words "…. while increasing the level of charges overall, including those imposed on the use of the private car".

All this is written around and in a context of competition and avoiding disruption between transport modes. Therefore, although not explicitly stated but confirmed later in 1998 in a White Paper, it is obvious that for the Commission 'road pricing' is not literally only for road transport of goods, but in principle includes all modes of transport. In the following years, the Commission analysed national and regional differences in transport costs, charges, and pricing.

It may be noted here, which is of much more general significance, that in 1997, a new text of the "Treaty of the European Community" (TEC) was accepted. The so-called "Treaty of Amsterdam" that came into force in 1999, attributed co-decision powers to the European Parliament and the Council on nearly all aspects of transport policy. The legislative procedure thus changed, with a clearly very big influence from the parliament.

[46] In 1994, Germany (till mid-2003), Denmark, and Benelux Member States (Belgium till April 2016) and later on also Sweden in 1998 undersigned an international treaty of which originated the Eurovignette certificate, a proof to have paid vehicle taxes for a motor vehicle or articulated vehicle combination intended exclusively for the carriage of goods by road and with a maximum permissible gross laden weight of not less than 12 tons

[47] The Communication later was published as: "The Future Development of the Common Transport Policy: A Global Approach to the Construction of a Community Framework for Sustainable Mobility - White Paper. COM(92) 494 final, 2 December 1992", *Bulletin of the European Communities*, Supplement 3/93.

[48] Paragraphs 98 – 103 and 345 -346 of COM(92) 494 final.

4 Towards a real policy decision

Main line: The above-mentioned White Paper of 1998 is described in more detail as the implementation of the 'Eurovignette Directive' (1999/62/EC) and its amendments in 2006 and 2011, caused by procedural disturbances in the original Directive of 1993. An external evaluation of the Eurovignette Directive in 2014 led to the demand of Parliament for new proposals of the Commission.

All road pricing elements described in the previous section returned in the subsequent White Paper of 22 July 1998, entitled 'Fair payment for infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU'[49]. The Commission considers that a gradual and progressive harmonization of charging principles in all major commercial modes of transport is required across the Community. It is proposed that the charging system be based on the "user pays" principle, i.e., all users of the transport infrastructure should pay for the costs, including the environmental and other external impacts they impose at. The principles do not impose a - central - community charging scheme. Rather, they provide a framework within which the Member States would be free to set charging levels. The "marginal social cost" charging principle should enhance both the efficiency and the sustainability of the transport system.

The Commission proposes a step-by-step approach for implementation. The first phase was going to run until the end of 2000. It would contain the complementing of the existing charging system for road freight traffic and ensuring that a broadly compatible structure is in place in the main modes of transport. Charging of external costs on the basis of an agreed Community framework would be allowed, but total charging levels would be capped by average infrastructure costs. The second phase (2001–2004) would see a greater harmonization and adaptation of charging systems, especially for heavy goods vehicles (HGVs). As of this period, charges should not exceed marginal social costs, the latter including external costs. It would be important for the Member States to decide on how to use the revenues.
Phase three: beyond 2004. A further implementation of harmonized charging principles, both in terms of the marginal cost basis and the consistency of cost estimation. The level of Community-wide charges for externalities should also be reviewed. Consideration could also be given to requiring mandatory charging structures, but not levels, for local externalities.

The judgment of 5 July 1995 by the Court of Justice**,** in the only procedural case of Parliament against the Council, which nevertheless annulled Council Directive 93/89/EEC of 25 October 1993, was the reason, in 1999, this Directive was replaced by a new Directive. [50] [51] Following the text of the Treaty of Amsterdam, nowadays, European Parliament and Council together decide on the legal basis of articles 71(1) ("implementation of common transport policy") and 93 ("harmonization of indirect taxes") TEC. Note that using article 75 ("no discrimination of transport contract prices") as a legal basis may be considered as a failure in the version of 1993. In addition, note that in the title the second part of the original title "and tolls and charges for the use of certain infrastructures" is no longer there. This issue, however, is treated as before in article 7[52].

The new directive is known as the "Eurovignette Directive". It does not oblige Member States to introduce user charges for HGVs but allows time-based as well as distance-related charges schemes, with minimum levels of vehicle taxes for HGVs with a maximum permissible laden weight of over 12 tons. It furthermore specifies the modalities of infrastructure charging, including the variation of charges according to the environmental performance of vehicles. It notably indicates that if

[49] COM(1998) 0466 final, Brussels, 22/07/1998.
[50] Case C 21/94; *OJ*, 95/C229/15, p. 8.
[51] 1999/62/EC of the European Parliament and of the Council of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructures, *OJ*, L 187 – 20/07/1999, pp. 0042 – 0050
[52] Article 7: "1. Member States may maintain or introduce tolls and/or user charges under the conditions set out in paragraphs 2 to 10".

infrastructure charges are implemented, they should be related to the construction, operation, and infrastructure development cost. In doing so, it laid down the foundations for the internalization of the costs generated by HGVs.

An indication about the next step in Commission's road pricing strategy may be found in the White Paper "European transport policy for 2010: time to decide", published in 2001[53].This paper showed a more decisive shift towards an environmentally orientated and more efficient transport policy as a way to adapt to uneven growth in the various forms of transport, congestion on Europe's roads and railways, and the rising impact of pollution. A mid-term progress review, that appeared in 2006, decided that more was needed to combat transport's negative impact on energy use and environmental quality. Parliament and Council followed, and the 'Eurovignette' Directive was amended in 2006 to include vehicles with a maximum permissible laden weight of over 3.5 tons[54]. Nevertheless, a possibility was allowed to exempt vehicles of between 3.5 and 12 tons. In addition, greater possibilities were allowed for varying tolls according to environmental or traffic management objectives.

In 2011, White Paper "Road Map to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System" stated that "The cost of local externalities such as noise, air pollution, and congestion could be internalized through charging for the use of infrastructure"[55]. The amending Directive of 2011 as indicated in the White Paper 2011 above gives the Member States the possibility to apply external cost charges related to traffic-based air pollution and noise[56]. This amendment also adapted the possibility to differentiate tolls according to time, type of day, or season, with a view to mitigating congestion. Finally, for this period, an external evaluation of the Eurovignette of 2014 concluded that "Most EU Member States have transposed the 1999 Directive and its amendment in 2006[57]. However, only a few Member States have systematically implemented and applied all the provisions of the Directive."

Following this, Parliament called on the Commission to submit proposals in order to provide:
- The internalization of the external costs of all modes of freight and passenger transport[58];
- Specific measures to ensure a wider application of the 'user pays' and 'polluter pays' principles;
- A general framework for national road charging schemes for passenger cars and light commercial vehicles prioritizing distance-based charging;
- Initiatives to ensure the interoperability of electronic road toll systems[59].

[53] COM(2001) 370 final, Brussels, 12.9.2001.
[54] Directive 2006/38/EC; *OJ*, L 157, 09 June 2006, p. 8 ff.
[55] COM(2011) 144 final, Brussels, 28.3.2011, Chapter 3.3 "Modern infrastructure, smart pricing and funding", par. 61.
Later, in March 2017, the situation was as described by Malmersjo (2017): four Eurovignette countries, including The Netherlands and Luxembourg, four vignettes (stickers on window) countries, nine network-wide electronics tolls countries, including Belgium, and six concession motorways tolls.
[56] Directive 2011/76/EU, *OJ*, L 269/1, 14 October 2011, p. 1ff.
[57] Evaluation of the implementation and effects of EU infrastructure charging policy since 1995, prepared for the European Commission by Ricardo-AEA, 2014.
[58] At the request of Parliament, in 2008, the Commission published a Handbook on estimating external costs. This has been updated in 2014 (see:
https://ec.europa.eu/transport/sites/transport/files/themes/sustainable/studies/doc/2014-handbook-external-costs-transport).
[59] European Parliament, *resolution of 9 September 2015 on the implementation of the 2011 White Paper on Transport: taking stock and the way forward towards sustainable mobility* (2015/2005(INI)) (2017/C 316/16), Strasbourg, 2015.

5 Present approach[60]

Main line: Considering the shortcomings related to existing provisions and problem areas that road charging could tackle, as well as the need for simplification and clarification of the directive, the current framework for road charging is deficient because the Eurovignette Directive disregard vehicles such as passenger cars, vans, and buses and does not cover CO_2emissions. In the European Commission evaluations and consultations in 2016, the Member States did not support the measures for subsidiarity reasons.
Nevertheless, the Commission adopted a proposal for a directive amendment of Directive 1999/62/EC in May 2017, which was linked to the energy union strategy and the Commission's strategy for low-emission mobility.
The proposal with amendments was voted on in the European Parliament and now, 31 March 2019, to continue the legislative procedure, it is waiting for the Council's position, but it is 'on hold'.

Evaluation of the current framework led to the identification of a number of shortcomings related to existing provisions and problem areas that road charging could tackle[61]. The fact that the directive does not oblige the Member States to introduce user charges and leaves some room for interpretation on road charging methods results in a situation where there are disparities in national road charging policies and a lack of harmonization when it comes to the type of charges. Member States are free to decide if they want to implement road charges, on which part of their road network, and to what extent they want to recover the costs of infrastructure. While twenty-four Member States have implemented some sort of road charges, only fourteen Member States apply distance-based charges to HGVs and only eight to passenger cars. The possibility of exempting vehicles between 3.5 and 12 tons leads to an uneven playing field in freight transport. For example, four Eurovignette countries (Denmark, Luxembourg, the Netherlands, and Sweden), as well as the United Kingdom, still use this possibility, while in Germany, tolls only affect vehicles over 7.5 tons. In addition, the application of charges to buses, coaches, vans, and passenger cars is outside the scope of the current legislation and is left to Members States' discretion, which leads to a situation where road charging is primarily focused on HGVs in most Member States and does not reflect the 'user pays' and 'polluter pays' principles for all road users. Only a very limited number of Member States introduced time-varying charges to deal with congestion. Another problem related to the provisions of current legislation is that time-based charges, authorized by the directive, do not seem to be effective in covering infrastructure costs, incentivizing cleaner and more efficient operations, or reducing congestion. Moreover, application of external cost charging is too complex, and the Euro class variation is not well-defined. Finally, the variation of charges to deal with congestion is also seen as too difficult to implement and may appear as unfair if addressing HGVs alone.

In addition to the need for simplification and clarification of the directive in certain areas, the current framework for road charging is also seen as deficient in two major areas:
- The Eurovignette Directive covers HGVs only, disregarding other vehicles such as passenger cars, vans, and buses;
- The current directive does not cover CO_2 emissions, although it addresses other externalities such as air pollution and noise; over 60 % of these emissions originate from passenger cars.

In order to prepare a review of the Directive, the European Commission used previous evaluations and consultations in 2016 with the general public and with specific stakeholders (among others the Member States). These made clear that, in contrast to most stakeholders, Member States did not support the measures to ensure the quality of roads infrastructures, notably for subsidiarity reasons.

[60] Most of the text in this Section has been taken from EP Briefings: G. Malmersjo, The Eurovignette and the framework to promote a European electronic toll service (EETS), PE 598.600, Strasbourg, *EPRS*, March 2017; A. Debyser, Revision of the Eurovignette Directive, PE 614.625, Strasbourg, *EPRS*, 8 December 2017; id., Revision of the European Electronic Tolling Service (EETS) Directive, PE 625.142, 2nd edition, Strasbourg, *EPRS*, February 2019.
[61] Commission Staff Working Document Impact Assessment-SWD/2017/0180 final-2017/0114(COD)

They considered that it is up to them to decide in what way they manage and fund their own road networks.

Nevertheless, the Commission adopted a proposal for a Directive amending (Directive 1999/62/EC) in May 2017, linked to two wider strategies, i.e., the energy union strategy which, inter alia, envisaged a road transport package, including more efficient infrastructure pricing, and the Commission's strategy for low-emission mobility[62]. The proposal was presented within the context of the Commission's 'Europe on the move' package[63].

The objective of the Eurovignette proposal, which substantially amends the existing legislation by extending the scope of vehicles covered, is to make progress in the application of the 'polluter pays' and 'user pays' principles, thereby promoting financially and environmentally sustainable and socially equitable road transport.

The changes proposed are:

- Scope of application to the goods vehicles over the 3.5-tons limit, passenger cars, minibuses, vans, coaches, and buses;
- Gradually phasing out the use of time-based user charges (vignettes) for heavy goods vehicles (HGVs), buses, and coaches (until 31 December 2023) and later on for passenger cars and vans (until 31 December 2027);
- Removing the possibility to exempt HGVs below 12 tons from road charging and as of 1 January 2020, charging applies to all HDVs;
- To be proportionate to the duration of the use of the infrastructure and introduction of upper limits to user charges;
- A distinction between different types of vehicles phase out the variation of charges according to the Euro emission class of the vehicle and instead introduce a variation of charges according to heavy-duty vehicles (HDV) on CO_2 emissions and to light duty vehicles on emissions of both CO_2 and air pollutants;
- Allowed will be the application of congestion charges, on top of infrastructure charges, to address the issue of interurban congestion;
- Member States levy tolls that could apply an external-cost charge from 1 January 2021 for heavy duty vehicles to at least part of the network;
- Regarding mark-up, extension of the possibility to use them beyond mountainous regions, but a mark-up would not be additionally applied to road sections where a congestion charge would be applied;
- Update provisions on reporting requirements on tolls, tolls revenues, and the use of revenues, as well as on the quality of toll roads, and simplify certain provisions such as those related to the application of external-cost charging for air pollution and noise allowing the use of reference values.

The proposal was voted on in the European Parliament Committee on Transport and Tourism (TRAN), and a mandate for negotiations in Trilogue was adopted in plenary[64].
On 25.10.2018, the European Parliament adopted a legislative resolution on the proposal[65].

[62] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank, a framework known as *A Strategy for a Resilient Energy Union with a forward-looking Climate Change Policy*, COM/2015/080 final, Brussels, 25.2.2015.
European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions, *A European Strategy for Low-Emission Mobility*, COM/2016/501 final, Brussels, 20.7.2016.
[63] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions, *Europe on the Move. An Agenda for a Socially fair Transition towards clean, competitive, and connected Mobility for all*, COM(2017) 283 Final, Brussels, 31.5.2017. Accompanied by a first series of eight legislative initiatives specifically targeting road transport.
[64] On 12.06.2018. For procedure see article 294 TFEU, in particular, par. 10 about the Conciliation Committee.

At its first reading under the ordinary legislative procedure, Parliament amended the Commission proposal. On 25.10.2018, the European Parliament adopted a legislative resolution on the proposal as follows (summarized)[66].
- Tolls and user charges: Parliament considered that road charging imposed by Member States would need to become distanced-based from 2023 for heavy duty vehicles and larger goods vans with a maximum permissible laden mass of between 2.4 and 3.5 tons and a height of more than 2 meters and from end of 2027 for light duty vehicles, meaning vans and minibuses. Note that passenger cars were removed from the definition of light duty vehicles. As of 1 January 2020, tolls and user charges applied to heavy duty vehicles shall apply to all heavy-duty vehicles and vans, rather than the carriage of goods.

- User rights [proportionality and equal treatment]: According to the amended text, road networks covered by an infrastructure charge shall offer a **[**high level of road safety] and be equipped with all the necessary infrastructure, such as safe parking areas in all weather conditions, to comply with the obligations laid down in the Regulation on rest periods and driving times.

- External cost charging: From 1 January 2021, Member States levy tolls that shall apply an external-cost charge [for traffic-based air or noise pollution] to heavy duty vehicles and vans intended for the carriage of goods on all parts of the network referred to in the Directive that are subject to an infrastructure charge.
From [1 January 2026] onwards, an external-cost charge imposed on any section of the road network shall apply in a non-discriminatory manner to all vehicle categories. Member States may apply derogations which allow external-cost charges to be adjusted for [vehicles of historical interest].

- Congestion charging: Parliament proposed that congestion charges may be introduced or maintained independently from infrastructure charges. Member States may, however, decide to exempt buses and coaches for the promotion of collective transport, socio-economic development, and territorial cohesion.

- Mark-up: The mark-up does not exceed 15% of the weighted average infrastructure charge, except for mountainous areas, where infrastructure costs, as well as climate and environmental damage, [are higher], and the mark-up may not exceed 50%.

- Variation in charges: Parliament proposed that, from the date of entry into force of this Directive, [zero-emission vehicles] will benefit from infrastructure charges reduced by [50%] compared to the lowest rate. The zero-emission operation will benefit from the same reduction, provided that such operation can be proved.
Member States may consider the improvement of the environmental performance of the vehicle, which is linked to that vehicle's conversion to [alternative fuels].

- Discounts: For heavy duty vehicles and vans intended for the carriage of goods, Member States may give discounts or reductions on the infrastructure charge provided that such discounts or reductions [do not exceed 20%] of the infrastructure charge paid by equivalent vehicles not eligible for the discount or reduction and those used for local or habitual transport, or both. Member States or competent authorities may introduce a [kilometre-based flat-rate exemption] on a specific road section, taking into account the mobility patterns and economic interest of peripheral regions.

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[65] *European Parliament legislative resolution of 25 October 2018 on the proposal for a Directive of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures* (COM(2017)0275 – C8-0171/2017 – 2017/0114(COD)) (Ordinary legislative procedure: first reading) Strasbourg, 2018.
[66] Text between brackets ("[ ]") is the text of the amendment.

In [mountain areas and peripheral regions], Member States or competent authorities may vary toll rates for heavy vehicles according to distance travelled by the tolled vehicles to minimize socio-economic impacts.

- Use of revenues: Revenues shall be used to (i) reduce air and noise pollution from road transport; (ii) finance collective and sustainable modes of transport; (iii) develop alternative fuel infrastructures; (iv) support the trans-European transport network and eliminating bottlenecks.

- Lastly, it is proposed to establish in each Member State an [independent supervisory authority] for infrastructure charging responsible for ensuring compliance with this Directive.

With the Council yet to agree on its position, there will still be a trilogue to obtain a text which can be adopted by Parliament and Council on equal footing and finally be published in the Official Journal. However, till now (i.e., 31 March 2019, date of finishing article), there is no reaction of Council. "On hold" is the only indication, without saying for how long[67] [68]. Obviously, without the Council's position, no trilogue, no formal adoption by Parliament and Council, and thus no final text of a revision of Directive 1999/62/EC exist for publication in Official Journal to become law.

6 Electronic toll collection[69]

In addition to what is related to road pricing, a number of matters can be mentioned that are related to this issue in some other ways. That relationship may be of a more or a less strong nature (i.e., either or not based on article 91 TFEU).

An example of the latter - based on article 113 TFEU - is fuel tax.
Many years ago, charges on road traffic were in the form of fuel taxes. Today, the latter largely consist of excise duties. In 1992, the EU brought about a certain harmonization, just by providing a minimum rate of a tax. In practice, however, excise duties are often way above these minimum rates[70].

Strongly related to – even part of – the subject of road-pricing is the interoperability of toll systems. The Directive on the interoperability of electronic road toll systems and the Commission Decision on the definition of the European Electronic Toll Service and its technical elements are the existing legal framework focused on making all European Electronic Toll Collection schemes interoperable through a European Electronic Toll Service (EETS)[71].

Directive 2004/52/EC prescribed the setting up of an EETS, enabling road users to subscribe to a single contract and use a single on-board unit (OBU) to pay electronic tolls across the EU. In

[67] The Secretariat General of the Council only refers to "Europe direct of the EU Commission". EPRS, nevertheless, was so kind to send me their "legislative train schedule - resilient energy union with a climate change policy".
[68] There was, however, already an indication in the past. Earlier European Commission consultations show that in contrast with most stakeholders, Member States did not support the measures to ensure the quality of roads infrastructures, notably for subsidiarity reasons, considering that it is up to them to decide how they manage and fund their own road networks. Member States and stakeholders' views also diverged regarding the possible measure to avoid discrimination and ensure a level playing field. Member States were divided according to the need for further measures to avoid discrimination, and the phasing out of vignettes attracted little support.
[69] Most of the text in this Section is taken from Debyser (2019).
[70] Council Directive 92/81/EEC of 19 October 1992 on the harmonization of the structures of excise duties on mineral oils (*OJ*, L 316, 31.10.1992, p. 12. Directive as last amended by Directive 94/74/EC (*OJ*, L 365, 31.12.1994, p. 4) and Council Directive 92/82/EEC of 19 October 1992 on the approximation of the rates of excise duties on mineral oils (*OJ*, L 316, 31.10.1992, p. 19. Directive as last amended by Directive 94/74/EC.
[71] Directive 2004/52/EC, *OJ*, L 166, 30.4.2004, pp. 124–143 and Commission Decision 2009/750/EC, *OJ*, L 268, 13.10.2009, pp. 11–29, respectively.

particular, new electronic toll equipment, brought into service after 1 January 2007, should use one or more of the following technologies:

- Satellite positioning (GNSS – "global navigation satellite system");
- Mobile communication (GSM – "global system mobile communication");
- Radio service (GPRS – "general packet radio service");
- Microwave technology (DSRC – "dedicated short range communication").

Decision 2009/750/EC defined the EETS and set out technical specifications and requirements as well as contractual rules relating to EETS provision. It outlined the various actors involved (Member States, toll chargers, clients, and EETS providers) and their rights and obligations. The legislation was intended to complement local electronic toll services, not to replace them. It had been stipulated that a fully interoperational EETS would be available, offering electronic toll collections services to HGV users by October 2012 and to all vehicles by 2014, but this was not achieved.
Parliament then calls for drastic action to address the lack of progress related to EETS, regrets the lack of interest among Member States in progressing with it, and calls for strong political action. It expresses concern about the regional approach suggested by the Commission to improve implementation. It calls for a continued EU-wide approach and infringement proceedings to be started against any non-compliant Member States. It asks the Commission to conduct a review of the available evidence to suggest options for an EETS based on best practice and if necessary, requests new proposals to address any issues identified by this review[72]. In the meantime, there is still a variety of around 140 collection systems across the EU, with DSRC as the most used technology. Interoperability between toll domains, however, is unsatisfactory.

Finally, there is now a new proposal as one of the actions of "Europe on Move"[73]. It is presented as a recast of Directive 2004/52/EC and facilitates the wider application of the "user pays" and "polluter pays" principles by making electronic tolls easier to deploy and apply. On top of ensuring the interoperability of the electronic road toll system, it proposes to work on a legal framework for the exchange of vehicle registration data for the purpose of toll enforcement. The various categories of EETS market players, currently defined only in Decision 2009/750/EC, are more precisely defined in the Directive itself. The main changes include the deletion of a provision in Article 1 to allow Member States to exchange information on those who fail to pay road fees where toll systems do not require the installation of on-board equipment. Regarding technological solutions (Article 3), the proposal confirms that, for the purpose of the Directive, portable devices used for electronic toll transactions are to be considered as on-board equipment. The list of technologies that can be used for electronic toll transactions is moved to Annex IV, and the Commission can amend the list by delegated act if a technology becomes obsolete or if a new technology should be added to the list[74]. The text also mentions that EETS on-board equipment can link to other devices installed or present in the vehicle, such as satellite navigation systems or smartphones. It also specifies that communication between on-board equipment and such other devices may use technologies that are not listed in Annex IV (for example Bluetooth). Article 3 is further modified in order not to compel EETS-providers to supply EETS to all types of vehicles and to allow them to choose to provide a service for heavy or light duty vehicles only. In addition, until 31 December 2027, EETS providers serving light duty vehicles are authorized to offer their clients on-board equipment suitable for use with 5.8 GHz microwave technology only. Finally, provisions are proposed for the cross-border exchange of information on the failure to pay road fees, by adapting the provisions of Directive (EU) 2015/413 to the tolling context[75].

At its June 2018 plenary session, Parliament confirmed the TRAN Committee's decision to enter into inter-institutional – "Trilogue" - negotiations. The Transport, Telecommunications, and Energy

[72] European Parliament, resolution of 11 June on a strategy for an electronic toll service and a vignette system on light private vehicles in Europe, Strasbourg.
[73] See footnote 31.
[74] Technology tested in the framework of pilot tests in compliance with Article 20 of Decision 2009/750/EC.
[75] Directive (EU) 2015/413 of the European Parliament and the Council of 11 March 2015 which facilitates the cross-border exchange of information on road-safety-related traffic offenses, *OJ*, L 68, 13.3.2015, pp. 9–25.

Council adopted its position ("general approach") on 7 June 2018. Trilogue negotiations resulted in a provisional agreement on 20 November 2018. The agreement improves information exchange on vehicle data, as national authorities will have access to other Member States' national vehicle registration data to identify the owners of vehicles which fail to pay road fees. It will thus put all road users on an equal footing. The agreement also gives electronic tolling providers easier access to the toll collection market, by removing administrative barriers, notably local technical ones, and allows for the development of a system whereby an individual can use a single on-board toll payment device when driving across the EU. Formally adopted by Parliament and Council, the final text of the Directive has been published in the Official Journal[76].

7 Conclusion

The European Union has law-making power with regard to road pricing, i.e. to the extent that the Treaties and derived law grant it jurisdiction for this.
Coordination, harmonization, and guarding subsidiarity are general competences in the Treaties, but also in transport (title VI TFEU).Where there is political will, all possibilities within a common transport policy can be used. It is exclusive to the European Commission to make proposals. For Parliament and the Council, on an equal footing, to make these into law.

Unfortunately, at the time of writing, this is not the case for the Council, that holds on to its position on the Eurovignette Directive revision, without a date limit.

For the Commission, its political will on road pricing is clear. It is practiced making use of the most recent scientific knowledge of road pricing, in adapting and packaging its proposals to the highest political possibilities. So too for Parliament, and even more. The latter several times summoned the Council to the Court for transport matters several times - and all times with success.

The possibility exists, of course, that the Council comes to a position soon, but it is doubtful because Commission's proposal and Parliament position in first reading under the ordinary legislative procedure contain a transfer of some sovereignty. Nevertheless, let's hope that the link of the Eurovignette revision to the energy union strategy and the Commission's strategy for low-emission mobility will be the catalyst to convince Council that the old and only one Directive about road pricing, still based on the context of competition and disruption between transport modes, will be adapted to the widely accepted principles of "the polluter pays" and "the user pays".

[76] Directive (EU) 2019/520 on the interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union, *OJ*, L 91, 29.3.2019, pp. 45–76.

11 International cooperation on freight transport pricing and investment

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Abstract

In this Chapter, international aspects of freight transport pricing and investment policies will be discussed, largely focusing on road transport. Specifically, the recent shift - in countries that are part of the EU - from fuel taxes towards distance charging for trucks will be emphasized, and the role of subsidies versus pricing to finance large infrastructures will be discussed.

1 Introduction

The European single market has generated a strong increase in international freight traffic, mainly by road. This required not only better regulation (for example, allowing cabotage), but also a more harmonized pricing system that makes sure the different users pay for the external costs they cause when they use a country's infrastructure. External costs include wear and tear of the road, congestion, local air pollution, accidents, and global pollution (CO_2). Although in principle these externalities can be fairly internalized, in practice political obstacles prevent many governments from doing so. This Chapter focuses on two issues in the economics of international freight transport that have been heavily discussed by European policy makers over the past decades. First, accounting for external costs required a revolution in the pricing of road use by trucks, and over time diesel excises and vignettes are being replaced by distance charges. It is explained why and how this evolved in Europe (Section 2). Second, the EU has been subsidizing the construction of international freight corridors. The merits of this investment program are assessed, and possible improvements are looked for (Section 3). The main conclusions from the Chapter are presented in Section 4.

2 Pricing of road use by trucks

Trucks and, to a lesser extent, buses cause damage to the roads. It is their axle weight to the 3rd or 4^{th} power that creates the damage to the road surface. This is also why cars contribute little to road damage. Trucks are also to a higher degree responsible for noise, pollution, accidents, and congestion.

This is all well-known, and governments all over the world have been trying to limit these externalities in diverse ways. For example, nowadays, regulations consider axle weight, and charging systems for trucks depend to some extent on the externalities caused while contributing to road maintenance.

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Although is not difficult for countries that have toll roads to implement a much better charging system, most countries have used a mixture of an annual vignette combined with diesel taxes. These second-best pricing systems came under increasing pressure when international trucking did grow strongly over the last thirty years due to the integration and extension of the European economy. Neighbouring countries tried to set up a vignette system (the "Eurovignette") that can differentiate according to vehicle characteristics (axle weight and emission abatement equipment). The idea was that the same national vignette could be used in the neighbouring countries. Using the same vignette in all countries and hence, on all international trips, saves a lot on transaction costs. Unfortunately, when countries had to reach a consensus on the price level of this common vignette, the result was the smallest common denominator, leading to cheap vignettes. Because of this, the diesel tax became the major financing and regulating instrument for trucks.

This had important consequences, because goods transport by road is to a substantial extent international traffic. Tax competition between countries puts restrictions on the behavior of individual countries (in a transport setting, see De Borger *et al*., 2005; De Borger *et al*., 2007). If the charges on truck use cannot easily be avoided (for example, in large countries where the charges imposed by a country can only be avoided by taking another route and avoiding the country's infrastructure), countries may impose high charges to generate large revenues. On the contrary, if the charges can easily be avoided, countries facing a lot of through traffic have incentives to set low user charges on trucks' road use so as to attract much traffic, and hence, earn high revenues.

Not surprisingly, then, as trucks pass through several countries, tax competition for diesel fuel implied that sustaining a high diesel tax was very difficult. Trucks can carry fuel in their tanks for 2000 km or more, and they simply fuel up where it is the cheapest. To see the implications, consider a large country and a small neighbouring country. The large country has no incentive to decrease its fuel tax to a level below the external cost. Doing so would mean that all traffic by domestic trucks pays less than the full social cost which is economically inefficient. The country would gain some tax revenues from the international trucks that trade goods between the two countries, but this gain will be small for two reasons: the large country does not need a lot of international trade with the small country, and the tax is small. In sum, the large country has no incentive to set low charges. Now, consider the decisions of the small country. This does have a strong incentive to decrease its diesel tax. In fact, it would gain high tax revenues since there are many trucks in the large country that will want to tank cheaply, and this will more than compensate for the underpricing for domestic trucks inside the own (small) country.

The fact that smaller countries may benefit from undercutting the taxes of the larger countries is one of the basic insights from the tax competition literature (Kanbur and Keen, 1993). To illustrate, in 2012, the excise on diesel was € 0.47 per litr in Germany and only € 0.30 per liter in Luxemburg. The € 0.30 per liter was close to the minimum fuel excise set by the EU ministers of finance. Otherwise, Luxemburg may have set an even lower excise on diesel. Tax undercutting by small countries also holds for taxes on cigarettes and alcohol, and for-profit taxes of international companies.

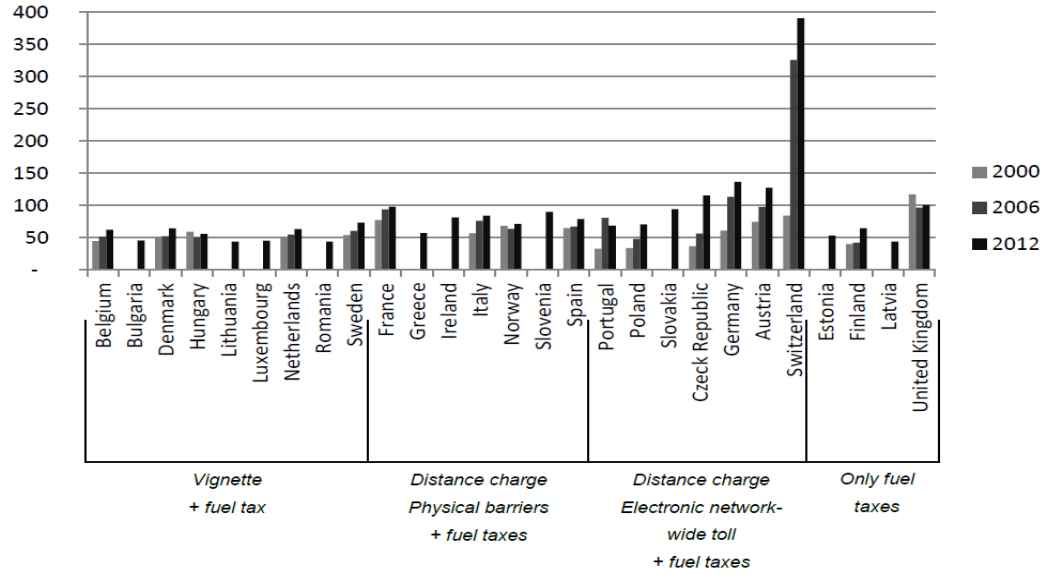
As expected, all those countries that suffered from intense diesel tax competition by neighbouring countries were forced to take action. One obvious response was to shift from the fuel tax towards instruments that cannot be avoided so easily. One such new instrument is a distance charge for trucks. It is an electronic payment system that lets trucks pay per kilometre driven in a country. This cannot be avoided, unless the truck totally avoids the country. To illustrate the shift, Figure 1 presents, for several countries, the total charges on road use for a 40-ton truck with a domestic haul of 400 km over the period 2000 to 2012. Several countries, such as Switzerland, Germany, Austria, the Czech Republic, Slovakia, and Poland. started to introduce new instruments over this period. Belgium (2016) later followed these.

It is interesting to see the underlying economics of the shift towards distance charges. A first thing to note is that countries are more or less forced to introduce distance charging for trucks (Mandell and Proost, 2016). To see this, start with two identical countries A and B that are linked by intensive

international truck traffic and use only diesel fuel taxes. The diesel taxes are initially set at the same level. Imagine now that country A lowers the fuel tax for a 100 km trip on its territory by € 1, but at the same time introduces a distance charge for the equivalent of € 1 euro per 100 km. For the domestic trucks in country A, there will be no change: they pay exactly the same. But all the international traffic from B will fuel up in country A; this will gain tax revenues, and country B loses revenues. The best reply of country B is to also introduce distance charges and lower its fuel tax.
This, however, is not the end of the story. Country A will have incentives to further reduce its fuel tax and replace it by higher distance charges in response to B's policy, to which B will again react. Therefore, over time the fuel taxes will be driven to the bottom and progressively replaced by higher and higher distance charges. There is now a risk, that truck charges become too high. Most international truck drivers can decide where to take fuel, but they have to use the roads of the countries that are part of their least cost route. Therefore, trucks have difficulties to escape the distance charges by rerouting. Small and medium sized countries with a lot of international traffic will find it beneficial to increase the distance charges and start to charge more than their external costs. The domestic trucks will also pay too much, but this may well be compensated by the extra profit that margin countries can earn from foreign trucks.

In sum, the change in charging instruments from diesel taxes to distance charges has transformed the problem of too low charging of trucks into a problem of excessive charges on trucks. Figure 1 illustrates this. The very high charge imposed in Switzerland is a clear example of overcharging compared to the social cost. It is a consequence of the fact that most trucks which go to Italy have to pass through Switzerland.

FIGURE 1 Truck charges for a standard 40-ton truck with a domestic haul of 400 km. Charging policy of 2012 Source: (Hylen et al., 2013, OECD)



What can be done to limit excessive charges on trucks? The EU can impose that charges have to be in line with the external costs. This is, however, difficult to implement since external cost estimation is complex, and it uses subjective valuations of health damage, noise nuisance, etc. Therefore, each country can claim that it has a unique ecosystem that needs to be protected at all cost. What the EU did instead is to oblige each member country to set an upper bound for the distance charge. The option that is chosen is that the distance charge cannot exceed the average infrastructure costs. This is a smart upper bound because international traffic and domestic traffic use the same road infrastructure. A member country cannot discriminate between a domestic truck and a foreign truck. The best it can do is to set a distance charge that corresponds to the investment level that is optimal for the domestic traffic (Van der Loo and Proost, 2013 and De Borger and Proost, 2016).

Over the last 20 years, we have seen a revolution in the way the use of trucks is priced, but there are some remaining problems. At the EU level, the present distance charges are not differentiated according to the level of congestion, and this will become important once road pricing is also introduced for passenger cars. Moreover, the current EU regulation limits the distance charges for the member states, but, unfortunately, this is not binding for Switzerland (that is not an EU-member). The only option for the EU is to negotiate with Switzerland and link it to other dossiers to strike a deal.

3 Investment in international infrastructure

Competition between countries is not limited to pricing; it also has implications for countries' investment in infrastructure. For example, countries facing much through traffic have no incentive to heavily invest in infrastructure, unless charges can be imposed on through traffic.
The benefits of their investment largely accrue to foreign users of the infrastructure so that, if they cannot charge through traffic one way or another, they will underinvest. To avoid this, coordination between countries is needed.

This is certainly the case for infrastructure that links two or more countries. Both the location and the timing of the investment have to be coordinated; moreover, each of the countries may think that the other one benefits more, and therefore, that it should pay a larger share of the investment cost.

These potential conflicts were one of the reasons why the EU intervened and started a program to improve the international freight infrastructure, i.e., the Trans-European Networks program for transport (TEN-T). The concept of a Trans-European transport network was formally recognized in the Maastricht Treaty (1992), and a priority list was drafted, consisting of thirty ‘‘priority’’ projects, to be launched before 2010. Project selection was based on a number of criteria, including the overall net socio-economic benefits and the project's ‘‘European added value’’. This concept considers the share of benefits that are truly international and the extent to which benefits also target the poorer member countries. Priority projects are eligible for European subsidies.

Proost *et al*. (2014) tested the merits of a large number of priority projects using a combination of cost-benefit methodologies. Based on a reasonable CBA threshold, it was found that the selection of TEN-T priority projects was not efficient. Out of the twenty-two assessed projects, only thirteen passed an elementary efficiency test; moreover, only a minority of these had any real ‘‘European added value’’ that may be considered a reasonable justification for EU financial aid. The ‘‘European added value’’ of half of the projects is below 10 %, and some of the projects even have a significant negative impact on other countries.

With respect to the issue of equity, some of the twenty-two projects mostly benefit the richer countries, while other projects mostly benefit the poorer countries. Hence, neither do the results suggest a systematic tendency of the selected TEN-T projects to favour lagging regions, nor is the opposite true.

It is interesting to look at two projects situated in the Benelux: the Betuwe line and the canal Seine-Scheldt. The Betuwe line is a railway project connecting the port of Rotterdam with the Rhein/ Ruhr area. The Dutch part of the rail track was opened for transport in 2007 and cost € 4.7 billion. One pricing scenario involved full marginal social cost pricing for all transport modes, which performed better than the current pricing approach, in which road use is underpriced. However, the Betuwe line gains only a small market share of the total traffic between the Hamburg-Le Havre range of ports and the German Ruhr area. The net discounted benefits are negative and in absolute value close to the investment cost. Thus, the project is not justifiable economically and can only survive financially with a subsidy that covers close to 100% of the initial investment. The main reason for the poor economic performance is the availability of substitutes for the new rail link from the port of Rotterdam, such as

an existing rail link and inland waterways connections, and the availability of other ports (Antwerp, Bremen) that are connected to the Ruhr area. Unfortunately, the rail line has already been built At this point, the discussions can be mentioned around the Iron Rhine, connecting the port of Antwerp to the Ruhr area, a project similar in spirit to the Betuwe line. This project is pushed by the Flemish government, but according to the Dutch government, the official CBA shows a clear negative result (ANP, 2018). Available at https://www.ed.nl/eindhoven/studie-heropen-ijzeren-rijn-via-venlo~a7a16e01/.

The aim of the Seine–Scheldt project is to connect Belgium and the Netherlands - in particular, the ports of Rotterdam and Antwerp - to northern France and Paris via inland waterways. The main bottleneck for inland waterway transport in this region is the Canal du Nord between Compiègne and Cambrai (in the North West of France). Navigability on this section is at the lower end of international standards, with access restricted to vessels of about 300 tons on some stretches. A new large-gauge one will replace this canal, which allows barges with a loading capacity up to 4,400 tons to pass. Belgium has been planning for a long time - in fact, since the middle of the twentieth century! - to improve navigability on the north axis of the bottleneck.

The canal between Compiegne and Cambrai will cost at least € 2.3 billion and is planned to become operational between 2010 and 2020. Usually, it is argued that freight traffic on canals should cover only a fraction of the investment cost, since a canal creates additional benefits, including water management, flood protection, accessibility for recreational vessels, and recreational facilities on embankments in addition to electric power generation. Traditionally, this lowers the required threshold of net benefits to 50–70% of the investment. Unfortunately, very low economic efficiency benefits are found based on the first nine years of operation: the net benefits are of the order of 5–10% of the total investment. There are several reasons for this. For example, the overall freight demand in this corridor is low, and there are parallel rail and road options that are not yet saturated. Clearly, the required threshold mentioned above appears unlikely to be achieved.

One other argument for subsidizing freight projects in poor regions is the contribution of these transport projects to attracting new economic projects to a region. This argument is not entirely convincing and is difficult to validate. Whether it is true is a methodologically tricky question. Regional growth theory is complex, and under some conditions, it may actually offer the opposite conclusion.

Indeed, as transport infrastructure typically runs both ways, and there are clear benefits of concentrating economic activities within a certain area, a well-intentioned transport project linking the periphery with the core regions may be counterproductive (Proost and Thisse, 2017). In the case of inland navigation, one should always take into consideration that both intra- and interconnection with other modes of transport are limited by the nature of their infrastructure.

One explanation for the apparent poor choice of priority projects is frequently defined as ‘‘pork-barrel’’ politics, which is likely to occur when transport investments favour a particular constituency, leading to the risk of excessive supply of local projects when paid for at the federal level. This is consistent with evidence on the allocation of the federal Highway Trust Fund in the US (Knight, 2004). Potential remedies include standardizing the CBA procedure under specific, pre-defined rules, and limiting European level subsidies only to projects that generate significant benefits (time savings, freight cost savings) accruing to users outside the countries investing in the infrastructure.

The discussion so far leads to the inevitable question: what instruments can prevent this misallocation of resources? Two powerful ingredients of the mechanism design may be emphasized that are required to ensure optimal infrastructure planning. The first one is related to the CBA procedure itself, the second involves the share of the projects that may be legally funded by federal public money (Proost *et al.*, 2011).

In 2000, the Netherlands introduced a requirement that all CBA for major infrastructure projects must be carried out using published guidelines. The results are in principle available to Parliament and, through this, also to the general public. In addition, the Dutch government decided that a CBA is only credible if peers review it. Consequently, the practice of a ‘‘second opinion’’ was instituted. Annema *et al*. (2007) discuss the effects of this requirement on decision making in practice. For many projects, the requirement of a standardized CBA led to a reformulation or postponement of the project. The reformulation is often a downsizing that permits the project to become economically efficient. It clearly cannot be concluded from the Dutch experience that the obligation of undertaking a CBA following certain guidelines is a guarantee that an economically inefficient project is never accepted, but Annema *et al*. (2007) find a clear impact on public decision making.

A second solution to restricting the common pool problem present in the federal funding of infrastructure would be to intervene only if a project has important spillovers. When there are no important benefit spillovers into other regions, it may be strictly preferable to leave the decision process at the level of the member country; moreover, one could require private funding (without state guarantee) to finance a pre-specified minimum percentage of the project. The likely outcome would be that inefficient projects remain on paper but are not executed, as private investors are generally careful at risking their own money.

There are two drawbacks to this procedure. Firstly, efficient projects may be selected but may not be priced correctly. Secondly, there may be socially efficient projects that will never be proposed by private operators, because the benefits of the project cannot be sufficiently ‘creamed off’ by the operator. In that case, a mismatch between private and social economic efficiency remains.

4 Conclusion

This Chapter analyzed the pricing of international road freight and investment in freight transport projects. For road freight, it has appeared that in Europe pricing has changed drastically, as the combination of vignettes and diesel excises has been substituted by a combination of distance charging and diesel excises. This new combination dominates the former system, and this explains why the new system did not need to be imposed but evolved naturally.

The EU has a poor record in selecting the best international freight projects. This is the result of political pork barrel politics, too generous funding, and a lack of rigorous and peer reviewed implementation of Cost Benefit Analysis.

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Part IV: PRACTICE

Chapter 12. Practical applications of road pricing and associated technology
M. COOLS

Chapter 13. Road pricing for bus and coach
S. LANNOO AND J. DE VOS

12 Practical applications of road pricing and associated technology

M. COOLS [1]

Abstract

Road pricing can serve multiple objectives. Several pricing instruments are available for this. This Chapter provides an overview of the various objectives and associated instruments. The urban road charging measures put into practice in London, Stockholm and Milan are explained and analyzed. These experiences are useful for road price applications elsewhere. But every application has case specific features that must be taken into account.

1 Road pricing objectives, types and fee collection options

When discussing road pricing, it is important to describe the different objectives, types and fee collection options to better understand the specific implementation of road pricing in a particular context. In terms of objectives, it is important to highlight the two commonly - and generally separately applied - goals of road pricing, *i.e.* (*i*) revenue generation, and (*ii*) congestion management (Rouhani, 2016). The first objective is to maximize revenue or recover specific costs-often dedicated to a road infrastructure project-and does not necessarily entail a desired shift to other routes and/or modes because of a reduced revenue generation. On the other hand, the second objective explicitly focuses on alleviating congestion, by stimulating a shift to other modes, routes and other time slots. It thus forms a travel demand management (TDM) strategy.
Road pricing can take different forms (types) and be implemented at different scales, using different technologies. The interplay of these different combinations will affect the impact of each particular road pricing solution. In terms of type of road pricing, the following main types can be distinguished (Victoria Transport Policy Institute, 2018): (*i*) road tolls, (*ii*) congestion pricing, (*iii*) cordon fees, and (*iv*) distance-based fees.

1.1 Road tolls

Road tolls, *i.e.* fixed fees for driving on a particular road, are a commonly used method to fund road infrastructure improvements. The underlying motivation is that a fee should be levied according to the service provided, as this is considered more equitable and economically efficient than options which cause non-users to help pay for improvements. Revenue generation is the major motivation for levying tolls, especially in the case of private road operators. Road tolls are usually implemented at a point such as a bridge or a tunnel - *e.g.*, the Liefkenshoektunnel in the city of Antwerp - or at an entire (or parts of a) facility, based on a per-kilometre basis - *e.g.* the “péages” on the French highway network.

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1.2 Congestion pricing

Congestion pricing, also referred to as “value pricing” or “smart pricing”, refers to road tolls where the fee is higher under congested than under uncongested conditions. The goal here, is to shift car traffic to other routes, times and modes. The tolls can vary according to a fixed (time) schedule or can be made dynamic, so that rates depend directly on the level of congestion at a given time. Alternatively, rewards - (*i.e.*, a form of subsidies - can be given for avoiding trip making during rush-hour, such as the “spitsmijden” (“avoiding the peak”)-trials in the Netherlands (Ben-Elia and Ettema, 2009; 2011; also see Chapter 4, Section 6 and Chapter 6, Section 4, in this book).

1.3 Cordon (area) fees

Cordon or area fees are tolls levied for driving in a particular area, typically an urban centre. Motorists are charged when they cross any of the charging points that are located at the entrance of the toll area. The charges can vary according to vehicle type, time of day, location and direction of the journey (Abulibdeh *et al.*, 2018). Successful implementations of cordon pricing systems include, for instance, London, Stockholm and Singapore.

1.4 Distance-based fees

Tolls based on distance are tolls based on the number of kilometres driven by a vehicle. These “pay-as-you-drive” charges can be further redefined into weight-distance fees, where the kilometre-based road use charge increases with vehicle weight, representing the roadway costs imposed by individual vehicles, or into kilometre-based emission fees, where the toll reflects the emissions of each vehicle. The latter require an objective calculation of emission rates, particularly in view of test-bed manipulations such as the Dieselgate scandal (Jiménez *et al.*, 2019).

In addition to the above four main types of charging for the use of roads, other types could be distinguished, such as: (*i*) road space rationing, which for instance rations peak period vehicle-trips or vehicle kilometres using a tradable credit system (see, *e.g.*, Dogterom *et al.*, 2017), license plate rationing (see, *e.g.*, Ramos *et al.*, 2017; Nie, 2017) and tradable mobility permits (see, *e.g.*, Fan and Jiang, 2013), and (*ii*) high occupancy toll (HOT) lanes, such as the Interstate 15 in San Diego, U.S. (Halvorson and Buckeye, 2006).

As mentioned above, charging for the use of roads can be implemented at various scales. A first one is that of a precise point or facility, where the charging is implemented on a particular roadway section or critical artwork such as bridge or tunnel. More widely, the charging can be implemented for a corridor. That is: all roads within that corridor are subjected to a charge. Further, for a particular area, charging can be related to a cordon. In this case, the use of all roads within that predefined cordon area is being charged for. Finally, charging for road use can be applied throughout an entire region - the Austrian road tax vignette is a good example of such a way of charging.

There are a wide range of options in terms of technology, with each technology corresponding to significant differences in cost of equipment, operating costs, user inconvenience, and adjustable price Table 1 provides an overview of different toll collection technologies, and highlights the main advantages and disadvantages of each. Note that this table does not consider the potential privacy intrusion the proposed technologies into privacy. In the light of the increased sensitivity to privacy awareness, especially the GPS based tracking method might be considered as too invasive from a privacy protection perspective. A more extensive discussion – *i.e.* from a technological point of view - can be found in Cottingham *et al.* (2007) and De Palma and Lindsey (2011).

TABLE 1 Overview of road pricing technologies (Victoria Transport Policy Institute (2014; 2018))

Type	Description	Equipment Costs	Operating Costs	User Inconvenience	Price Adjustability
Pass	Drivers must purchase a pass to enter a cordoned area.	Low	Low	Medium	Poor-Medium
Tool Booths	Drivers stop and pay at a booth.	High	High	High	Medium-High
Electronic Tolling	An electronic system bills users as they pass a point in the road system.	High	Medium	Low	High
Optical Vehicle Recognition	An optical system bills users as they pass a point in the road system.	High	Medium	Low	High
GPS	A GPS system is used to track the location of each vehicle. Data are automatically transmitted to a central computer that bills users.	High	Medium	Low	High
On-Board Data Collection	An electronic system in each vehicle tracks mileage. Data are transmitted automatically to a central computer.	High	Medium	Medium	Low-Medium
Odometer Audits	Odometer readings are collected by certified odometer auditors.	Low	Low	Low-Medium	Low
VUDAR	Vehicle operating hours are recorded by a small instrument installed in each vehicle. Data are transmitted annually at a special station.	Medium	Low	Low	Medium

2 Lessons learned from best practice examples

In terms of successful implementations of charging for the use of roads in Europe, in particular the stories of the cordon charges in London, Stockholm and Milan are frequently cited. Table 2 provides an overview of the main features of the charging schemes, as well as their impacts. Note that all three cities have implemented a cordon (area) fee as an instrument.

TABLE 2 Comparison of urban road charging: London, Stockholm and Milan (Croci (2016) and Hensher and Li (2013))

	London	**Stockholm**	**Milan**
Characteristics			
Starting year	2003	2006	2012
Area	21 km²	30 km²	8 km²
Area / City surface	1.3%	16.0%	4.5%
Type of charge	Cordon charging	Cordon charging	Cordon charging
Fee structure	Daily fee Pay for entrance, exit, intra-area trips	Single passage fee (with daily limit) Pay for entrance and exit of the area	Daily fee Pay for entrance in the area
Time of application	Weekdays, 7:00-18:00	Weekdays, 6:30-18:30	Weekdays, 7:30-19:30
Impacts			
Reduction in traffic entering the zone during charging hours	18%	18%	14%
Change in traffic round the charging zone	-5%	+10%	-4%
Increase in speed inside the charging area	30%	30-50%	4%
Increase in the use of public transport	7%	9%	*6%*
Reduction in CO_2 emissions within the charging zone	16%	16%	14%
Reduction in NO_x emissions within the charging zone	8%	9%	17%
Reduction in PM10 emissions within the charging zone	6%	10-14%	18%

Based on a comparison of the cities of London, Singapore, Stockholm and three Norwegian cities, Albalate and Bel (2009) highlighted the main aspects that need to be taken into account when implementing road charges to alleviate urban congestion as follows: (*i*) the particular characteristics of the city and its traffic patterns – this, given the importance of local circumstances, (*ii*) allocating the use of revenues, (*iii*) treatment of equity concerns to reduce public rejection, (*iv*) make use of trials and early investments in public transport, (*v*) the development of local-national political interaction = to

promote the road charges. This in line with the key lessons ~~of~~ Valletta scheme, where successful implementation revolves around three principles: (*i*) purpose and goals, (*ii*) the scheme, and (*iii*) the political champion (Attard and Ison, 2010). The explicit support of a person or group of people who are willing to undertake the necessary changes and face the associated problems is crucial.

3 Practical considerations for an implementation in a Belgian context

The lessons learned from abroad should be taken into account when implementing road pricing schemes in a Belgian context. The multi-layered division of authority regarding charging for the use of roads, *i.e.* one federal, and three regional ministers of transport, does not facilitate a single common proposal. The latter is, however, a prerequisite for achieving the required public support for the policy measure. The success stories abroad were mainly about the implementation of cordon (area) charges. The implementation of such charges in a Belgian context seems more straightforward than the introduction of distance-based fees, since low-emission zones have already been implemented (*e.g.* in Brussels and in Antwerp) or approved (Ghent). Moreover, the case of Milan illustrated that the conversion of a low-emission zone to a toll zone is a path in which support for road pricing can be increased. In addition, the same technology can be used to identify vehicles entering / exiting the low-emission zone for cordon the cordon and no large additional infrastructure costs are required.

A few preconditions need to be met to ensure a successful implementation, as highlighted by Schade (2017). First, revenues should be earmarked and redistributed to the broader transport system. Users should personally experience the advantages such as time savings while using roads and fewer parking problems. The explicit use of revenue to improve public transport should therefore be envisaged.

This is particularly true given the broad consensus and approval of policy measures that improve the existing public transport offer (see, *e.g.*, Cools *et al.*, 2012). Secondly, the pricing structure and differentiation levels should be simple and predictable. In this regard, Schade (2017) recommends avoiding great differentiation and avoiding elements that vary non-linearly, vary unpredictably - *e.g.*, charge as a function of congestion, are not clearly observable - *e.g.*, price based on current emissions, or are based on values that are not readily known, *e.g.*, charges expressed per kilometre, because lack of general knowledge about journey distances.

A crucial element in the discussion of charging for the use of road use is the determination of the level of charges. Cools *et al.* (2011) highlighted a negative effect caused by perceived fairness on changes in activity-travel behaviour, implying that charges should exceed a minimum threshold before people will actually change their activity-travel behaviour. This is particularly true for the structural changes, such as residential relocations and changes of job location. Nevertheless, this finding does not imply that there are no limits to the congestion charges. After all, when congestion charges are too high, and there are no reasonable alternatives available, people may oppose to the congestion charges and accessibility (see *e.g.* Condeço-Melhorado *et al.*, 2011) and equity problems (see *e.g.* Eliasson and Mattsson, 2006) can arise. Such accessibility problems are a real concern in the case of Belgium, given the continued work-job imbalance (see *e.g.* Saadi *et al.*, 2016). Furthermore, the road charges need to be tailored to the activities that people perform, given that the likelihood to make behavioural changes predominantly dependent on the type of activity that people carry out (Janssens *et al.*, 2009).

The foreign experiences mentioned above provide important lessons for Belgian policy-makers, but at least some scrutiny is required. Vonk Noordegraaf (2014) emphasized that many case-specific factors need to be taken into account by authorities aimed at implementing road pricing. This is also highlighted by Börjesson and Kristoffersson (2015), who pointed out that, compared to Stockholm, for the city of Gothenburg a different topology and differences in the main objectives of the congestion charge had to be communicated to the public. Understanding the mechanisms determining public acceptance of road pricing is critical for its implementation (Nikitas *et al.*, 2018). Defining appropriate support measures (*e.g.* discounts) for the most affected users helps in gaining public support (Beria, 2016). Finally the role of media should not be disregarded (see *e.g.* Ardıç *et al.*, 2015; 2018).

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13 Road pricing for bus and coach

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Abstract

In this Chapter, the effects of road pricing on demand for bus and coach services in Belgium are examined. Buses and coaches are an essential part of a sustainable transport system. They have a carbon footprint that is comparable to rail transport. They also are a cost-effective mode of transport. Despite these two features, buses and coaches often do not have access to the same subsidy or tax shelter arrangements as their competitors in rail and air transport. This Chapter holds a brief exploration of the effects of a road pricing scheme on demand for buses and coaches. For this, first the effects on monetary and time costs for bus and coach on the one hand and its main competitor (car/air) on the other are looked at. Then, for three different scenarios of pricing schemes and for three typical cases of coach or bus journeys, the effects on demand for buses and coaches are estimated.

1 Introduction

From the perspective of economic theory, road pricing is an instrument to internalize the many external costs that are associated with road transportation. Such an instrument should ensure that the damage road transportation causes to the environment, our health, and the economy is reflected in its price. In theory, overconsumption of mobility will consequently be avoided, resulting in welfare gains for all of us. From this perspective, the advantages of road-pricing are so self-evident that one can only wonder why such a system has not been generally implemented in our transportation system before.

However, a few problems exist with this view, the most important one being that it is rather simplistic. As we are all aware of, in reality, the world does not function the way a classic economic model assumes. For one thing, human decision making is only partially guided by rationality. Habits, attitudes, emotions, and even fear play a significant role in our decisions about where to live and work, or about how and how often we choose to travel. Moreover, next to the presence of external costs, a number of other mechanisms disturb the functioning of the transportation market. Government interventions in the industry are very common and take many forms.

Market regulations, direct subsidies, fiscal benefits, and monopolies by state-controlled institutes are the rule rather than the exception. Whether one supports these policies or not, they do influence the way the market functions and the way the introduction of a road pricing scheme will exert an effect on human behaviour. Therefore, it is important that, prior to the introduction of such a scheme, all possible effects are carefully examined, and appropriate measures are undertaken to avoid undesirable outcomes.

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In this Chapter, we will examine the effects of road pricing on the demand for bus and coach services in Belgium. Buses and coaches are an essential part of a sustainable transport system. Due to their collective nature and advances in zero emission technology, they have a carbon footprint that is comparable to rail transport (Borken-Kleefeld *et al.*, 2013). Moreover, the effectiveness of Euro VI-emission standards for heavy duty vehicles has reduced NOx and particulate matter (PM) emissions in real-world operations to an absolute minimum (Muncrief, 2016). Buses and coaches are also a very versatile mode of transport. They can move small or larger groups, and in *Bus Rapid Transit*-applications, they can even be deployed for transporting large groups of passengers (Cervero, 2013). Being a relatively inexpensive transport mode, they are especially interesting when metro or (light) rail applications are not economically viable.

Since they offer transport operators with a green, cheap, and flexible solution, they are deployed in many different contexts including public transport, commuting to school or work, tourism, or occasional group transfers.

Nevertheless, buses and coaches also suffer from several important drawbacks. In general, they are assumed to offer a less satisfying travel experience as compared to rail, air, or the private car (e.g., Ettema *et al.*, 2011; Morris and Guerra, 2015). When deprived of segregated lanes, they get stuck in the same traffic jams as private cars do, which has an adverse effect on their punctuality and commercial speed. Investments in leg space and on-board facilities can improve comfort levels and attract passengers (Lannoo *et al.*, 2019), but on the downside, they push operational costs to a higher level. In addition, although buses and coaches are a cost-effective mode of transport, they often do not have access to the same subsidy or tax shelter arrangements as their competitors from the rail or air transport sector.

Given this specific position of buses and coaches in our transport system, we believe that it is of pivotal interest to investigate the effects road pricing schemes will exert upon them. After all, undesirable outcomes are not at all unlikely, and they can have consequences for all parts of our mobility system.

1 Methodology

2.1 Journey examples and road pricing scenarios

As mentioned above, buses and coaches are deployed in many different situations and for many different purposes. Depending on issues such as journey length, time of travel, location, or travel motive, road pricing can be expected to exert a certain (positive or negative) effect on travel demand. Therefore, -the effects for three specific cases of coach journeys have been calculated.

In the first case, we consider a day trip from Bastogne in the Walloon region to the Belgian coast (De Panne). We will calculate effects on demand for the coach and for the car, the latter being considered the main competitor in this kind of excursions. The second case is an international four days trip from Lommel in Flanders to London. For the second example, the plane is considered the main competitor (connection from the airport of Eindhoven in Neighbouring Holland, located approximately 40 km from Lommel). The third and final case is a so-called Office Bus-line, a new concept that has been introduced by private bus companies. An office bus is a coach equipped with facilities allowing passengers to work while traveling: a fast and reliable Wi-Fi connection, a desk, ample space, and a coffee machine. The lines make a connection between office areas tormented by heavy congestion problems and the lack of well-served public transport connections on the one hand and several cities accommodating large numbers of commuters on the other. In this specific case, the line makes a connection between the periphery of Ghent and Brussels. Currently, it is a non-subsidized service to companies seeking to shift their employees from passenger car use to collective transport.

It was opted for,not to include here any cases from a public transport context, because it is unlikely that a public company would include a tax increase in the ticket price, and therefore, the example would be of no interest for our research questions. The specific journeys that were studied are described in Table 1.
Not only are there quite different kinds of bus and coach journeys, but also road pricing schemes can take many different forms. For an overview of these different forms, reference is made to other Chapters in this volume. In this Chapter, a closer look is taken at three different scenarios, the rates of which are shown in Table 1.

The three scenarios are, quite evidently, not chosen at random. The first scenario is based on the texts of the revision of the *Eurovignette Directive* that is currently on the table of European Union legislators. The text proposes to make the application of distance-based charges that are currently applicable for heavy duty goods vehicles mandatory for all heavy-duty vehicles (Debyser, 2018). This means that the new legislation would introduce a kilometre-based charge for buses and coaches, but not for private cars. The current scheme for heavy duty goods vehicles is a distance-based charge with different rates dependent on the maximum permissible mass of the vehicle and the euro norm of its engine, but not dependent on the time of day or the specific road junction used. In our calculations, we use the rate applied to euro norm 5 and 6 and to weight class 12-32 tons, which is the weight class most buses and coaches would fall into. For the specific journeys studied in this example, the use of recent vehicles is very likely.

TABLE 1 Overview of rates for three scenarios of road pricing

	Bus/coach						**Car**					
	Peak			Off-peak			Peak			Off-peak		
S= Scenario	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Highway	12.4	26.3	0.0	12.4	17.3	0.0	0.0	15.0	15.0	0.0	9.0	9.0
Other roads	12.4	26.3	0.0	12.4	17.3	0.0	0.0	15.4	15.4	0.0	9.4	9.4
City	12.4	24.9	0.0	12.4	18.9	0.0	0.0	14.8	14.8	0.0	10.8	10.8

The second scenario is based upon the decision of the Flemish Government to order a study on the application of a distance-based charge for all vehicle categories. The rates in ~~of~~ this scheme are dependent on the time of travel (peak versus off-peak hours) and the kind of road that is used (highway, urban roads, or other roads). The aim of the scheme is threefold: to reduce congestion, to internalize external costs, and to make users pay for infrastructure costs. In order to reduce congestion, we apply a congestion charge of 4 eurocents per kilometre on urban roads and 6 eurocents per kilometre on highways and other roads. Buses pay 1.5 times more than cars, a proportion that is currently proposed in the texts of the revision of the Eurovignette Directive (cf. infra). The charge is only introduced on peak hours and road junctions that are congested. We choose to apply a higher rate on non-urban roads because it is believed that, in the long run, this stimulates moving to city centres, which will also help reduce congestion problems (De Vos, 2016). The external costs taken into account are based on external costs estimated for road transport in a recent study conducted on behalf of the Environmental Council of Flanders (Delhaye *et al.*, 2017). Costs related to noise, direct emissions, and accidents are all taken into account. Finally, infrastructure costs for the entire road network are based on proper calculations. A rate of 3.9 eurocents per kilometre is applied. For buses, this rate is increased by 2.87 eurocents, which is estimated to be the marginal infrastructure costs of buses in Belgium (Delhaye *et al.*, 2017).

The third and final scenario is a copy of the second one but introduces zero rates for bus and coach. This scenario should allow us to assess the effects of a possible exemption applied to this mode.

2.2 Calculating effects on demand

Combining three journey examples with three road pricing scenarios results in nine situations for which the effect of road pricing can be examined. For every situation, a calculation is made of the effects on the demand for coach/bus on the one hand and demand for its main competitor on the other. Calculations are based on a simple model that takes four elements into account i.e.: (1) changes in monetary costs for the mode under consideration, (2) changes in time costs for the mode under consideration, (3) changes in monetary costs for the competing mode, and (4) changes in time costs for the competing mode.

TABLE 2 Elasticities used in the calculations

	Elasticity	**Source**
Price Elasticity Bus Commute	-0.85	Dunkerley *et al.*, 2018 (table A3)
Price Elasticity Bus Leisure	-1.1	Dunkerley *et al.*, 2018 (table A3)
Time Elasticity Bus Commute	-1.15	Dunkerley *et al.*, 2018 (table A4)
Time Elasticity Bus Leisure	-1.05	Dunkerley *et al.*, 2018 (table A4)
Price Elasticity Auto Commute	-0.24	Bogaert *et al.*, 2006 (tabel 10)
Price Elasticity Auto Leisure	-0.38	Bogaert *et al.*, 2006 (tabel 10)
Time Elasticity Auto Commute	-0.36	de Jong and Gunn, 2001 (table 3)
Time Elasticity Auto Leisure	-0.21	de Jong and Gunn, 2001 (table 3)
Demand bus after change in price of car (commute)	0.18	Bogaert *et al.*, 2006 (tabel 10)
Demand bus after change in price of car (leisure)	0.12	Bogaert *et al.*, 2006 (tabel 10)
Demand bus after change time cost of car (leisure)	0.46	de Jong and Gunn, 2001 (table 7)
Demand bus after change time cost of car (commute)	0.23	de Jong and Gunn, 2001 (table 7)
Demand car after change prince bus (leisure + commute)	0.116	Litman, 2010, (table 40)
Demand car after change time cost bus (leisure + commute)	0.09	Litman, 2010 (table7)
Demand air travel after change in prince bus	0.01	Dargay, 2010 (table 27)
Demand air travel after change in time cost bus	0.01	Dargay, 2010 (table 27)

Algebraically, the following two equations can represent the model:

$$\Delta Q_{bus} = E_{P_{bus}} * \Delta P_{bus} + E_{T_{bus}} * \Delta T_{bus} + CE_{P_{comp.}} * \Delta P_{comp.} + CE_{T_{comp.}} * \Delta T_{comp.}$$

$$\Delta Q_{comp.} = E_{P_{comp.}} * \Delta P_{comp.} + E_{T_{comp.}} * \Delta T_{comp.} + CE_{P_{bus}} * \Delta P_{bus} + CE_{T_{bus}} * \Delta T_{bus}$$

in which ΔQ_{bus} represents changes in demand for the bus and $\Delta Q_{comp.}$ changes in demand for the main competitor. Changes in monetary and time costs that are a consequence of the road pricing scheme are represented by ΔP and ΔT, respectively. To determine ΔP, we assumed that bus companies recharged the cost increase caused by the road pricing scheme entirely to their customers. Changes in ΔT are not based on calculations, but on estimations made by the authors.

$E_{P_{bus}}$ represents a price elasticity for the bus and $CE_{P_{comp}}$ a cross price elasticity for the main competitor. Price elasticities are deduced from the literature. The values used and the sources from which they were collected are mentioned in Table 3 (see below Section 3 "Results").

3 Results

Table 3 shows the results of the calculations. For the first case (daytrip Bastogne-De Panne), we had a marginal cost of € 15.25 for the coach and € 56.64 for the car. The marginal cost for the coach ticket is equal to the cost of renting the bus divided by the number of passengers (cf. Table 1). For the private car, only fuel costs are included in the marginal cost. Cost of purchase, insurance, etc. are fixed costs and should therefore not be included. Although maintenance costs are in fact variable costs, we believe that the cost structure is too obscure for travelers to take them into account when deciding whether or not to take the car. Therefore, they are excluded from external costs. Time costs for the journey were estimated at nine hours and five minutes for the coach and 7 hours and 52 minutes for the car.

In the first scenario, the current heavy-duty goods charge is applied to bus and coach. As can be read from Table 1, this means a constant charge of 12.4 eurocents per kilometer. To calculate the increase in marginal cost for the passengers of the coach, we first divided the tax for the journey by the number of passengers on-board and subtracted the cost of the current tax for coaches. The cost of the tax is estimated at 1.44 eurocents per kilometer[77]. For the daytrip - as an example - the first scenario leads to a marginal cost increase of 10% for the coach. Since there is no change in the marginal price of the car, there is no effect on congestion. Therefore, also the time cost for both car and coach remains unchanged. As a result, the introduction of this road pricing scheme leads, in the case of the daytrip to the coast, to a decrease of 10.94% in demand for the coach and an increase of 1.15% for the car.

In the second case, we start from a marginal cost of € 75 for the coach and € 85 for the plane. The increase in marginal cost is lower as compared to the first example because a large part of the mileage of the journey is covered abroad. Under the first scenario, this leads to an increase of 1% in marginal cost and a decrease of 1.52% in demand for the coach. Since there is no change in monetary cost for air travel and in time costs for both modes, and since the cross elasticity of air travel for changes in monetary costs for coach is very low (see Table 3), the effect on demand for the plane is limited to an increase of 0.01%.

In the third example, the Office Bus-line, marginal costs were € 19.90 for the bus and € 12.29 for the car. Important to note here is that this kind of special regular services are not submitted to the current tax scheme. Consequently, the increase in marginal cost caused by the road pricing scheme of the first scenario makes marginal costs increase by € 0.64 per passenger or by 3% of the ticket price. The result is that demand for the office bus decreases by 2.71%, and ~~the~~ demand for the car increases by 0.37%.

The second scenario introduces a smart distance-based charge with time and place-dependent rates for bus and coach as well as for cars. Since the rates per kilometer are higher as compared to the first scenario, the increase in marginal costs is also higher. For the first example (daytrip to the coast), marginal costs increase for the coach is € 2.49 or 15% of the ticket price. For cars, the increase is as high as € 57.39 or 101% of the marginal cost before the tax. Both for cars and buses the scheme allows for a reduction of 10 minutes in travel time or about 2% of total time costs. This combination of factors drives demand for cars down by more than 36%. Demand for the coach, however, decreases by 3.27%. This negative evolution means that the improvement in the relative price competitiveness of the coach and the reduction in time costs are not sufficient to offset the increase in monetary cost.

[77] Although this is a fixed tax for the bus company, it is a variable cost for the traveler since the bus company includes the tax cost in the ticket price. We assume that the introduction of the road pricing scheme will replace the existing fixed road tax. This means that for the marginal cost increase, the cost of the old tax scheme should be deduced. For cars, this is different since the existing tax is not a marginal cost for the car user.

TABLE 3 Results

		Scenario 1: applying current heavy duty goods charge to bus & coach		Scenario 2: smart distance-based charge, no exception for bus & coach		Scenario 3: smart distance-based charge, 0-rates for bus & coach	
		Bus/Coach	**Car/Air**	**Bus/Coach**	**Car/Air**	**Bus/Coach**	**Car/Air**
Case 1: Daytrip Bastogne-De Panne	Kilometers (return)	590		590		590	
	Marginal cost before road pricing	16.25 €	56.64 €	16.25 €	56.64 €	16.25 €	56.64 €
	Δ Marginal cost (€)	1.6163 €	0.0000 €	2.4928 €	57.3893 €	-0.2127 €	57.3893 €
	Δ Marginal cost (%)	10%	0%	15%	101%	-1%	101%
	Time cost before road pricing (min)	545	472	545	472	545	472
	Δ Time cost (min)	0	0	-10	-10	-10	-10
	Δ Time cost (%)	0%	0%	-2%	-2%	-2%	-2%
	Δ Demand (%)	**-10.94%**	**1.15 %**	**-3.27%**	**-36.44 %**	**15.04%**	**-38.37 %**
Case 2: International trip Lommel - Londen	Kilometers (return)	900		900		900	
	Marginal cost before road pricing	75.00 €	85.00 €	75.00 €	85.00 €	75.00 €	85.00 €
	Δ Marginal cost (€)	1.0333 €	0.0000 €	1.8541 €	0.0000 €	-0.3245 €	0.0000 €
	Δ Marginal cost (%)	1%	0%	2%	0%	0%	0%
	Time cost before road pricing (min)	901	540	901	540	901	540
	Δ Time cost (min)	0	0	-10	0	-10	0
	Δ Time cost (%)	0%	0%	-1%	0%	-1%	0%
	Δ Demand (%)	**-1.52%**	**0.01 %**	**-1.55%**	**0.01%**	**1.64%**	**-0.02%**
Case 3: Office Bus line Gentbrugge - Zaventem	Kilometers (return)	128		128		128	
	Marginal cost before road pricing	19.90 €	12.29 €	19.90 €	12.29 €	19.90 €	12.29 €
	Δ Marginal cost (€)	0.6349 €	0.0000 €	1.2233 €	17.1867 €	0.0000 €	17.1867 €
	Δ Marginal cost (%)	3%	0%	6%	140%	0%	140%
	Time cost before road pricing (min)	202	102	202	102	202	102
	Δ Time cost (min)	0	0	-15	-15	-15	-15
	Δ Time cost (%)	0%	0%	-7%	-15%	-7%	-15%
	Δ Demand (%)	**-2.71%**	**0.37 %**	**21.75%**	**-28.25 %**	**26.97%**	**-28.96 %**

In the example of the London trip, the effects are different. The increase in marginal costs is limited to € 1.85 per passenger for the coach, and there is a gain of ten minutes in travel time. There are neither changes in monetary nor in time costs for air travel since this mode is not impacted by the road

pricing scheme. The coach suffers a decrease of 1.55% in demand, and demand for air travel goes up by 0.01%.

In the example of the Office Bus, the ticket price goes up by 6% or € 1.22 Marginal costs for car commuters go up by € 17.19 or 140%. Both bus and car reduce travel times by 15 minutes or 7% and 15%, respectively. This leads to an improvement in the relative competitiveness of the bus both in monetary and time cost terms. As a result, demand for the bus goes up by 21.75%, and demand for the car goes down by 28.25%.

In the third scenario, the same smart distance-based charge as in the second scenario is introduced, but with 0-rates for bus and coach. Since the introduction of the distance-based charge implies the disappearance of the fixed charge, this leads to a reduction in marginal travel costs for the coach both in the coast trip and the London trip examples. For the office bus example, there is no reduction since for this kind of transport no charge was in place. Monetary cost evolutions for the car remain the same as in the second scenario. In addition, time costs remain the same for both coach and car.

In the case of the coast trip, this results in an increase of over 15% in demand for coach travel. Demand for cars decreases by 38.37%, almost one percentage point more than in the second scenario. For the London trip example, there is an increase of 1.64% in demand for the coach. This is a minor change, but still better than the decrease in the second scenario. This time, there is also a marginal decrease of 0.02% in demand for air travel. Finally, for the office bus example, we notice a small reinforcement of the effects noticed in the second scenario, i.e., an increase of almost 27% in demand for the coach and a decrease of 29% in demand for the car.

4 Conclusion

In this study, we introduced a brief exploration of the effects of a road pricing scheme on demand for buses and coaches. We looked at the effects on monetary and time costs for bus and coach on the one hand and its main competitor (car/air) on the other. Making use of time and price elasticities deduced from the literature; we estimated the effects for three different scenarios of pricing schemes and three typical cases of coach or bus journeys.

The results show that the introduction of a pricing scheme pricing bus use but exempting car use has a strong negative effect on demand for the first, even when the current fixed tax scheme would disappear. This is especially the case for domestic occasional services. When the cost of the scheme is completely integrated into the ticket price, a strong reduction in demand can be expected. Since this would in turn negatively affect load factors and/or utilization days of the vehicle, such an evolution would put many companies under severe financial pressure. However, not integrating the cost into the ticket price would lead to strong cost increases and would have the same financial consequences. Moreover, since the price scheme improves the relative competitiveness of the car, small but nonetheless relevant increases in demand for car trips are to be expected. It is clear that this scenario should be avoided, both from an economic and a sustainable transport perspective.

The effects of a general smart distance-based charge for all road transport modes are quite different, at least for those journeys where the coach competes mostly with the car. This is due to the fact that the negative effects of a monetary cost increase are (partly) offset by the positive effects of the decrease in time costs and the increase in monetary costs for the car. In the case of the Office Bus, this even leads to an increase in demand. However, when interpreting the results, one should take into account that the model used for the estimation is a simplification of reality. For one thing, it does not take into account that coaches also compete with the train. Since the introduction of the pricing scheme deteriorates the competitive position of the coach compared to the train, it can be expected that the positive effects reported here will be somewhat weaker in reality. Moreover, it does not take into account that abolishing the fixed annual road tax for cars might lead to an increase in car ownership, which in turn stimulates car use.

For journeys where the coach competes with the plane, the introduction of the smart pricing scheme has a negative impact on demand for the coach and a positive one on demand for air transport. This is a clear example of an undesired effect of road pricing. Although the effects reported are small, they are not negligible. First of all, the negative effects of the charge would be larger when it would simultaneously be introduced to other European countries. Given the texts for the revision of the Eurovignette directive that are currently on the table, this is not at all unlikely. Second, one should take into account that, unlike coach travel, air travel momentarily benefits from VAT and excise duty exemptions and other forms of positive discrimination (Piket, 2009). For the coach, the introduction of a road pricing scheme would, therefore, mean adding a competitive disadvantage on top of many other competitive disadvantages that already exist. In an ideal world, the introduction of a pricing scheme should be accompanied by measures abolishing these positive discriminations of air travel and the introduction of an equivalent system for the internalization of external costs. When these measures are politically impossible, other accompanying measures should be considered.
One possible measure would be the introduction of zero rates for bus and coach. Our analysis shows that in the case of competition with air, zero rates can turn the negative effects around. In the case of competition with the car, the positive effects are reinforced. Of course, zero rates are at odds with the goal of road pricing, i.e., to put the right price on road transportation. From an economic perspective, equal fiscal treatment of all modes and subsidies in line with the social added value of a mobility service are the optimal choices. However, given the existing political constraints, zero rates can constitute a good second-best.

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Part V: CONCLUSION

Chapter 14. City mobility in 2019 – sustainable and smart?
D. BANISTER

Chapter 15. What lessons can be learned both from theory and from practice of the management of road pricing?
F. WITLOX

14 City mobility in 2019 – sustainable and smart?

D. BANISTER [1]

"The fundamental question here is whether all society can capture the huge benefits of greater mobility without incurring the damaging costs that currently accompany those same high levels of mobility"

Transport is a key and central element in maintaining and enhancing global and local connectivity, and its importance has been augmented by the ubiquitous availability of the internet and social media. It is relatively easy to contact people across the World and even to visit them – we live in a networked society. Such ready connectivity is reflected in the number of motorised vehicles that now (2017) number more than 1.2 billion, with 3.5 billion people making use of the internet, and about 3.2 billion users of social media with 7.68 billion mobile phone subscribers, all for a global population of 7.6 billion (https://data.worldbank.org/indicator/it.cel.sets.p2). Physical connectivity will increase with an expected doubling of travel by 2050, with an even greater growth in electronic connectivity (Schäffer *et al.*, 2009).

This growth is primarily driven by global population increases, the continued growth in the global economy, ever expanding social networks, and the desire to travel. But it is also well known that such an attractive future comes at a cost, principally adding to global warming, road crashes, local pollution, health, neighbourhood severance, noise and other externalities. Such a future is compounded in urban areas where more than half the global population live, as the impacts of traffic congestion and other externalities are detrimental to the quality of life. The fundamental question here is whether all society can capture the huge benefits of greater mobility without incurring the damaging costs that currently accompany those same high levels of mobility.

In 2008, the sustainability mobility paradigm was published, and this questioned conventional thinking on transport planning together with the strong assumptions that were embedded within it (Banister, 2008). The conclusions reached were that there were good opportunities to address the problems created by motorised transport in cities. In essence, the focus of transport planning on time minimisation should be reframed as planning for reasonable travel times and improved travel time reliability. Travel should be seen as a valued activity in itself, as not all travel time is wasted. The importance of the links between transport and land use planning was recognised as one means by which travel distances could be reduced, as was the potential for the substitution of physical movement through the increased use of the internet. It was also suggested that all great cities are dependent on high quality public transport, supplemented by priority for walking and cycling.

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New thinking would embrace more imaginative use of the available infrastructure and capacity through efficient management that raised occupancy levels and load factors through demand management (e.g. pricing and regulation). The overall aim would be to significantly improve the quality of places and spaces in cities, as all citizens have a right to a safe and secure environment. Such thinking is based on the acceptance that cities are for people and for social interaction. This is the rationale for cities, and the old (transport) and new (internet and social media) technologies should support this primary objective rather than making it much harder to achieve.

Over the last ten years, what has changed? The same issues are still central as are the priorities, but two new dimensions have emerged. The debates about quality of life were framed in the global issues of climate change (principally CO_2 in the case of transport), but this has been added to by the impacts of local pollution on air quality and people's health (principally CO, NO_x, and $PM_{2.5}$). It is much easier to engage with the people in a debate over the local rather than the global issues, as it has a much more direct and short-term immediacy. In both the global and local pollution debates, transport contributes about a quarter of all emissions (Brand and Hunt, 2018).

The second change has been the concerns over inequality, and whether large scale public investments in transport together with the many forms of transport subsidy benefit all travellers. The evidence seems to suggest that many decisions benefit the rich more than the poor, both directly as it allows the rich to travel further, faster and more often, and indirectly as the poor travel less far and to local destinations, but they are more likely to be impacted by the activities of others (Banister, 2018). This is known as the double injustice, meaning that you contribute less to the problem, but you are impacted more by those that contribute more to the same problem (Gough, 2017).

In the past, as illustrated by the contributions in this volume, economists have long argued for the allocation of road space by price and the individual's willingness to pay. But almost universally, road pricing has proved difficult to implement in cities, and positive outcomes have only been possible where there is high quality public transport, where there is effective land use planning, and where there is strong governance (e.g. London, Stockholm and Singapore). More recently, the debate over congestion and sustainable mobility in cities has been hijacked by the technologists promising a highly mobile future using only renewable energy. This possibility is seen as being sustainable and smart, but the reality is more complex as the impacts on congestion, inequality, pollution and city liveability are all unclear. For example, new technology (e.g. autonomous vehicles and electric vehicles) tend to work alongside existing technologies and do not necessarily replace them, and the problems of transition from one regime to another are difficult. The energy mix in many cities is not carbon neutral, and there are substantial amounts of carbon embedded in the vehicles themselves, in the infrastructure and in the management of the system, and there is also pollution from tyres, brakes and other vehicle components. The complexity of the city, its transport and road network, and the diversity of demand make such solutions seem rather utopian (Batty, 2018). How then might 'sustainable and smart' mobility in cities evolve?

Underlying the attractions of simple solutions (e.g. road pricing) and technologies (e.g. electric vehicles and autonomous vehicles) are a series of more fundamental issues that need to be addressed to improve the liveability of cities for all. One relates to the types of cities that we wish to live in and the role of the car in that vision. A second issue concerns the availability of space in cities and how this space should be used. These two issues are interrelated. About 20-25 per cent of street space is allocated for roads, and this figure excludes parks, open spaces and parking (UN-Habitat, 2013). This street network also provides the connectivity necessary for urban productivity and for necessary services (e.g. water, energy and drainage), as well as for movement. In transport terms, this space is used for traffic, including cars, freight distribution, public transport, cycling and pavements for walking. It is also a space for markets and other types of street trading, a space for social activities, and a space for leisure.

The key issue here is over the ownership of that space and who has priority access to it. Pricing is one mechanism that can be used to allocate this space, but this does not consider people's rights to that

same space, the quality of that space, and its importance to all people. The amount of space available is a given and it will not increase, but the uses made of it may well change over time and by time of day. Underlying such thinking is the availability and affordability of street space to as many people and different activities as possible – it must be seen as a public asset and not as private space. This means that creative thinking is needed to address the means to make the best use of that space for all people so that the quality of city life can be enhanced. For example, walkability in cities could be given priority, as this concept addresses health, safety, and experiential aspects of wellbeing, as well as raising the potential for street-based activities.

The role of the car is an essential part of the debate. At present, the technologists, supported by politicians and city administrations, are encouraging the use of electric vehicles and autonomous vehicles in cities. The vehicles being developed take up far too much space and they are too heavy. To design a new electric car that weighs over 2 tonnes and is 5 metres in length to carry one person (80 kg) will always be inefficient in both resource costs and its space requirements. There is a huge opportunity to design a small, slow, shared and lightweight vehicle for city use.

Reflecting on the six years since I was the 1st BIVEC-GIBET Chair (2012-2013) and on the four lectures I gave in the Benelux countries, my conclusion would be that there has only been limited new thinking on the sustainable mobility debate, and, as noted here, the technologists have taken over the sustainable and smart transport agenda. To my mind what is now being proposed is neither sustainable nor smart, and this comment is even more apparent in cities. The debate on sustainable and smart mobility needs to build upon the sustainable mobility paradigm (Banister, 2008) together with the new health and inequality dimensions. Most trips in cities are short and this means that motorised trips can be undertaken primarily on public transport, supplemented by some demand responsive shared services directed at those with mobility difficulties or for particular groups late at night or for those in more suburban areas. The Mobility as a Service (MaaS) concept has potential but should be seen as an integral part of the overall supply of transport. Most effort should be directed to promoting micro mobility that encourages active, healthy and fair movement. This would include networks and priority for walking, cycling, bike sharing (and dockless bikes), scooters and other devices. Perhaps some of these would be e-bikes or e-scooters; with the new mobility hubs for recharging becoming the new ‘hots spots’ in cities for social and leisure activities. Such a new set of priorities would address the constraints of space in cities and rebalance the efficiency of transport, as the mode of travel would weigh less than the person being transported. To me this is both sustainable and smart!

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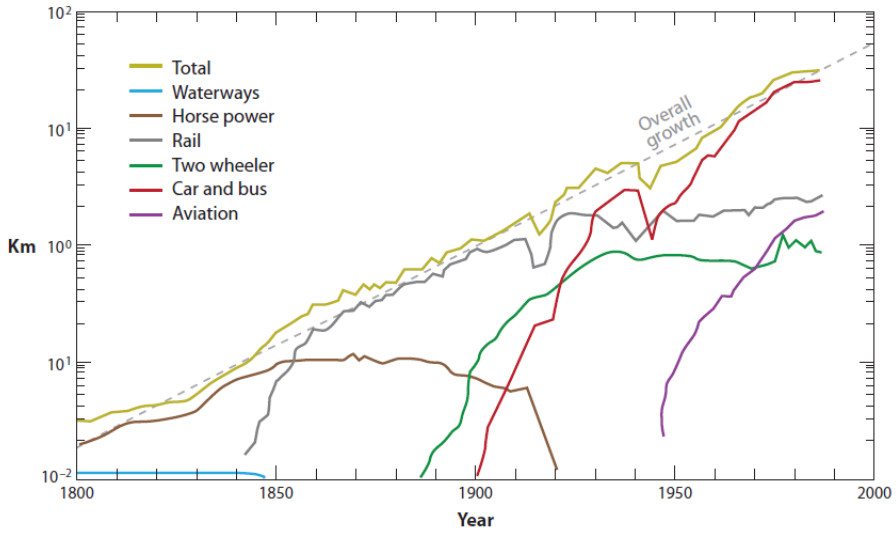
15 What lessons Benelux can learn from theory and practice of the managing of mobility through road pricing?

F. WITLOX [1]

"In theory, there is no difference between theory and practice. But, in practice, there is."
(Jan L. A. van de Snepscheut)

Developments like globalization and internationalization, combined with a growth in population and in income, have undeniably led to a spectacular increase in the movement of people and of goods. Unique longitudinal research by Grübler (2004), analysing average daily travelling distances in France (excluding walking), revealed this overall growth pattern (see Figure 1).

FIGURE 1 Average daily travelling distances in France, 1800-2000, by mode of transport



With the exception of the periods of the two World Wars, the growth of transport is (quasi-)continuously increasing. Especially the growth in the use of car and bus - and aviation - transport is stunning.

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Given the positive relationship between travel growth and prosperity, the increase in travelling distances can be considered as a virtuous development. However, this relationship is questionable if transport systems become over-saturated and malfunction, leading to loss in efficiency and quality. The resulting societal costs – such as those of climate effects, of environmental damage, road safety, loss of time and productivity – are most likely very high.

Being mobile and having access to mobility is nowadays considered a basic right. The right to mobility/transport stands at equal level with the right to education, housing, freedom of speech, or medical treatment. When confronted with a temporary or permanent loss of mobility, our daily lives are immediately affected (remember: "without transport everything stands still").
So transport and mobility are as essential for human development as food and clothing. Yet – at least at the Benelux level – remarkably little real innovation can be noted in tackling the mobility problem. Not that we have not yet tried everything: ranging from spatial planning, price measures, modal shifts, employer-based measures, information campaigns, developing new technologies and innovations, in more detail:

a) *Built environment, spatial planning*
    - Constructing new infrastructure (missing links)
    - Increasing capacity of existing infrastructure (peak hour lanes, HOV lanes, block driving, vehicle/truck platooning, eco-combi, autonomous driving)
    - Adapting infrastructure (road signs)
    - Transport-Oriented-Development (TOD)
b) *Pricing mechanism*
    - Road user charge, tolls, road/cordon pricing
    - Traffic/travel mitigation fees ('spitsmijden')
    - Travel trading schemes (tradable permits)
    - Fuel charge
    - Parking charge
c) *Modal shift*
    - Active travel: walking, bicycling
    - Public transport renaissance
    - New forms of individualized transport (MaaS, Uber)
d) *Employer-based measures* (carpooling, flexible/compressed work hours, teleworking)
e) *Information* (public awareness)/ *Lifestyle*
f) *Technology* (cleaner, smarter, more sustainable, leaner, faster technologies; catapult transport, tubes, container zeppelins, drones, foldable cars, hyper-loop)

In unravelling the mobility/transport problem, one issue is agreed upon by all: 'the' solution does not exist. So we need to combine measures, mitigate negative externalities, and search for the most effective/efficient measures. From the above, it will become clear that different perspectives exist and that, consequently, different measures can be taken, these ranging from:

- Supply- vs. demand-oriented measures
- Push vs. pull measures
- Top down vs. bottom up measures
- Private vs. public participation (PPP) measures
- Price instruments (market-based) vs. regulatory (command and control) measures
- Short- vs. long-term measures
- Passenger- vs. freight transport-related measures
- Employee (commuter)- vs. employer-based measures (this, in respect to home-to-work travel)

When it comes to the point of confronting the user of mobility -the car user- with the costs he/she causes, i.e. by means of a road pricing mechanism, this approach seems to be off-limits. This is odd, as there are strong reasons for adopting a 'polluter pays principle'. This is because marginal external

costs associated with a transport activity, viewed from a life cycle assessment (LCA) approach, are tremendous. The principle relates to: (i) vehicle operation: accidents, noise, air pollution, climate change, upstream and downstream processes, congestion, (ii) vehicle fleet: use of public space, and (iii) transport infrastructure: damage to nature and biodiversity, visual intrusion, barrier formation.

The growing awareness - with climate marches, citizen science projects relevant to clean air, etc. - pushes politicians to take action. But, apparently, no sense of urgency has emerged in Benelux. In quite some other countries around the world, some form of market-based mobility management system is operational. Within Benelux, only in Belgium a Kilometre Charge for heavy goods vehicles (HGV's) of over 3.5 tons entered into force April 1, 2016 (see also Chapter 6.). All Belgian and foreign lorries operating in Belgium must be equipped with a switched-on On-Board Unit (OBU). The charge ranges from €0.074 to €0.292 per kilometre driven and depends on the weight of the lorry, its emission class, and type of road (www.viapass.be). This type of charge is, however, not designed to allocate road space or to optimize congestion over time. In fact, we are dealing, here, with a taxation system that has little to do with making good use of the road assets (Button, 2010). A much better – smarter - system would vary the charge in space and time.

In theory, the most appropriate way forward seems to be to influence travel demand by charging the costs caused by road users. To this end, a whole range of road charging measures -which have proven to be efficient and effective in practice- are available. So, from the point of view of economic theory this should be the 'easy road', after all, the free flow of people and goods, clean air, quietness and safety are scarce/economic goods. Anyone who uses these scarce goods and "consumes" them will have to pay for them – as is the case with all economic goods.

Opposite to trying to influence demand for transport is the idea of expanding infrastructure capacity. That is, instead of focusing on decreasing/managing transport demand, in principle a supply side approach could be followed. Building more infrastructure is however always controversial. It may - temporarily, see Anthony Downs' (1962) law of peak-hour expressway congestion, and Duranton and Turner's (2011) fundamental law of highway congestion - alleviate the capacity issue, and governments presently are less inclined to play their traditional role as a major investor in (road) infrastructure. As a consequence, investment budgets lose priority over maintenance costs vraag: is dit zo of worden hier investeringen vs overdrachtskosten (in ruime zin) bedoeld?. Note that increasing transport capacity also quickly clashes with public support (NIMBY at its best). Therefore, a more expanded investment policy for road infrastructure seems to have less acclaim today as a solution to the current mobility problem.

History has shown us various tipping points that gave direction to how the mobility issue would evolve. The use of the steam engine resulted in the development of the railways and (sea) shipping. The use of fossil has boosted road and air transport. The Internet and the digital revolution contributed to virtual mobility (when it comes to personal communication), but also gave rise to e-commerce and the subsequent 'vanisation' of the economy (meaning: the use of small vans to distribute goods). The burning question is: what is to follow? Will the next tipping point be stagnation, decline or, as some call it, degrowth, referring to a "voluntary transition towards a just, participatory, and ecologically sustainable society" (Mastini, 2017) as a result of growing congestion, climate and clear air awareness? If so, then fundamental policy changes are needed.

As stated at the beginning of this book, the latter deals with problems concerning the use of the infrastructure for road transport only. Other modes of transport, however, face similar problems: e.g., how to allocate space on busy parts of rail networks, slot allocation at airports. This means, that the above conclusions for roads are also valid for a broader transport debate: the optimum use of infrastructure does not present itself as a problem just for road infrastructure, but for all other kinds of transport infrastructure as well.

Finally, when matters are complicated - as they are - it seems wise to seek help, and not trying to solve the conundrum on one's own. This also holds true for Benelux. It would be intelligent to start a joint

future-oriented discussion on this issue in Benelux - after all, one of the most important transport regions in Europe. The Benelux Union is supported by the three countries' advanced scientific research, in transport economics as well as in other, related, fields. Also, the Benelux is supported with an active input from both public and private stakeholders. In turn, the problems that arise from the practice of transport can provide an incentive for further scientific research. This joint discussion should lead to a clear and, above all, cross-border, coherent Benelux vision on mobility, transport, and logistics.

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ANNEX

Annex 1: Forty years of BIVEC-GIBET
L.D. VAN DEN BERG AND J.B. POLAK

Annex 2: Referees

Annex 3: Author index

ANNEX 1

Forty years of BIVEC-GIBET

L. D. VAN DEN BERG [1] AND J. B. POLAK [2]

Abstract

BIVEC-GIBET originated from the Benelux Port Workshops. These had developed out of student excursions in the 1960's. These Workshops were started at the initiative of the late Professor Henk Kuiler, who at the time held the chair of Transport and Port Economics, at the "Nederlandse Economische Hogeschool", now Erasmus University Rotterdam.
The purpose of these Port Workshops was to convince the younger generation of Benelux transport economics students of the importance of co-operation between major ports in the Benelux, by offering them first-hand knowledge of the people and authorities at work in these ports.

With these Port Workshops, it was sought to integrate transport economics education via a common action, so that greater insight would make the younger generation of students better prepared for their future transport- and port-related jobs. Building on this objective, BIVEC-GIBET was founded in 1977.

During the course of years, the number of members has grown steadily and substantively. The aim has always been to have the activities the highest possible level. During the earlier years, BIVEC-GIBET received active logistical support from the General Secretariat of the Benelux Union.
In recent years, the task of BIVEC-GIBET has entered into a new era, given the increasing importance of international co-operation in society, and particularly given the European evolution. With the growing harmonization of higher education, via the (European) Bologna Declaration and the introduction of the bachelor-master structure, the issue is to underline three BIVEC-GIBET pillars: education/knowledge transfer, scientific research and the institutional framework. BIVEC-GIBET responds proactively to these developments by encouraging the universities and polytechnics in Belgium, Luxemburg and the Netherlands to incorporate transport economics courses into their curricula.

(1) Former Senior Policy Officer and Head of Department, General Secretariat of the Benelux, Brussels (Belgium)
(2) Professor Emeritus of Transport Economics, University of Groningen and former lecturer in this field, University of Amsterdam (both: the Netherlands)

1 Start: collaboration in the teaching of Port Economics and of Transport Economics

On 21 June 1978, the Articles of Association of the Benelux Interuniversity Grouping of Transport Economists (BIVEC-GIBET) were approved during a solemn academic session in Rotterdam[1].

The informal cross-border collaboration in the field of transport economics, started in the 1960s, at the initiative of a number of Belgian and Dutch University professors, now, finally, was formalizedWhat follows, here, is a review of BIVEC-GIBET activities over the period of its existence. During this academic session BIVEC-GIBET pioneer and first chairman, Prof. H.C. Kuiler, looked back at the first period of collaboration during the aforementioned session (see photo below; standing: Professor Kuiler).

Kuiler outlined the usefulness and necessity of this Benelux interuniversity collaboration. His then analysis provides an insight into the start-up of BIVEC-GIBET and therefore deserves a full place in this jubilee book:

> *"At the beginning of the 1960s, the Benelux Port Study Days were born out of student excursions[2]. These excursions grew into a recurrent event that no longer could be ignored in our university world of the Benelux. Their aim was to convince the young generation of transport economics students of the superfluity of the struggle between the major Delta ports by acquainting them in practice with persons working in the ports, their problems and their solutions. And also, to indicate the importance of these port activities for the transport of essential goods to and from the European hinterland. Transport activities that lie at the base of the prosperity of the Benelux countries.*

[1] The official founding of BIVEC-GIBET took place in the presence of the then Dutch Secretary of State for Transport, Public Works and Water Management, Mrs. N. Kroes and the then Secretary general of the Benelux Economic Union, Mr. E.D.J. Kruytbosch.

[2] The Benelux Port Days and Transport Study Days are part of a long tradition. They were first organized in 1964. They were in the form of a, mostly annual, two-day event, bringing together students and teachers in transport economics from the Benelux around a port-related theme. Their main intention was to bring participating students into contact both with economic theory and practice of ports.
After the establishment of BIVEC-GIBET, in 1978, the association took over the organization of these Study Days. This always was in close cooperation with the General Secretariat of the Benelux Economic Union. In the mid-1980s, BIVEC-GIBET and Benelux opted for a formula in which the *Port* Study Days were alternated with *Transport* Study Days, hereby widening the scope of these meetings. An overview of these activities is given in below.

The idea appeared to be successful. Many students from that time are now in leading positions in the Delta ports. The competition has not disappeared - and that is healthy - but the old contradictions no longer appear as bright as before. When this was achieved, the idea of going one step further matured in the "inner circle" of the organizers of the Benelux Port Study Days. When the Benelux countries have a common European function in transport and when ports are of such great importance for their respective economies, then it must also be possible to integrate transport economics teaching on both sites of the border in such a way that the young generation of students becomes better prepared for their future professional tasks in the field of transport and port. The BIVEC-GIBET was initiated in 1977.

The goal was clearly formulated, the design and elaboration initially remained vague. They had to get their exact content in the mutual contact. It is this process that has taken place in the past two years in the friendliest way and without any distinction of nationality, especially in the bosom of the Executive Board[3].

It soon became apparent that three interrelated main lines could be distinguished. There was, first and foremost, education itself, the transfer of knowledge. Secondly, however, education presupposes, especially in the case of transport and ports, the regular supply of knowledge, obtained from research, which transcends the possibilities of the individual scientist. To this end, recourse should be had to the results of research institutes, first and foremost from the Benelux. Thirdly, education in Transport and Port economics, as one of its data, also has the institutional provisions of the Benelux Governments, which, in determining these, again fall back on the results of science.

We (Founding Fathers), as representatives of teaching, succeeded in setting up both forms of scientific contact. The research concerns the (at that time) non-commercial transport institutes of Belgium and of the Netherlands[4]*. For the governments it concerns the High level group Communications ("Commissie Verkeer" / "Commission des Communications") of the Benelux Economic Union*[5]*.*

The elaboration into documents of possible theses for a master's degree, which can be of value to the governments is a still open line in this context. We will have to consider this in the near future.

Concerning teaching itself, a first integration step is almost complete, i.e. classification of theses about transport and ports economics written for a master's degree. This will increase the accessibility of these theses in the Benelux, especially for students working on similar or related subjects. They can then build on already achieved results and thereby gain a deeper insight.

A next step will be the inventory of the content of teaching at the various universities and universities of applied sciences. The Executive Board will take the necessary steps in the

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[3] Further information about the structure of BIVEC-GIBET in Section 2.

[4] The first research institutes that joined BIVEC-GIBET as collective members were: Institute for Road Transport (IWT / ITR, Brussels), Institute for Transport along the Inland Waterways (ITB, Brussels), Netherlands Transport Institute (NVI, Rijswijk) and Economic Office for Road and water transport (EBW, Rijswijk).

[5] Chapter 4, Article 28, of the Treaty setting up the Benelux Economic Union of 1958 provides a High-Level Committee for Traffic. This Committee supported the initiative to establish BIVEC-GIBET. Members of this Committee regularly cooperated with BIVEC-GIBET representatives in order to be able to link BIVEC-GIBET activities to current policy questions. A new Benelux Treaty was signed on 17 June 2008, introducing "Benelux Union" – no longer merely "Economic" - as the new name of the Union. The new Treaty no longer provides for permanent consultative committees, but an annually adaptable project orientated structure in which consultations on subjects related to traffic and transport have a prominent place.

coming months. Such an inventory can be the basis for the exchange of lectures, common courses, and post-academic teaching.
A legal framework for the collaboration could of course not be lacking. Its development took a great deal of time - for scientists too much time. In this context, I would like to expressly mention that we received an invaluable secretarial aid from the General Secretariat of the Benelux Economic Union. Without this help we would certainly not be ready in just two years' time as is presently the case. Hope that our universities will also find reason to support the BIVEC-GIBET along roads that are open to them for that purpose."[6].

2 Design: structure, decision-making and financing of BIVEC-GIBET

2.1 Legal anchoring

The founders of BIVEC-GIBET opted for an association with legal personality. For practical reasons, an "International association without profit goal" ("IVZW/AISBL") according to Belgian law was chosen[7].

2.2 Membership structure

The Association has four categories of members:
- active members, persons employed in the field of transport economics at a university or college within the Benelux;
- associated members, people from outside the educational field with an affinity with transport economics and employed within the Benelux;
-collective members, research institutes within Benelux employed in the field of non-profit transport economics;
- corresponding members, persons outside Benelux with affinity to the field of transport economics.

2.3 Decision-making and Management

The General Assembly is the highest decision-making level. The active, associated and collective members are entitled to participate in that Assembly, which must be held at least once a year.
The association has a Board of Directors, which is chosen from the active members. From the beginning, it has been strived for that all universities and universities of applied sciences in the Benelux with transport related courses are represented in this Board. Representatives of the collective members have an advisory vote in the Board. The Board of Directors elects from among its members a chairman, a vice-chairman, a secretary and a treasurer. Together they form the Daily Management Board of the Association.

2.4 Financing

The financing of BIVEC-GIBET takes place through a contribution from its members.
The contribution of the collective members is an important source of income. The starting point is that the activities of BIVEC-GIBET will take place completely independently and in full academic freedom. External sponsorship as a structural source of income was therefore deliberately omitted. However, grateful use has been made of targeted facility and substantive support by companies and governments in the organization of study days, seminars and colloquia. Here too, care has been taken

[6] Above text is the integral text pronounced by Kuiler.
[7] Its Articles of Association state that the seat of BIVEC-GIBET is at the address of the General Secretariat of the Benelux (Economic) Union in Brussels, Belgium.

to ensure that this does not detract from the scientific quality and independence of the work. The aforementioned support is solely aimed at increasing the quality of the activities of BIVEC-GIBET.

2.5 Benelux

The then Secretary general of the Benelux Economic Union, E.D.J. Kruytbosch, was a warm advocate of closer Benelux collaboration in the field of transport economics and related science areas. He saw the importance of actively using science as a basis for policy making and strengthening international collaboration. And he believed that BIVEC-GIBET, through its scientific activities, could play a useful role in bringing about greater coherence between the three countries. He not only ensured that BIVEC-GIBET was supported through a deputy secretary (J. Rousseau, L.D. van den Berg, Mrs. S. Stevens, Mrs. S. van Rossem and P. Janssen), but also made useful contacts between the BIVEC-GIBET board and representatives of governments, research institutes and the business community. The General Secretariat also gave active administrative, organizational, translation and secretarial support to the Association until 2003. Afterwards, BIVEC-GIBET took these tasks on itself. In addition, the good contacts with the Benelux Secretariat continued to exist.

3 Getting started

3.1 Overview

BIVEC-GIBET, thanks to the enthusiastic efforts of its members, knew a good take-off. The association already had thirty active members at the start. In the first year, four transport institutes joined as a collective member. The number of active members has grown over the years and is now stabilizing around a hundred. There are currently three collective members.

From the beginning, activities have been focused on three target groups: students and lecturers at universities and universities of applied sciences and those interested in the results of scientific research not connected to an educational institution. Initially the emphasis of the activities in education, gradually and in connection with a - Europe-wide - changed study design at the educational institutions, shifted this emphasis to research. In what follows, the activities of BIVEC-GIBET will be reviewed in more detail.

3.2 Teaching

BIVEC-GIBET supported the organization of the Benelux Ports- and Transport Study Days (for details, see 5 below). These Study Days were usually very well attended and always highly appreciated by participants. A special point of attention has always been a low-threshold access for students to events such as study days and working visits.

Until the 1990s, work was done on a database of scientific transport economics publications in the Benelux, the “BIVEC-GIBET script”. This turned out to be a stubborn project that never really got off the ground. The work on this project was discontinued after the internet gradually began to offer much more extensive information possibilities.

In the early 1980s, work was done on an inventory of study programs for educational institutions relevant to transport in the Benelux. This inventory provided useful insights for teachers and stimulated the exchange of knowledge and of people. This activity was terminated when such an inventory was set up in a European framework for a broader field and also linked to exchange projects for students.

After the passing away - in 1979 - of Prof. Raoul Jacobs, co-founder of the association, a prize named after him was set for the best graduation work of transport economics students. Over the years many

papers by were judged by a jury formed by members of the organization, which resulted in many laureates. It should be noted that the jury has always set the scientific bar high and also did not hesitate to award the prize for a year if the quality of the submissions remained below the stated expectations. The participation in this competition and certainly the winning of the prize was a nice reference for the participants in their later career. The prize went down to its success. The assessment of the sometimes dozens of submissions turned out to be too great a burden for the judges, reason for ending this activity of BIVEC-GIBET in 2005.

BIVEC-GIBET pioneer and Honorary Chairman Prof. Kuiler passed away on September 1, 1998. His special merits for the group in mind, this was reason for BIVEC-GIBET to organize three forums around a current theme[8].

In 2012, the BIVEC-GIBET Transport Chair was set. This Chair awards an individual who has made an important scientific contribution and/or significant social merits related to transport and mobility within Europe. The recipient of this award gives a few guest lectures, each time at different universities.[9]

Because, as mentioned above, the effectiveness of BIVEC-GIBET gradually shifted from the field of education to that of the research, a new competition was introduced in 2009. This "Piet Rietveld Prize" – named after one the foremost Dutch transport economists, who passed away at a relatively early age - is an award for the best doctoral-dissertation in the field of transport research - broadly defined - within Benelux. The evaluation of dissertations submitted is in the hands of a jury whose members are both from inside and outside Benelux.

3.3 Research

From the start, BIVEC-GIBET organized two distinct kinds of meetings that dealt with research. These are seminars and colloquia, respectively. The former are aimed only at the Groupings own members; the second category is intended for a wider audience.

In later years, two other forms of study meetings have been added: Workshops and the Transport Research Days. The latter were held for the first time in the year 2005, and since then have taken place bi-annually. With the aim of stimulating academic research in transport and in logistics, two awards for a best paper presented have been created:
- award for Best Junior Paper;
- award for Best Paper.

[8] Forums "Prof. H.C. Kuiler":
1998, University of Antwerp, *Economic Principles in Transport Policy*, Emeritus Prof. Trevor D. Heaver (UBC Sauder School of Business, Vancouver);
2000, Free University Brussels, *Transport deregulation and privatization - should Europe follow Britain?*, Prof. John Preston (University of Southampton);
2001, University of Antwerp, *Airline Restructuring and Privatization*, Prof. Rigas Doganis (Visiting Professor at Cranfield University).

[9] Recipients of the BIVEC-GIBET Chair were:
- Prof. David Banister (University of Oxford): *The Sustainable Mobility Paradigm* (2012).
- Prof. Jonas Eliasson (Royal Institute of Technology [KTH], Stockholm): *Towards an efficient and sustainable transport system: the role of transport policy analysis* (2014).
- Prof. Alan C. McKinnon (Kuehne Logistics University, Hamburg): *Low Carbon Freight Transport in a Climate-Changed World* (2016).

4. Some comments

To conclude the above overview of forty years of BIVEC-GIBET, some comments can be made.

An important motive for the start of the Benelux Port Study Days and - subsequently - the establishment of BIVEC-GIBET was to stimulate cross-border contacts between (future) colleagues and thus stimulate the exchange of knowledge. These initiatives must also be seen in the light of the then important developments in European and Benelux integration. I In the 60s and 70s, Benelux associations were set up in various fields by people who cherished this integration
It was obvious that this should also be done in the area of transport and ports, given the significant role of the Benelux countries in European transport.

In the early days, BIVEC-GIBET-contacts were of the kind that is currently called "cross-border networks" - a term not yet in use at that time. Forty years later, the internet has replaced a part of this networking. Despite instruments like teleconferencing, Skype, WhatsApp and Facebook, it is good, and therefore also occasionally useful, to see each other "in reality" and to "taste" the practice of a port or a terminal on the spot. The possibilities for this kind of "classic" network activities are much more limited than forty years ago, due to the strict programming of the curricula and the study and work pressure.

The original aim of BIVEC-GIBET, namely the promotion of cross-border joint actions for students, both among themselves and with practice, nowadays is given less priority. The fact that the contacts between this breeding ground of transport economies and their future work environment were reduced is also probably an important reason why it appears to be increasingly difficult for stakeholders - both in the research field and in the business community and government - to be structurally involved with BIVEC-GIBET. Interest is there, but then on an ad hoc basis. The challenge for BIVEC-GIBET to respond to this.

Communication is key point of attention for an association such as BIVEC-GIBET. At the beginning of the 1990s, thanks to the efforts of several enthusiastic young members, a website was developed with information about the Association. Incidentally, "paper" publications have also appeared about many activities[10].

Given the fact that it is not easy to interest a large audience for BIVEC-GIBET, an approach has been adopted in which especially the "inner circle" - researchers and teachers and representatives of transport-related institutes - is approached and, as far as possible, actively involved in its activities. For example, the Transport Research Days also have the function of finding new parties interested in BIVEC-GIBET.

Looking at the list of approximately 100 organized activities (see i, iii and iv), it is striking that many subjects are in line with the current political and social relevance. That is certainly not a coincidence. Certain topics are still very current today. The starting point has always been to approach the chosen subjects from a scientific point of view. This does not in any way alter the fact that the treatment of these topics can also be valuable for policy makers, civil society organizations, the media and politics. Due to the scientific approach, complex and socially sensitive problems in the area of traffic and transport are often stripped of emotions and prejudices and knowledge instead of perception is paramount. Now that not only traffic but also decision-making about traffic problems seems to become a problem, the question arises whether BIVEC-GIBET would do well to bring more publicity to what the association can offer to governments and businesses.

This jubilee book is an example of how scientific knowledge can be of importance for the solution of practical issues concerning transport.

[10] https://www.bivec-gibet.eu/en/

5. Study days, colloquia, seminars and symposia

Legend:

C = Colloquium

S = Seminar

SD = Study Day

TD = Theme Day

1979, Brussels, Modal split (S)

Id., Rijswijk, Simulation models for Management in Public Transport (S)

1980, Antwerp, Transport Policy in Crisis Time (C)

Id., Brussels, Tariffs in road goods transport in Benelux (S)

1981, Rijswijk, Evaluation of investment projects in transport infrastructure (C)

Id., Rotterdam, Freight pricing in transport by barge in Benelux (S)

1982, Brussels, Market observation of freight transport (C)

Id., Antwerp, Border obstacles in international freight transport (C)

1982, Utrecht, Cost allocation and coverage in passenger and freight transport by rail (S)

1983, Groningen/Delfzijl, The role of the small seaports (C)

1984, Ghent, The interaction between spatial planning and passenger transport (S)

1985, Antwerp, Cost/benefit analysis with regard to the expansion of the Belgian waterway network (S)

1986, Amsterdam, Benelux ports in a world perspective (S)

Id., Louvain, High speed rail links (C)

Id., Brussels, Energy and Transport (in collaboration with Benelux Association of Energy Economists) (SD)

1987, Antwerp, The future of land transport in Europe (SD)

Id., Brussels, The European transport market after 1992 (C)

1988, Rotterdam, The elderly and public transport (S)

Id., Brussels, Traffic congestion: an (un)soluble problem? (C)

1989, Antwerp, Where with trade and transport documents? (S)

Id., Antwerp, Transport and port policy (C)

1990, Antwerp, The Economic Impact Study (E.I.S.) as a policy instrument for the government - an application in the maritime sector (S)

Id., Brussels, Mobility, Traffic and Environment (C)

1991, Amstelveen, Telematics in the Transport Market (C)

1993, Traffic and transport statistics in Benelux (in collaboration with Central Bureau for Statistics, The Hague, and National Institute for Statistics, Brussels) (S)

1994, Brussels, The road facing its growth (C)

Id., Corsendonk, Transport economics of the year 2000 (at the occasion of the third lustrum of BIVEC-GIBET) (S)

1995, Eindhoven, The regional airports in Benelux (C)

1996, Namur, Transport economics of the year 2000: external costs of transport and mobility (S)

1997, Brussels, The liberalization of European inland navigation in the year 2000 (C)

1998, Delft, Underground pipeline transport: a new and sustainable transport mode for the 21st century? Transport Research Day

1999, Antwerp, Iron Rhine and Betuweroute. The debate on the right tracks? (C)

2000, Mons / Strépy- Thieu, Transport Science in 2000 as seen from an economic point of view (S)

2002, Lille, Liberalization of inland navigation - experiences and perspectives (C)

2003, Antwerp, Staying accessible 'on land, at sea and in the air' (C)

Id., Antwerp, Dullaert, W., B.A.M. Jourquin and Polak, J.B., eds, *Across the border, building upon a quarter century of transport research in the Benelux, Antwerp*, De Boeck (ISBN 90 455 0956 3). Book at the occasion of 25th anniversary of BIVEC-GIBET

2004, Antwerp. *Security in freight transport Myth, Might or Necessity?* (C)
(Book: Frank Witlox, ed., title as colloquium, Antwerp/Apeldoorn, Garant, 2005, ISBN 90 441 1775 0, 978 90 4411 775 2)

2006, Breda, Military and civil logistics - what can the two learn from each other? (together with Netherlands Defence Academy) (S)
(Book: Walther Ploos van Amstel and Frank Witlox, eds. *Civil and Military Logistics. Similarities, Synergies and Differences*, Zelzate, Nautilus, 2007, ISBN 978 90 8756 013 3)

Id., Brussels, Transport and Energy (TD)

2007, Rotterdam, Transport Research Day
(Book: Cathy Macharis and Laurence Turcksin, eds *Proceedings of the BIVEC-GIBET TRANSPORT Research Day* Brussels, VUBPRESS, 2009, ISBN 978 90 5487 580 2)

2008, Road safety in Benelux (C)

2009, Brussels, Transport Research Day

Id., Brussels, Cross-border mobility (C)

2011, Rotterdam, Chinese Logistics in Europe (S)

Id., Namur, Transport Research Day

2012, Louvain, Eco zones (S)

2013, Luxemburg, Transport Research Days
(Book: Hesse, M., G. Caruso, Ph. Gerber and F. Viti, eds *Proceedings of the BIVEC-GIBET Transport Research Days 2013*, Zelzate, University Press, ISBN 978 9 4619712 2 7)

2015, Antwerp, Infrastructure and mobility (sponsored by Regional Science Association Netherlands, RSAN)

Id., Eindhoven, Transport Research Days

2016, Brussels, Is Belgium a logistic top location? (together with Belgian Institute for Transport Organizers - BITO-IBOT) (S)

Id., Brussels, The future of collective transport by road (Conference together with Belgian Institute for Car & Bus, ICB)

2017, Liège, Transport Research Day (S)

2019, Brussels (Secretariat General of Benelux), On the occasion of BIVEC-GIBET'S 8th lustrum, a Conference on the subject of "Road pricing in Benelux" was organized (8th May) (TD).

ANNEX 2 Referees

Éric Cornelis, Université de Namur, Belgium

Luc Van Capellen, BITO-IBOT, Brussels, Belgium

Jan Simons, Free University Amsterdam, the Netherlands

Veronique Van Acker, Luxemburg Institute of Socio-Economic Research (LISER), Esch-sur-Alzette, Luxemburg

Thomas Vanoutrive, University of Antwerp, Belgium

Bert van Wee, Delft University of Technology, the Netherlands

Frank Witlox, Ghent University, Belgium

ANNEX 3 Author Index

Abulibdeh *et al*., 108
Albalate and Bel, 110
Annema *et al*., 104
Ardiç, 79
Ardıç *et al.*, 2015; 2018, 111
Arnott and Krauss, 34
Arnott *et al.*, 1993a,b, 33
Arnott *et al*., 1994, 33
Attard and Ison, 111
Baeten et al., 21, 70, 71
Banister, 2008, 126, 128
Banister, 2018, 21, 71, 127
Batty, 127
Ben-Elia and Ettema, 2009; 2011, 108
Benelux Secretariat General, 85
Benelux Secretariat-General, 83
Berechman and Pines, 34
Beria, 111
Bickel *et al*., 51
Blauwens, 70
Blauwens *et al.*, 72
Bogaert *et al.*, 118
Börjesson and Kristoffersson, 111
Borremans *et al.*, 58
Braid, 35
Brand and Hunt, 127
Brands *et al*., 36
Breemersch *et al.*, 57
Brunet and Boyer, 6
Button, 132
CD&V, 2009, 2014, 71
Cervero, 116
CO_2logic, 53
Commissie Mobiliteit, 70
Condeço-Melhorado *et al.*, 111
Cools *et al.* (2011, 111
Cools *et al.*, 2012, 111
Cottingham *et al.*, 108
Courbe, 71
CPB and PBL, 79
Croci, 110
CurieuzeNeuzen, 2018, 50
De Borger and Proost (2013, 2018, 41
De Borger and Proost, 1997, 70
De Borger and Proost, 2012, 40
De Borger and Proost, 2013; 2018, 40
De Borger and Proost, 2016, 40, 101
De Borger *et al.*, 54
De Borger *et al*., 2005, 100
De Borger *et al*., 2007, 100
de Jong and Gunn, 118
De Palma and Lindsey, 108
de Saint Martin, 72
De Standaard, 71
De Vos, 70, 117
de Wit/Henk van Gent, 88
Debyser, 93, 96, 117
Delhaye *et al.*, 2010, 52
Delhaye *et al.*, 2017, 55, 117
Departement Mobiliteit en Openbare Werken, 2001, 70
Departement Mobiliteit en Openbare Werken, 2013, 70
Departement Mobiliteit en Openbare Werken, 2018, 58
Derycke, 69
DG MOVE, 2018, 49
Dogterom *et al*., 108
Downs, 132
Duranton and Turner, 132
EC, 2015, 48
EC, 2015; 2017, 48
EC, 2016, 48, 49
EC, 2018, 48, 51, 55
ECA, 2014, 53, 54
ECA, 2018, 46, 47
Ecolife, 52
Ecolo, 71
EEA 2016, 48
EEA, 2016, 46, 47, 49
Eliasson and Mattsson, 111
Ettema *et al.*, 116
European Commission (2018), 47
European Commission, 2017b, 49

European Environment Agency, 2017, 48
European Parliament, 56
Fan and Jiang, 108
Federaal Planbureau, 2015, 50
Federaal Planbureau, 2019, 50
Gazet van Antwerpen, 69
Gough, 127
Goulder, 1995, 57
Groen, 2009, 2014, 71
Grübler, 130
Halvorson and Buckeye, 108
Hensher and Li, 110
HLN, 2016, 71
HLN, 2018a, 71
HLN, 2018b, 72
Hylen et al., 101
ICCT, 2018, 48
Immers and Stada, 54
IPCC, 2018, 46
IRCEL, 2017, 50
Janssens *et al.*, 111
Jensen, 69
Jiménez *et al.*, 108
Kanbur and Keen, 100
Knockaert *et al*., 35
Krauss, 34
Kuik *et al*., 53
L'Echo, 71
Laffont, 2008, 51
Lambregs, 71
Lannoo *et al.*, 116
Le Vif, 71
Lebeau and Macharis, 47
Lévy-Lambert, 35
Lier *et al.*, 2017, 51
Lindsey, 69
Litman, 118
Lyons and Urry, 70
Macharis and van Lier, 2017, 50, 51
Macharis *et al.*, 2019, 58
Maibach *et al.*, 52, 54
Malmersjo, 92, 93
Mandell and Proost, 100
Mastini, 132
Maus, 72
Mayeres and Proost, 33
McDonald, 69
Meurs et al., 79
Meyer, 70
Minister of Communications, 70
Ministerie van VROM; Ministerie van V&W, 79
MIRA, 2017, 50
MIRA, 2018, 49
Mohring and Harwitz, 31, 34
Mommens *et al.*, 2016, 56, 57
Mommens *et al.*, 2018, 58
Morris and Guerra, 116
Muncrief, 116
NCC, 2016, 47
Newberry, 34
Nie, 108
Nikitas *et al.*, 111
N-VA, 2009, 2014, 71
OECD, 101
OpenVLD, 2009, 2014, 71
Owens, 70
Parry and Bento, 35
Pearce and Howarth, 2000, 51
Pigou, 30, 31
Piket, 122
Proost and Thisse, 103
Proost and Westin, 43
Proost *et al*. (2014, 102
Proost *et al*., 2011, 103
PwC *et al*., 71
Ramos *et al*., 108
Ricardo-AEA, 52, 53
Ricardo-AEA, 2014, 51, 54, 92
Rouhani, 107
Saadi *et al.*, 111
Sauwens, 70
Schade, 111
Schade and Schlag, 69
Schäffer *et al.*, 126
Schmidtchen *et al.*, 51
Smaal, 72, 78
Small, 33, 34
Small et al., 34, 43
Smith, A., 7
sp.a, 2009, 2014, 71
T&E, 2016, 55, 56
T&E, 2017, 56
TEN-T, 56
TML, 56, 57
Transportmedia, 72
Tweede Kamer, 78
UBA, 53
UN-Habitat, 127
UWE, 72
VAB, 84
Van Apeldoorn, 72
Van der Loo and Proost, 101
van Lier and Macharis, 52
van Lier and Macharis, 2017, 51
van Lier *et al.*, 2010, 52
van Lier *et al.*, 2019, 58, 59, 60
Van Lier *et al*., 2019, 62
Vanoutrive, 69, 70
Vanoutrive and Zijlstra, 2017, 69

Vanoutrive and Zijlstra, 2018, 21, 69, 71
VBO, 72
Verhoef *et al*., 1996, 35
Verhoef *et al*., 1997a, 34
Verhoef *et al*., 1997b, 36
Viapass, 72
Vickrey, 31, 33
Victoria Transport Policy Institute (2014; 2018, 109
Victoria Transport Policy Institute, 2018, 107
Vlaams Parlement, 70
Vlaamse Overheid, 2019a, 57
Vlaamse Overheid, 2019b, 57
Vlaamse Regering, 71
VMM, 2016, 50
VMX, 71
VOKA, 72
Vonk Noordegraaf, 79, 111
VRP, 71
VTM, 70
VUB MOBI, 61
Watkiss and Downing, 53
WEF, 2018, 46, 47
Weinreich *et al.*, 50
Witlox *et al*., 2007, 6
Witlox *et al.*, 2013, 71
www.benelux.int, 6

Road traffic is the lubricant of our prosperity. Without transport, everything comes to a standstill. But on the other hand, traffic causes congestion, noise pollution and the emission of harmful substances. As an important CO_2 polluter, road traffic is partly responsible for the climate problem. As traffic increases, the nuisance increases. Measures need to be taken. Road pricing is increasingly referred to as a solution. But how does road pricing actually work, what are the pros and cons. Why does it cause such a fierce social and political debate?

The Benelux Interuniversity Association of Transport Economists (BIVEC-GIBET) represents forty years of cooperation between universities and research institutes in the Benelux. This jubilee was a suitable moment to publish a book explaining the theory, practice and policy aspects of road pricing in the Benelux, and this because scientific knowledge contributes to finding the best and most widely supported solution to our daily traffic jam problem.

Editors

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