Transport policy and environmental impacts: The importance of multi-instrumentality in policy integration

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Abstract

Despite the introduction of many instruments in the transport system, they failed to reach their target since gains in global environmental efficiency have not been enough to cope with the consequences of transport growth. The ultimate environmental challenge for transport policy makers is to improve the effectiveness of implementation of policy instruments. This paper explores the concept of multi-instrumentality as a systematic approach for transport policy integration and implementation. Based on extensive literature review, we assess a set of 14 transport policy instruments (weaknesses, strengths and barriers to implementation) and perform a pair-wise analysis of potential synergies in their integrated implementation. Conclusions are drawn on the potential success of multi-instrumentality.

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1. Introduction

Developments in transport policy have been rather successful in many areas and global trends display extraordinary gains in the ease, cost and safety of movement for persons and goods in Europe, over the last 50 years (Viegas, 2003). However, transport growth generates increasing environmental impacts hardened by the growing share of road transportation.

Importantly, some improvements were obtained (EEA, 2004) mainly through technological innovation (International Energy Agency, 2004) and through the implementation of Transport Demand Management (TMD) instruments (Online TDM Encyclopaedia1). However, these have not been sufficient to reduce environmental impacts, mainly because road and air transportation that display higher average external costs have been growing faster than less harmful alternatives (INFRAS and IWW, 2000; EC, 2001).

In this sense, we argue that instruments aiming to improve the environmental performance of the transport system have been implemented but, all in all, are failing to reach the goal of curbing current trends of increasing environmental impacts. In complex systems such as transportation, there are many trade-offs occurring and unexpected side-effects from isolated interventions often occur. For example, according to the EEA, road transport has gained a greater and rising share of the freight market until 2005 (EEA, 2006), which indicates that the EU is not fulfilling the objective of stabilising road freight share at its 1998 level, regardless of the massive investments in rail infrastructure and the clarification of charging systems of European roads through the Eurovignette Directive.2

Traditional approaches to cope with the transport growth such as predict and provide strategies are no longer sustainable options mainly due to the induced demand of enlarged infrastructure capacity (ECMT, 2003). Nevertheless, increasing transport demand must be accommodated and the combination of transport supply with other types of instruments is potentially a better approach. Planners and decision makers hold a wide and diversified variety of TPIs (Acutt and Dodgson, 1997; May et al., 2003; REFORM, 1999; PROSPECTS, 2001; SPECTRUM, 2003).

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1http://www.vtpi.org
The challenge is now to figure out how to integrate and implement them in a more effective way.

Despite some successful examples (such as the London Congestion Charging Scheme (CCS)), policy integration “has proved easier said than done” (ECMT, 2001). It has also been recognized that the transferability of good-practices and the procedures of policy integration for more successful implementation of transport policies have to be further researched (May et al., 2003). The present paper explores the concept of “multi-instrumentality” (Viegas, 2003) as a complementary and systematic approach to the current procedures of transport policy implementation and integration by highlighting potential synergies between TPIs.

Section 2 deals with the methodology of the research. Section 3 presents the results obtained from the analysis of TPIs and discusses their weaknesses, strengths and barriers to implementation. Based on the previous analysis, Section 4 explores the concept of multi-instrument integration and implementation by identifying synergies between instruments and suggesting possible combinations of TPIs for future transport policy implementation. Finally, Section 5 illustrates the concept here by proposing a possible multi-instrument implementation for a fiscal reform of freight transportation.

We focus our analysis on freight transportation, firstly, to constrain the scope of research and, secondly, because it is one major polluter. Depending on the air pollutant, emissions can reach up to 60% of total EU transport emissions (EEA, 2004). Thirdly, although literature on integrated transport-policy encompasses mostly passenger transportation, our paper also intends to foster the discussion on effectiveness of policy implementation in freight transportation.

2. Concept and methodology

The methodological problem faced in our study is twofold: it relates to how policy instruments can be complementary instead of alternatives, and how to perform a systematic search for the most adequate complementary instruments when implementing one (or several) core TPIs. Therefore, the option was first to select a set of criteria to assess TPIs and thereafter to perform a pair-wise analysis of instruments and identify potential synergies between them. Taking advantage of synergies between single instruments and implement those in an integrated way can potentially lead to more successful policy implementation. As referred previously, the present paper explores the concept of multi-instrumentality that is here defined as a procedure of policy integration and implementation whereby a systematic search for complementary instruments is sought when planning and designing one (or several) core policy instrument(s) aiming to fulfilling one particular policy, more effectively.

Our methodological steps were: (1) definition of the assessment methodology and selection of TPIs, (2) assessment of TPIs, (3) identification of synergies between instruments, and (4) proposal of a multi-instrument strategy for a fiscal reform in freight transportation.

Although there is not a unique and indisputable classification of policy instruments, Viegas (2003) suggests that TPIs can be grouped in three major clusters: transport supply, regulation, and economic instruments. Transport supply aims to expand the capacity of the infrastructure and vehicles to accommodate increasing demand. Regulatory instruments include laws and regulations that define technical regulation of products and services (for example, EURO standards that force the industry to provide new and more efficient vehicles) and also economic regulation that defines the conditions to access and operate within the transport market place. Economic instruments use market mechanisms to solve transport-related problems. Planners expect significant responses from citizens and companies to price variation, since, among other reasons, consumers show great willingness to pay for better transportation services and the transport sector is very capital intensive (i.e., small variations involve big quantities of capital).

2.1. Transport policy instruments

TPIs considered in this study were selected according to: sufficient literature to draw consistent conclusions on each TPI, representativeness of the TPI within its cluster (i.e., whether it is a fine example of the TPI sub-class), and coherence of the TPI in light of the European Transport Policy orientations, i.e., whether or not the TPI contributes to achieve the overall objectives stated in the White Paper (EC, 2001), and more specifically, to the reduction of environmental impacts from freight transportation. The selected TPIs are now briefly described.

2.1.1. Transport supply instruments

‘Supply side instruments’ integrate all actions aiming to modify the behaviour of the transport-system agents by changing the quantity and/or quality of the available transport infrastructure capacity, equipment and/or vehicles. The following instruments were selected:

Construction of railways: The EU policy for sustainable transportation includes a shift from road transportation to alternative modes, which in the case of freight are railways, short-sea-shipping and inland transportation (EC, 2001). The EU defined 30 priority projects within the TEN-T framework (EC, 2004), among which we analysed the “Betuwe line” linking Rotterdam to Germany (EC, 2002a). We choose this project due to the availability of detailed information on policies to promote modal shift from road...
to rail through infrastructure expansion, and also due to the fact that this policy is actually failing.\textsuperscript{4}

Alternative fuels for road transportation: We reviewed two major technological strategies to overcome the burden of fossil fuels in transportation: increase fuel economy of vehicles and introduce end-of-pipe technologies to reduce emissions, or introduce alternative fuels, such as biofuels (Plaut, 1998; Geerlings, 1996).

Information systems to optimize the use of road capacity: Information technologies (IT) can induce a better use of available capacity and increase energy and environmental performance of the transport system (Blinge, 2003; Giannopoulos, 2004). We analyse the use of IT for freight transportation.

Eco-driving: Eco-driving affects energy and environmental efficiency of road vehicles in two ways: better vehicle maintenance by owners and less accelerations and decelerations in driving behaviour. We will analyse this instrument based on the experiences reported by Escudeiro and Nunes (2001) and Vlieger et al. (2000).

Environmental management in transport companies: Environmental management systems (EMS) provide ways to cut down energy balance sheet, among other resources, but are also useful for marketing purposes and ameliorate their competitiveness (IRU, 2002). We analyse the campaign launched by ANTRAM (2004) for the implementation of EMS in Portuguese freight operators.

2.1.2. Regulatory instruments

They include actions aiming to modifying agents’ behaviour by defining or changing sets of rules (e.g., restrictions, standards, and controls). The selected instruments are:

Vehicle emissions regulation: Stringent regulation on emission standards has proven to be quite successful in bringing down specific emissions from vehicles (Faiz et al., 1996; Acutt and Dodgson, 1997; Plaut, 1998). We not only analyse the effects and problems of “technology-following” regulation approaches but also “technology-forcing” approaches such as the Auto-Oil program (EC, 2000).

Restricted access of freight vehicles to city centers: Access to city centre by freight transportation has long been restricted, usually based on the vehicle’s weight. However, new regulation emerges and restriction starts being based also on the emission factors of trucks. We analysed the PROSPECTS report (2001) that presents a large review on this subject.

Reform of inspection and maintenance (IM) programs: Wear of vehicles usually implies some deterioration of the vehicle’s efficiency. Maintenance is thus critical to sustain the increased efficiency that new vehicles bring to the overall fleet. We review reported analysis on the potential of IM programs to induce good maintenance levels of vehicles (USEPA, 1992; TNO, 1998; Harrington et al., 2000).

Enforcement of lower speed limits: Emission factor from vehicles mostly depend on speed (Beever and Carslaw, 2005; Moura et al., 2003). We analyse how enforcement of lower speed limits has multiple benefits (i.e., reduction of emissions and accidents).

2.1.3. Economic instruments

They include actions aiming to modifying agents’ behaviour through a market-based approach. The selected instruments are:

Circulation taxes based on the vehicle efficiency: In the EU, circulation taxes have been commonly used to finance the construction of road infrastructure (PROSPECTS, 2001). Although the structure of these taxes rarely includes external costs of road transportation, there are some examples of such schemes. For example, Gröger (2000) refers that circulation taxes in Germany depend on the emission factor of vehicles and results of emissions reduction are encouraging. These tax differentiation schemes can potentially foster the shift towards more efficient vehicles (OCDE and IEA, 2001).

EU fuel tax harmonization: Fuel taxes constitute the largest share of the global transport-related taxes in the EU (INFRAS, 2000). In addition, this tax significantly determines the variable costs of transportation, thus also determining the use of vehicles (PROSPECTS, 2001). The European Commission wants to perform the harmonization of fuel taxes within the EU as well as take into consideration external costs of the different modes in the new structure of this tax (EC, 2002b).

Differentiation of vehicle acquisition taxes: We also analysed the implementation of tax on vehicle’s acquisition based on the efficiency of vehicles. Many authors argue that this instrument is crucial to force the entrance of more efficient vehicles concomitantly with stringent regulation on emission of pollutants (Komor, 1995; OCDE and IEA, 2001).

Internalization of external costs in the taxation of transport infrastructure: Taxation of the infrastructure has been mentioned as a privileged way to internalize external cost from transportation. Many examples are being implemented throughout the EU and were reviewed in our analysis (Perkins, 2003; Nash, 2003; Rothengatter, 2003; Viegas, 2002; INFRAS, 2000). The following sections present the methodology for the assessment of TPIs in more detail.
2.2. Assessment criteria and barriers to implementation

There is an extensive literature on policy assessment and many methodologies and criteria are proposed, but none is universally accepted or adopted since these are usually target-oriented for specific analysis and vary to some extent, depending on the subject being focused, i.e., whether it is transport, environmental impacts or economics, not to mention many others or possible combinations between them. Importantly, we highlight that the results obtained are forcedly associated with the selected methodology and set of criteria.

The “umbrella criteria” for the assessment of TPIs are coherence and global effectiveness: coherence of the TPI regarding the overall policy orientations (as referred in the previous section), and global effectiveness when assessing the final results after implementing one TPI.

An example of incoherent TPI is the ‘ecopoint’ system that Austria and the EU chose to promote environmental sustainability in the Alps by seeking a reduction of the negative effects of transport (Giorgi and Schmidt, 2005). Somehow controversial, this regulatory instrument was implemented although the policy orientations from the White Paper for the European Transport Policy went in the opposite direction, i.e., progressive deregulation of the EU transport system. Regarding the second criteria, the referred case of the London Congestion Charge is an example of an effective implementation of a TPI, since the expected results were actually achieved, whether these were mobility, environmental or other objectives (Beevers and Carslaw, 2005; Santos and Bhakar, 2005).

However, these “umbrella criteria” remain rather vague and more specific criteria were adopted. As referred previously, many methodologies have been proposed. The European Commission’s Green Paper on fair and efficient pricing in transport policy (EC, 1995) used the following set of criteria for the selection of TPIs: effectiveness, economic efficiency, transparency, equity and lateral effects. The Auto-oil Programme (EC, 2000), aiming to reduce gas emissions from the transport sector, holds its assessment on the effectiveness in reducing emissions and on the generation of indirect effects (energy security and other social benefits). The Congressional Budget Office of the United States of America (CBO, 2002) assessed the alternatives to reduce gasoline consumption based on cost-effectiveness, predictability of fuel economy enhancements, effects on safety and effects on other external costs related to driving. Despite some variations, some criteria are repeatedly used. Considering the scope and objectives of our research, we selected the following criteria: effectiveness, economic efficiency, acceptability, enforcement and lateral effects.

It is important to underline that the main objective of this paper is not the evaluation of the TPIs per se, but to demonstrate the advantages of multi-instrumentality. This group of criteria provides a (sufficiently) comprehensive comparison of TPIs and is adequate to demonstrate the trade-offs between them.

Effectiveness refers to the potential improvement in the environmental performance of the transport system after the implementation of a TPI.

Economic efficiency relates the effectiveness of TPIs to their implementation costs.

Acceptability translates the stakeholders’ appreciation and level of agreement on new TPIs. This is an important criterion since transportation is a major player in the global economy and lifestyles of individuals.

Enforcement indicates if (and how) TPIs can be implemented effectively (at the operational level). Many transport policies can be effective, efficient and acceptable at both strategic and tactical level, but tend to be very difficult to implement due to operational problems that arise due to poor enforcement.

Lateral effects: These were included in this analysis in order to encompass possible positive spillovers of TPIs on other sectors of the economy. For example, the use of biofuels can have a big impact on agriculture but this analysis goes beyond the scope of our study. However, it should not be neglected.

After determining whether or not a TPI is coherent with overall policy orientations, the assessment criteria presented above determine the potential global effectiveness of TPIs. Besides these criteria, we also analysed possible barriers to implementation of instruments that could (complementarily) explain why TPIs are eventually not successful (i.e., ineffective).

The concept of barriers to implementation considered in this study refers to exogenous factors that do not allow or limit the possibilities to carry out a certain policy as conceived initially. Four types of barriers were considered (SPECTRUM, 2004): legal and institutional, resource (financial), political and cultural, practical and technological.

Legal and Institutional barriers refer to legal or regulatory conflicts that may arise in the implementation phase of TPIs or when lack of legal powers may affect the implementation of a TPI. Institutional barriers arise when legal powers are spread throughout various institutions or organizations and may lead to implementation difficulties.

Financial barriers refer to the possible lack of financial or physical resources to implement some instrument, or by lack of flexibility to use certain funds for that purpose.

Political and cultural barriers usually occur when groups of citizens oppose some policy and manage to impair its implementation. They also relate to acceptability issues.

It is usually difficult to collect reliable information on both effectiveness and costs of implementation. Therefore, the assessment on ‘economic efficiency’ is based on a qualitative evaluation by the authors of the potential contribution of each instrument to improve the overall economic efficiency of the transport system. Based on the available information that we could collect, this assessment was performed by determining whether or not the TPI could contribute to bring the transport market closer to its optimum point of equilibrium, in the viewpoint of the society (refer to Section 3.1 for examples).
Some TPIs are particularly sensitive to lobbying pressures. Although a TPI might have good levels of global acceptability, they can face barriers to implementation due to the action of one or a few particular interest groups.

Practical and technological barriers are associated with practical problems that may arise in the implementation of certain TPIs, such as technical problems, transferability difficulties, or lack of sufficiently reliable technology.

2.3. Identification of synergies between TPIs

After evaluating each instrument, we analysed the potential benefits of implementing pairs of instruments whereby we identify the cases where the integrated implementation of two instruments would be mutually advantageous and thus generate synergism. In Section 5, we propose a more complex multi-instrument combination for a possible fiscal reform in the freight transportation sector.

According to May and Roberts (1995), there are three sources of synergy that should be considered in the formulation of integrated combinations of TPIs: complementarity, financial support, and public acceptability. We analysed the following types of synergies in each pair of instruments (A and B):

- instrument A improves the effectiveness of instrument B;
- instrument A improves the acceptability of instrument B;
- instrument A creates an economic incentive or finances the implementation of instrument B;
- instrument A improves the enforcement of instrument B.

The latter was also included since many environmentally oriented TPIs face serious enforcement problems.

Improved effectiveness occurs whenever the positive benefits of integrated implementation are greater than the aggregate positive results obtained by implementing both instruments separately. For example, the construction of rail infrastructures in a logistic platform is expected to increase the attractiveness of both types of infrastructure and thus possibly reinforce the effectiveness of both instruments when compared to their separate construction.

Improved acceptability happens whenever the acceptability of one policy instrument can be improved by implementing another instrument. For instance, people tend to react negatively to taxes on road transport. This negative reaction is worsened when no alternatives are available. If alternatives are provided by some other TPI, the acceptability problem can potentially be mitigated.

Economic incentive, or financial synergy, occurs when one policy instrument (usually, economic instrument) is used to finance another instrument or to create a market incentive to some transport product or service. For example, taxes can be used in order to internalize the environmental costs of the more polluting technologies (for example, cars), thus making the less polluting alternatives more competitive.

Enforcement synergies take place when the implementation of a TPI can be used to enforce the implementation of another instrument. For instance, IM programs were implemented to enforce safety standards of vehicles but are also used to enforce environmental standards and could be used to verify the compliance with taxes (i.e., those based on the vehicle’s performance).

3. Results

As referred in Section 2, the TPIs were selected based on their representativeness and coherence regarding global policy orientations. The following individual assessment of TPIs is performed in order to set the grounds for their pairwise analysis and identify possible synergisms between them (Section 4).

3.1. Individual assessment of TPIs

The assessment of TPI presented in Section 3 was based on the literature review of relevant experiences encompassing both the implementation process and results of TPIs (PROSPECTS, 2001; Plaut, 1998; Acutt and Dodgson, 1997; May and Roberts, 1995, among others). We reviewed the theoretical basis that sustains each instrument and completed the analysis by considering at least one real-world application of that instrument. Table 1 summarizes the results.

The “umbrella criteria” that determined the choice of TPIs requires coherence of the TPI regarding environmental objectives of the European Transport Policy. Therefore, we expected that all policy instruments would be effective in promoting higher levels of environmental performance of the transport system. Our results also highlight strengths and weaknesses in all instruments, and suggest that none of them could solve all transport policy problems, individually. In addition, most of the selected instruments have positive lateral effects. This is probably due to the fact that most environmental consequences of transport activity are inefficiencies in the system. Therefore, TPIs that improve the environmental performance might potentially improve the overall efficiency of the transport system (for example, by improving fuel efficiency or maximizing the use of transport infrastructure).

Based on the information collected during this study, these results strengthen the thesis that multi-instrumentality could possibly overcome some of the identified weaknesses and eventually enhance the strengths of single implementation of each TPI. It also suggests that synergies between TPIs should be identified and possible integrated implementation of several instruments should be analysed.

Transport supply instruments have chiefly a positive influence on the public acceptance of the remaining TPIs. This is due to the fact that supply instruments widen the capacity or number of mobility alternatives and, therefore, can be combined with TPIs that would, conversely, restrict the capacity or number of alternatives (and that consequently have often acceptability problems). However, they do not necessarily promote economic

efficiency. Although these instruments can potentially contribute to achieve a better environmental performance of the transport system by shifting passengers and freight to more efficient modes (regarding energy and environmental efficiency) they can also induce greater transport activity (induced demand), i.e., more capacity in infrastructures induces more transport demand and more energy performing vehicles induce increased miles travelled (so-called "rebound effect"). The overall balance may not necessarily be a global reduction of environmental impacts by the transport sector. The strong impact of transport supply instruments in enhancing the acceptability of citizens and companies must be recognized for the framework of multi-instrument policy implementation.

*Regulatory instruments* are very effective and easier to enforce, as regulation is, by its nature, compulsory. Nevertheless, their economic efficiency and public acceptance are hard to ensure. Over the last decades, public authorities have been progressively reducing economic regulation, as it is thought to be distorting market competition and reducing overall economic efficiency. However, technical regulation is still used as a mean to force the market to reduce externalities. Even though this technical regulation is still regarded by the industry as a threat to economic efficiency, according to the “Porter Hypothesis” (Porter and Linde, 1995), properly designed environmental regulation can trigger innovations that lower the total costs of a product or improve its value, as it leads to enhanced resource productivity making companies more competitive. Applying regulation as a way to stimulate innovation and force the entrance in the market of new technological achievements may be an important tool within a multi-instrument approach to improve the environmental performance of the transport system.

*Economic instruments* can combine some effectiveness on environmental targets with good economic efficiency. In fact, these instruments bring transport market equilibrium closer to a point where, theoretically, a more social-efficient allocation of resources is usually obtained (Banister and Button, 1993). According to ecological economists, with the implementation of taxes on transportation, the market responds by changing both demand and supply of that transport activity. If the tax is equal to the amount of uncovered externalities, the new market equilibrium to be achieved should be more efficient in a socio-economic viewpoint. Demand tends to react to the imposed tax by reducing the level of consumption, adopting more efficient alternatives of transportation or compensating those affected by the externalities. However, these policy instruments tend to face acceptance problems, as a result of price increases. Economic instruments can be seen as potential fund raisers for the implementation of other TPIs or to create financial incentives to certain products or services, considering a multi-instrument approach.

### Table 1

Results of the assessment of transport policy instruments

<table>
<thead>
<tr>
<th>Instrument Type</th>
<th>Effectiveness</th>
<th>Economic Efficiency</th>
<th>Acceptability</th>
<th>Enforcement</th>
<th>Positive lateral effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport supply instruments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of Railways</td>
<td>+</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td>Networks of logistic platforms</td>
<td>+</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td>Alternative fuels for road transportation</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td>Information systems to optimize the use of road capacity</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td>Eco-driving</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Environmental management in transport companies</td>
<td>0</td>
<td>–</td>
<td>+</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Regulatory instruments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle emissions regulation</td>
<td>+</td>
<td>–</td>
<td>0</td>
<td>+</td>
<td>No</td>
</tr>
<tr>
<td>Restricted access of freight vehicles to city centres</td>
<td>+</td>
<td>–</td>
<td>0</td>
<td>–</td>
<td>Yes</td>
</tr>
<tr>
<td>Reform of IM programs</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Enforcement of lower speed limits</td>
<td>+</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Economic instruments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulation taxes based on the vehicle’s efficiency</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>Yes</td>
</tr>
<tr>
<td>EU Fuel tax harmonization</td>
<td>+</td>
<td>0</td>
<td>–</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Differentiation of vehicle acquisition taxes</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Internalization of external costs in the taxation of transport infrastructure</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
</tbody>
</table>

Symbol “+” is used whenever an instrument is assessed positively according to some criterion. Conversely, the symbol “−” indicates a negative assessment and “0” is used whenever the evaluation of the impact of the instrument regarding the criterion is neutral or not clear. If the instruments have “positive lateral effects” then “yes” appears in the right-most column. Conversely, if there are no “positive lateral effects” (or if there are negative lateral effects), then “No” is marked. Again, the sign “0” is used whenever there is no clear tendency for positive or negative lateral effects of some instrument.
3.2. Analysis of barriers to implementation

Table 2 presents the barriers to implementation that were identified when analysing all instruments.

The global appreciation is that all TPIs face potential barriers to implementation, but legal and practical barriers are apparently more frequent. Instruments that are not largely diffused can face practical and technological barriers.

In the case of transport supply instruments, the construction of new infrastructure and introduction of new technologies usually face legal barriers due to changes imposed on the regulatory status quo. New rules have to be defined for the operation of the new component of the transport system. If transport supply instruments require high start-up investments then financial barriers are frequent. As referred previously, the implementation of technological innovation faces political and cultural barriers mainly due to natural resistance to novelty by users.

Regulatory instruments face practical and technological barriers. New technical regulation necessarily induces the diffusion of new technology. For example, more stringent emission standards induce the diffusion of more efficient vehicles. However, barriers may appear since it may take long for more efficient vehicles to be supplied by carmakers at reasonable costs. Legal barriers also occur in the implementation of regulatory instruments, particularly when these TPI conflict with existing legislation. For instance, enforcement of TPI using video-based detection systems may face barriers due to personal data protection legislation.

Economic instruments are opposed with many practical and legal barriers since they usually implicate changes in the existing tax system. For instance, the economic instruments analysed in this study aim to incorporate the environmental dimension in the tax system whether the latter affects fuels, vehicles or infrastructures. The practical and technological barriers that these TPI may face are related with changes of the current tax system. The incorporation of the environmental dimension in the tax system would have to rely on tools to monitor environmental emissions. These are not still available, at least with low cost and higher availability necessary for economic instrument enforcement. In addition, changes in the tax structure may impair the sustainability and reliability of fiscal revenues of states, thus creating financial barriers.

Our analysis shows that all TPIs face barriers to their implementation. The next section identifies synergies between TPIs that can potentially minimize or overcome some of these barriers. It also suggests a procedure for systematic search of multi-instrumentality when planning and designing one (or a set of) core TPIs.

4. Advantages of multi-instrumentality

As described in Section 2.3, four types of synergies between the TPIs were analysed: complementarity (C), acceptability (A), enforcement (E), and financing (F). Table 3 presents the results obtained.

Based on the pairs of TPIs reviewed here, several cases of synergy between instruments could be identified. The results presented in Table 3 show the following:

- Synergies between transport supply instruments and regulatory or economic instruments have a common pattern, i.e., the former can possibly increase the

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Table 2
Results of the identification of barriers to implementation of transport policy instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Legal and institutional</th>
<th>Financial</th>
<th>Political and cultural</th>
<th>Practical and technological</th>
</tr>
</thead>
<tbody>
<tr>
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<td>✓</td>
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<td>✓</td>
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<td></td>
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<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>Reform of IM programs</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Enforcement of lower speed limits</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Economic instruments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulation taxes based on the vehicle’s efficiency</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>EU fuel tax harmonization</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Differentiation of vehicle acquisition taxes</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Internalization of external costs in the taxation of transport infrastructure</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The signals (✓) mark the cases where each type of barrier was reported.
Table 3
Potential synergies between transport policy instruments

<table>
<thead>
<tr>
<th>Transport supply instruments</th>
<th>Regulatory instruments</th>
<th>Economic instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Construction of railways</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>(2) Networks of logistic platforms</td>
<td>C/E</td>
<td>A</td>
</tr>
<tr>
<td>(3) Alternative fuels for road transportation</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>(4) Information systems to optimize the use of road capacity</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>(5) Eco-driving</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>(6) Environmental management in transport companies</td>
<td>C/E</td>
<td>A</td>
</tr>
<tr>
<td>(7) Vehicle Emissions Regulation</td>
<td>C/A</td>
<td>A</td>
</tr>
<tr>
<td>(8) Restricted access of freight vehicles to city centres</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>(9) Reform of IM programs</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>(10) Enforcement of lower speed limits</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>(11) Circulation taxes based on the vehicle’s efficiency</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>(12) EU Fuel tax harmonization</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>(13) Differentiation of vehicle acquisition taxes</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>(14) Internalization of external costs in the taxation of transport infrastructure</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

Complementarity (C)—instruments listed in the rows improve the effectiveness of those in columns; Acceptability (A)—instruments in rows increase the acceptability of those in columns; Enforcement (E)—instruments in rows contribute to the enforcement of those in columns; Finance (F)—instruments in rows finance those in columns.
acceptability of implementation of the latter. Basically, transport supply instruments typically induce transport demand while regulatory and economic instruments tend to restrict transport demand. Using the ‘Carrot and Stick’ metaphor, transport supply instruments are the ‘Carrots’ while regulatory or economic instruments are the ‘Sticks’. Additionally, information technologies can possibly improve the enforcement of regulations or taxes, because recent developments in detection technologies made possible the automatic and remote enforcement of these TPIs. For example, digital tachometers enable an increased enforcement of speed limits regulation. Alternatively, many systems to pay road tolls, without forcing a stop in toll booths, are being implemented, allowing the extension of charging systems of infrastructure over larger geographical areas.

- Combined implementations of two regulatory instruments or a regulatory with transport supply instrument are complementary, considering the cases we analysed. The introduction of regulations and standards that define restrictions to vehicle emissions (e.g., EURO standards for road vehicles) creates an opportunity for other regulatory restrictions to be introduced in parallel, such as regulation that restricts the access to infrastructures or sensitive urban areas by less efficient vehicles. Here again, multi-instrumentality can be extended. These regulation restrictions also induced a response from the carmakers that are expected to provide zero or near-zero emissions vehicles in the medium-term at reasonable costs.

- Based on the sample of TPIs that we selected for our analysis, we identified several types of synergy when comparing the trade-offs between regulatory and economic instruments. Therefore, we could not determine a unique type of synergy between regulatory and economic instruments. However, it is expectable that regulatory instruments increase the acceptability of economic instruments. In fact, if regulation forces the introduction of more efficient vehicles or fuels into the market place, varying taxes based on environmental criteria become more acceptable. In addition, in some cases, regulation may also improve the enforcement of economic instruments. For example, IM programs may be used to enforce those environmentally based taxes, because it enables varying taxes based on real emissions of the vehicle instead of standard emissions and the payment of those taxes can be controlled more easily.

As referred previously, although collected evidence is not definitive, the analysis presented above strongly suggests that there are high-potential enhancements in transport policy implementation through multi-instrumentality. Although there is no dominant type of synergy between all pairs of instruments, patterns of synergies between clusters could be detected. The general sense is that TPIs are complementary, i.e., the effectiveness of instruments implemented together is potentially bigger than the sum of the effectiveness of each instrument being implemented separately.

Based on our review, transport supply instruments potentially increase the effectiveness of the remaining network because the new-built infrastructure increases its overall connectivity and, in turn, there is eventually an increase of demand of the new infrastructure. For example, the construction of logistic platforms at some points of the rail network can potentially increase the competitiveness of railways for freight transportation, as it might reduce the costs of intermodal cargo transfers. On the other hand, while serving that logistic platform, railways contribute to enhance its competitiveness (as would happen with any other infrastructure), since more transportation options are available.

Apparently, there is one major type of synergy between economic instrument and each of the other clusters, considering the TPIs analysed here. Firstly, economic instruments are frequently used to finance or create economic incentives to the construction or use of infrastructures. Among many examples, the use of circulation taxes to finance infrastructure expansion or maintenance is widely practiced in the EU. Moreover, regulatory instruments have synergies with economic instruments, i.e., the former enhance the acceptability of the latter. Conversely, economic instruments can be implemented in a complementary way with regulation, as those may induce drivers to comply with regulation whenever compliance reduces the acquisition and operational costs of vehicles. For example, the variabilization of circulation taxes according to vehicle emissions along its life cycle stimulates the maintenance of vehicles and, hence, it increases the compliance with air quality regulation. Based on the cases analysed here, one economic instrument can possibly increase the acceptability of another, in the sense that a price increase in the first can somehow be compensated by the simultaneous price decrease of the other.

Based on our review, we could draw the following general types of synergism (Fig. 1):

- Transport supply instruments can be implemented in a package with both regulatory and economic instruments in order to improve their acceptance.

Fig. 1. Diagram of potential synergies between transport policy instruments. (Notes: Loops represent self-reinforcing synergy and arrows represent reinforcing synergy between instruments.)
Regulatory instruments increase the acceptability of economic instruments and are complementary to transport supply instruments.

Economic instruments are complementary to regulatory instruments and can finance transport supply instruments.

Information technologies (included in the transport supply cluster) can potentially play an important role in overcoming practical barriers to implementation in all clusters of policy instruments.

The overall conclusion is that, although not obligatory, a systematic search for multi-instrumentality when planning or designing some transport policy intervention should be sought, as collected evidence (although not definitive) strongly suggests that this procedure has a high-potential to enhance the success of transport policy implementation.

5. Multi-instrumental implementation of a fiscal reform of freight transportation

According to the White Paper “European transport policy for 2010: time to decide” (EC, 2001), as prices do not reflect the full social cost of transport, demand has been artificially high. If appropriate pricing and infrastructure policies were to be pursued, these inefficiencies would largely disappear over time. The paradox is that transport has too many taxes: registration tax, road and insurance tax, fuel taxes and infrastructure charges. However, while transport may be heavily taxed, it is above all badly and unequally taxed. There are inequalities between the various modes of transport (for example, high fuel taxes for road transport and almost absence for aviation or shipping), and some of the existing taxes do not present any incentive to improve the environmental performance (for example, the Air Passenger Duty in the UK does not reward more efficient airlines). Users are mostly treated alike, irrespective of the infrastructure damage, bottlenecks and pollution they cause (EC, 2001). As already referred in the Green Paper of the European Commission (EC, 1995), there is a large consensus that the fiscal structure of the taxes and charges in the transport sector need to be reviewed. However, little progress has been achieved, which is particularly troublesome in the EU freight transport system since, over the last decade, it has been experiencing a radical liberalization and taxes could now be distorting market competition and possibly generating social and economic inefficiencies.

This section proposes an example of multi-instrumentality for the implementation of a fiscal reform of freight transportation. Therefore, economic instruments (i.e., environmentally oriented taxes and charges for...
circulation, fuels, acquisition of vehicles and infrastructures based on environmental and energy performance of vehicles—bold-line boxes of Fig. 2) are the core set of this policy. The following figure illustrates how the implementation of this policy could be orchestrated (through multi-instrumentality) in order to maximize its positive effects and minimize barriers or negative effects.

Fig. 2 illustrates positive impacts (arrows) between suggested TPIs. Differentiated acquisition taxes of vehicles (upper-right corner of the figure) can possibly induce companies to choose more efficient vehicles. This TPI enhances the acceptability of both circulation and fuel taxes since, in the first case, circulation taxes would also be based on the vehicle’s performance (consequently, reduced) and, on the second, vehicles spend less fuel. Again, circulation taxes based on the vehicle’s performance would increase the acceptability of the infrastructure taxes if these would depend also on the vehicle’s efficiency. Hence, the dominant relationship is an enhanced acceptability of higher taxes on vehicle use if this increase is consistent with a decrease in taxes related with vehicle ownership.

Concerning impacts between economic instruments and other clusters of TPIs, two “typical” pairs of interactions are analysed: (1) economic instruments create economic incentives or finance transport supply instruments, which, in turn, have positive feedback impact in the acceptability of that economic instrument; and (2) transport supply or regulatory instruments contribute to an easier enforcement of the economic instrument.

The previous diagram also illustrates how the overall acceptability of this policy could be improved by including transport supply instruments, such as providing more railways and logistic platforms or introducing alternative fuels into the market. Eco-driving training of drivers could also be included in order to change their behaviour and maximize efficiency in the use of vehicles. In parallel, regulation could enhance the enforcement of economic instruments, for example, IM programs as explained in Section 4. Finally, the use of information technologies could enhance the enforcement of the referred taxes by increasing the efficiency of the monitoring system.

6. Conclusions

As mentioned earlier, collected evidence (although not definitive) strongly suggests that multi-instrumentality has a high-potential to enhance the success of transport policy implementation. Therefore, our main conclusion is that, although not obligatory, a systematic search for multi-instrumentality should be sought when planning and designing a transport policy intervention. After deciding on the core (or core set of) TPI(s) to be implemented, a systematic search for complementary instruments should follow in order to increase effectiveness and minimize the negative effects and barriers to implementation. However, the political message for the transport system stakeholders should highlight the core set of TPI while the complementary instruments should be put less forward (at least in the early stages) in order to keep the message simple and straightforward.

Additionally, multi-instrumentality should be considered not only at the strategic or tactical level, as explored in our analysis, but also at the operational level. Our analysis focuses on the maximization of the expected results of one transport policy that is composed by several instruments. However, at the operational level, opportunities may arise for other apparently unrelated instruments when actually implementing the initial policy package. For example, if a new transport infrastructure (e.g., tramway) is constructed in an urban area, complimentary works (e.g., urban regeneration) could be included in order to maximize the benefits of the overall intervention.

Finally, our analysis also emphasizes that particular attention should be given to enforcement issues because many instruments are implemented but expected effects may not occur. Here again, a systematic multi-instrumental approach may positively contribute to a better enforcement of policy instruments.

References


