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Mechanisms for Financing Roads: A Review of International Practice

Infrastructure and Energy Sector
Multilateral Investment Fund

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ABBREVIATIONS

APP	Asociaciones Público-Privadas
BID	Banco Interamericano de Desarrollo
ETC	Electronic Toll Collection
FDN	Financiera de Desarrollo Nacional S.A.
FOMIN	Fondo Multilateral de Inversiones (FOMIN/BID)
GRSF	Global Road Safety Facility
IADB	Inter-American Development Bank
IDB	Inter-American Development Bank
ITS	Intelligent Transportation Systems
INVIAS	Instituto Nacional de Vías
LAC	Latin America and the Caribbean
MIF	Multilateral Investment Fund (MIF/IDB)
O&M	Operation and Maintenance
PMS	Programa de Mantenimiento Sostenible
PPP	Public Private Partnerships
RONET	Road Network Evaluation Tools
RUC	Road User Charges
TOR	Terms of Reference
VfM	Value for Money

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ABSTRACT

In the last two decades there has been an increased contribution of the private sector, through some form of public-private partnership (PPP), to finance transport infrastructure in general, and roads in particular, in both the developed and developing worlds. Such contribution has helped several countries to maintain, rehabilitate and expand their road networks, including the construction of new motorways, bridges and tunnels. Some governments have increased the public contribution to potential PPP road projects to make them attractive to private investors. Such support may take the form of grants (or subsidies) to project construction, as well as availability payments and operational grants or minimum revenue guarantees during the operational phase of the PPP project. Nevertheless, there are projects that will not be able to attract private financing and will have to be financed with only public funds.

The main objective of this paper is to provide an overview of the most commonly used means to charge road users to generate financial resources for supporting PPP projects or to finance totally public projects. Such charges include *inter alia* fuel taxes, vehicle taxes, vignettes, and tolls. A brief survey of road user charging systems in selected European countries is presented. Consideration is given to different forms of PPP, including a review of potential application of the World Bank Toolkit for PPP in Roads and Highways as an instrument to help decision-makers and practitioners to define the best PPP approach for a specific country. Developing and transition economies can also take advantage of guarantees offered by international financial institutions, an example of which is the World Bank's partial risk guarantees that can increase a project's attractiveness to private investors through lower interest rates and longer maturities of loans.

Keywords: PPP; public private partnerships; road net; road; transportation; Colombia; road evaluation tool; performance based; alianza publico privada; APP; operations; highways; infrastructure financing

JEL Codes: R40; R42

I INTRODUCTION

Transport costs are a significant part of the cost structure of the goods that a country produces or imports. If transport costs are unnecessarily high, then the country's products will not be competitive on international markets. Road transport costs include not only the cost of building and maintaining the road network, but also road user costs, which increase as roads deteriorate due to increased vehicle operating costs (e.g., maintenance and fuel consumption), the costs associated with increased time in transit, as well as the costs associated with road crashes, which amount to about 1% to 3% of a country's gross domestic product – GDP, as estimated by the Global Road Safety Facility (World Bank 2014).

Experience has shown that timely maintenance is much less expensive than delayed maintenance. If roads can receive maintenance at the appropriate time, then the overall cost of maintaining the roads is less than if roads deteriorate to the point that requires reconstruction rather than less expensive treatments such as surface dressings or asphalt overlays. For example, reconstruction costs in the order of five times as much per kilometer as an overlay, and 25 times as much as a bituminous surface dressing.

Consequently, it is imperative for the efficient operation of the road transport system that resources be available for timely road maintenance, as well as for the expansion of road networks with essential new or upgraded links that will reduce traffic congestion, travel times and transport costs.

Some governments have increased the public contribution to potential public-private partnership (PPP) road projects to make them attractive to private investors. Such support may take the form of grants (or subsidies) to project construction, as well as operational grants or minimum revenue guarantees during the operational phase of the PPP project. Nevertheless, there are projects that will not be able to attract private financing and will have to be financed with only public funds.

According to the World Economic Forum (2014), governments need to develop a holistic and long-term strategy for operating and maintaining their physical assets that may represent a considerable financial burden for future taxpayers. A current initiative by the government of Colombia, the Sustainable Road Maintenance Program (INVIAS 2013) is a good example of such approach. While there is usually a political bias toward funding new assets, PMS focuses on existing road assets.

It is anticipated that many countries will be looking to modern road user charging (RUC) systems that would provide more funds for maintaining and expanding their road networks, both through purely public projects, or through some form of PPP arrangement (Queiroz 2009).

In Western Europe, countries such as the UK, Spain, Italy and France have taken considerable advantage of private financing of road infrastructure, while countries such as Norway and Sweden still have a vast potential to explore. In Central and Eastern Europe there has been mostly positive PPP experience in countries such as Hungary, Croatia, and Poland. In Latin America, countries such as Argentina, Brazil, Chile, Colombia, Mexico and Peru have been able to attract substantial private investments to the road sector, as is also the case, for example, of China, India, and South Korea in Asia.

This paper covers the most commonly used means to charge road users, such as fuel taxes and tolls, which provide a source of public funds for roads. A brief survey of road user charging systems in selected European countries is presented. Consideration is also given to private financing of roads through different forms of PPP. Developing and transition economies can take advantage of guarantees offered by international financial institutions, an example of which is the World Bank's partial risk guarantees, that can increase a project's attractiveness to private investors through lower interest rates and longer maturities of loans.

II ROAD USER CHARGES

It is in the interest of the road users to have well maintained roads, as the operating costs of their vehicles are reduced substantially more than the corresponding cost of road maintenance. Thus, the first step in seeking financing for road maintenance is to look to the users of the roads to pay the cost of road maintenance. Road users can pay directly, for example through tolling, or indirectly, for example through fuel taxes. Experience in a number of countries has shown that road users are willing to pay for road maintenance, as well as expansion, if they can see that the fees and taxes that they pay result in improved road condition.

The preferable road user charges are those that link the charges most closely to the use of the roads. Generally, the most appropriate are charges for the use of the road space, and charges for the disproportionate damage caused by heavy vehicles.

Method of Charging for Roads. The principles of taxing road users are that charges should be economically efficient, equitable, cost little to collect and be difficult to evade. They should also be adjusted for inflation (Yenny 2002).

Taxes on Vehicle Fuel. Such taxes satisfy, to a certain extent, the above criteria and are widely used. They are relatively inexpensive to collect, easy to administer and reasonably equitable, as they are proportionate to road use. Their main disadvantage is that they do not reflect the much higher damage done to roads by heavy vehicles. Although trucks consume more fuel per kilometer than cars and would therefore pay more fuel taxes per kilometer traveled, this is not in proportion to their higher impact on the roads. Therefore, fuel taxes need to be supplemented by additional charges on heavy vehicles (e.g., higher annual registration fees).

Taxes on fuel are also used by Governments for purposes such as restraining fuel consumption or raising revenues for the budget, and this is common practice in many developing and developed countries. Nevertheless, there should be sufficient funds allocated to carry out an appropriate level of road maintenance and expansion.

Vehicle Licenses are common in most countries, mainly in the form of annual license fees (or for a two-year period, as in the United States). They are easy to collect and can differentiate between types of vehicle and reflect the costs that each type causes to the roads. The main drawback is that they are not related to use. A truck used for only 20,000 km per year would pay the same as one traveling 100,000 km per year. Nevertheless, they are a good complement to fuel taxes.

Vehicle-distance Traveled Charges (or Fees) have been implemented in a number of countries, including Norway, Sweden and New Zealand. The charges are administered through sealed hub odometers or other measuring devices. The problem is that such systems require a substantial initial outlay, sophisticated administration, and are prone to evasion. Even in law-abiding New Zealand, the evasion is estimated at 10 to 20 percent. Some of these shortcomings can be avoided with more modern charging systems, such as the ones now in use in Germany and Austria (discussed later in this paper), which are considered a form of tolling. Vehicle-distance traveled fees and tolls are usually called “direct user fees.”

Tolls are used for specific roads, bridges and tunnels. Although they charge directly for the use of particular facilities and are therefore equitable, they are a relatively expensive means of raising revenue. They have relatively high capital costs (e.g., construction of toll plazas and tollbooth, controlled access) and operating costs (toll collection). A rough rule of thumb is that tolls should not be considered for roads with traffic of less than some 5,000 vehicles per day, to keep the administrative costs at a relatively low percentage of the toll revenues. Toll systems also reduce the economic benefits of the tolled facilities by minimizing entry and exit points, delaying traffic at tollbooths and diverting traffic to parallel roads with higher vehicle operating costs. Modern toll

collection procedures, such as the German Toll Collect system, discussed later, can minimize such drawbacks.

Issues regarding toll collection include *inter alia* the toll rate structure and enforcement systems. A review of the toll rate structure adopted in several countries indicates that a toll rate structure simply based on the number of axles of trucks and buses is commonly used. Several countries simply multiply the rate for a passenger car by the number of axles of a truck (or bus) to compute the toll rate for such vehicle. This is the case, for example, of all the federal highway concessions in Brazil, as detailed in the concession contracts under the Brazilian Agency for Land Transport (ANTT). Such contracts are available on the ANTT website at:
http://www.antt.gov.br/index.php/content/view/5261/Concessoes_Rodoviarias.html

The site below, of the International Bridge, Tunnel and Turnpike Association (IBTTA), provides links to a series of toll-related publications:
http://ibtta.org/node/114220

Regarding toll violation enforcement, the system recently introduced by the US State of Virginia is an interesting example. As in several other systems, it uses cameras to take photos of toll violators. This may be challenging where license plates tend to be very dirty. Information on the Virginia system is available at:
http://www.virginiadot.org/sitemap/default.asp

In the United States, the Federal Highway Administration maintains a comprehensive database of toll facilities, which can be accessed on their website at:
http://www.ops.fhwa.dot.gov/tolling_pricing/resources/toll_facilities_info/search_results.cfm

Vignette, which is used in several European countries**,** is a form of road pricing imposed on vehicles, usually as a small, colored sticker that is affixed to a vehicle windscreen. It can also be electronic, which is the case of Hungary and Romania. Typically, vignettes are used to charge vehicles for the use of an entire class of roads such as motorways and expressways. This charge does not have the costs associated with tolls described above. However, vignettes do not take into consideration distance traveled. Vignettes are usually sold for a fixed period (e.g., one year, month or week), when they can be used irrespective of the number of kilometers driven. Vignettes limited to one or a few days have been used, although short periods may add considerably to the cost of administering the system. Evasion is considered a serious problem, as random checks are the only way to verify that vignettes are displayed on the vehicles. Vignettes for the use of motorways are in effect, for example, in the Czech and Slovak Republics and Hungary. In Poland, vignettes are required for trucks and buses with total weight over 3.5 tons to use specific sections of the road network.

Charges for non-standard and overweight vehicles are levied in many countries, the principle being that these charges should compensate for the extra damage caused to the roads by over-sized or overloaded vehicles. These charges seldom reflect the costs imposed on the roads by these vehicles and barely cover administrative costs. They tend to be easily avoided by payment of bribes. In the case of overloading, it would be better to enforce axle load limitations by stricter control, fines and forced unloading of contravening trucks.

Charges on the purchase of new vehicles, practiced in many countries, can be graduated for different kinds of vehicles (more for trucks). Similar to annual vehicle registration fees, they are relatively easy to collect, but are not related to subsequent vehicle use.

Sales taxes, of which part of the revenues have been assigned to roads. This is the case, for example, of the State of Virginia, in the U.S. Despite the fact that these taxes are not directly related to road use, they have been used to provide funds for roads in several countries.

General practice: The most widely used road user charges are a combination of fuel taxes (usually responsible for 70 to 80 percent of the total road user charges); an annual vehicle registration fee that varies depending on the size of the vehicle; special charges for extra heavy vehicles, approximately in proportion to their weight; and transit fees for foreign vehicles, to compensate for the local fees and charges that they do not otherwise pay. Electronic toll collection (e.g., US, Norway, France, Canada, Chile, Brazil), congestion charges (e.g., London, Singapore, Stockholm), and satellite-based system (e.g., Germany) are being adopted or considered for adoption by several countries. Some related examples are discussed later in the paper.

III DEVELOPING A ROAD FINANCING PLAN

When the funds available to the road sector are substantially less than the amount required to maintain the road network in a stable, long-term condition and to undertake justified improvements (e.g., projects with an economic rate of return of more than 12%), the road agency should prepare an explicit, long-term financing plan. The financing plan should show the size of the financing gap and suggest how it might be bridged (Heggie and Vickers 1998). Among other things, the financing plan should consider how existing resources could be used more efficiently, for example, by exposing in-house work to competition from outside contractors, contracting out design and implementation work to the private sector, and carrying out value engineering[1] analysis for relatively large projects.

In addition to ensuring financing, governments also need to create the right conditions for optimizing operation and maintenance (O&M) for the long term, build capabilities, and reform governance[2] (World Economic Forum 2014). A relevant example of such program is being developed in Colombia. It is the Sustainable Road Maintenance Program, or PMS, for its name in Spanish, "Programa de Mantenimiento Sostenible." While there is usually a political bias toward funding new assets, PMS focuses on existing road assets. The PMS includes observation, definition, implementation, monitoring and evaluation of all the features, activities and conditions related to a road corridor, including geometric characteristics and traffic, as well as structural, geological, geotechnical, hydraulic, social and environmental aspects. Measures to improve road network condition include routine and periodic maintenance, rehabilitation and upgrading (INVIAS 2013). A PMS special feature is the use of the Road Network Evaluation Tools (RONET) to optimize road network maintenance, rehabilitation and reconstruction over the analysis period (Archondo-Callao 2009). As part of such methodology, an optimal allocation of funds is developed for the entire road network being analysed. The PMS is being structured according to a public-private partnership (PPP) availability payment model, as adopted in the country (Colombia 2014).

A sound financing plan should also include costs of measures to enhance disaster resilience. Infrastructure assets repeatedly face natural hazards, and can suffer major devastation. Paying for greater disaster resilience usually costs far less than fixing the damage. Such measures include (World Economic Forum 2014):

(a) Conduct a scenario analysis and a socioeconomic cost-benefit analysis to identify the optimal resilience measures.
(b) Consider both "preparedness" and "responsiveness" measures.
(c) Take a cross-sector perspective. For example, when evaluating a road, consider its linkage to agriculture, coastlines and the local ecosystem.
(d) Involve the various relevant operators and departments in a collaborative approach.
(e) Enhance the identification, assessment and communication of risks. Combine structural with non-structural measures to reduce risk. Make financial and institutional arrangements that can support resilience.
(f) Promote PPP opportunities for delivering resilience initiatives most efficiently. An example of this is the dual-purpose tunnel in the center of Kuala Lumpur, which operates either as a storm water channel or a road tunnel (depending on weather conditions), preventing US$1.6 billion of flood damage and saving US$1.3 billion by avoidance of traffic-congestion over the concession period (ITS International 2012).

[1] Value engineering is a systematic process of review and analysis of a project. Its application to the road sector is discussed in detail, for example, by the U.S. Federal Highway Administration at: https://www.fhwa.dot.gov/ve/
[2] Governance consists of the traditions and institutions by which authority in a country is exercised. For details, see for example the Worldwide Governance Indicators at: http://info.worldbank.org/governance/wgi/index.aspx#home

IV A BRIEF SURVEY OF ROAD USER CHARGING IN EUROPE

Examples of Road User Charging (RUC) Systems in Europe include the adoption of toll for cars and vignette for trucks in Poland; the heavy vehicle fees of Germany (satellite based), Austria and Switzerland; the London and Stockholm cordon charge systems; the Norwegian toll ring system; tolling in countries such as Spain, Greece, Portugal, Italy, France, Poland and United Kingdom. The European Union has established requirements for interoperability of different charging systems in its member countries.

The summary of a brief survey of road user charges in selected European countries is given in Table 1. Table 2 provides some comparison of the amount road users pay in terms of road expenditures and per vehicle in each country surveyed.

For all the countries surveyed, there is no direct link between revenues from fuel tax and road expenditures, except for Lithuania and Poland. The situation in these two countries, however, is different. Lithuania abolished its Road Fund several years ago, but the legislation still includes earmarking of part of the fuel tax for roads. In Poland, about 12 percent of revenues from fuel excise duty are allocated for road expenditures. Additionally, the so called “fuel charge” goes directly to the Road Fund. While several EU member countries have earmarking for roads, Poland is the only one which still has a Road Fund.

Fuel tax revenue is the most significant form of road user charge, amounting to about 87 percent of the total road user charges for the countries surveyed. On average, annual fuel tax collection is about 142 percent of a country’s total expenditures on roads. However, fuel tax is relatively low in Norway and Switzerland, but this is compensated by higher vehicle ownership taxes, such as annual vehicle registration.

Tolls have been imposed by 8 of the 15 countries surveyed. Relative to fuel tax revenues, tolls are

Table 1: Summary results of a brief survey of road user charges in selected European countries

Country	National road expenditures (mln EUR)	Length of national roads (km)	Total road network (km)	Total fuel tax (mln EUR)	Toll collection (min EUR)	Vignettes (mln EUR)	Vehicle registration fees (mln EUR)	Other road use related taxes (mln EUR)	Total road user charges (mln UR)	Total road expenditures (mln EUR)
Latvia	196	20167	69675	314	0	n.a.	n.a.	195	509	240
Hungary	449	31067	187800	1848	n.a.	108	n.a.	341	2297	n.a.
Finland	840	78189	430000	2946	0	n.a.	n.a.	n.a.	2946	n.a.
Slovenia	736	6301	33562	n.a.	158	n.a.	n.a.	593	n.a.	n.a.
Sweden	n.a.	103000	572000	2800	n.a.	n.a.	n.a.	n.a.	2800	1860
Lithuania	295	21328	80509	377	0	11	11	1	102532	373
Italy	2900	30128	80477	36200	5394	n.a.	n.a.	n.a.	41594	n.a.
Germany	6120	55000	231581	40000	1080	n.a.	n.a.	n.a.	41080	n.a.
Switzerland	n.a.	1800	70000	3000	n.a.	n.a.	n.a.	n.a.	n.a.	4500
UK	9000	41972	41700	37000	306	n.a.	7300	n.a.	44606	n.a.
France	5100	20000	n.a.	26000	6600	n.a.	2200	2000	36800	n.a.
Norway	2230	27000	93000	1200	520	n.a.	n.a.	n.a.	n.a.	2600
Austria	1500	2080	n.a.	n.a.	935	300	n.a.	n.a.	n.a.	n.a.
Poland	2200	18000	360000	4368	49	145	n.a.	1450	6012	n.a.
Slovakia	388	3521	18278	882	0	51	0	83	1016	n.a.

Note: Not all data is available for each of the 15 countries surveyed.
Source: Queiroz et al. 2008

Table 2: Comparison of road user charges in selected European countries

Country	National road expenditures (mln EUR)	Length of national roads (km)	Total fuel tax (mln EUR)	Total road user charges (mln EUR)	User charges % of national road expenditures	Stock of motor vehicles (000)	User charges per vehicle (EUR) in 2006
Latvia	195	20167	314	509	261.0	866	588
Hungary	449	31067	1848	2297	511.6	3334	689
Finland	840	78189	2946	2946	350.7	2805	1050
Slovenia	736	6301	n.a.	n.a.	n.a.	1016	n.a.
Sweden	n.a.	103000	2800	2800	n.a.	4628	605
Lithuania	295	21328	377	400	135.6	1593	251
Italy	2900	30128	36200	41594	1434.3	38942	1068
Germany	6120	55000	40000	41080	671.2	48939	839
Switzerland	n.a.	1800	3000	3000	n.a.	n.a.	n.a.
UK	9000	41972	37000	44606	495.6	31886	1399
France	5100	20000	26000	34800	682.4	36702	948
Norway	2230	27000	1200	n.a.	n.a.	2523	n.a.
Austria	1500	2080	n.a.	n.a.	n.a.	4949	n.a.
Poland	2200	18000	4368	4562	207.4	14723	310
Slovakia	388	3521	882	1016	261.9	1487	683

Note: Not all data is available for each of the 15 countries surveyed.
Source: Queiroz et al. 2008

most significant in Norway, where annual toll collection is about 43 percent of annual fuel tax revenue. In this respect, Norway is followed by France (about 25 percent) and Italy (about 15 percent).

V ELECTRONIC TOLL COLLECTION

5.1 Background

Electronic Toll Collection (ETC) is a fairly mature technology that allows for electronic payment of highway tolls. ETC systems take advantage of vehicle-to-roadside communication technologies (traditionally via microwave or infrared communication, more recently via GPS technology) to perform an electronic monetary transaction between a vehicle passing through a toll station and the toll agency. ETC systems require Onboard Units (OBU), vehicle detection and classification as well as enforcement technologies.

Essentially, ETC equipment substitutes for having a person (or coin machine) to manually collect tolls at toll booths. In addition, it allows such transactions to be performed while vehicles travel at highway cruising speed. ETC benefits include:

- Increase in toll lane capacity
- Reduction in motorist waiting time
- Convenience for toll payers
- Fuel savings and a decrease in mobile emissions by reducing or eliminating waiting times
- Reduction in toll collection costs and enhancement of audit control by centralizing user accounts
- Possibility to implement congestion pricing by breaking technical barriers: non-intrusive toll collection requires much less infrastructure, automatic vehicle counting and classification and automated accounting systems
- Identification of toll violators through digital license plate recognition devices

ETC is a part of Intelligent Transportation Systems (ITS), which are systems that use electronics, communications and information processing to improve the efficiency and safety of surface transportation. More information on ITS is available, for example, from:

(a) Intelligent Transportation Society of America: http://www.itsa.org/
(b) U.S. Federal Highway Administration (FHWA): http://www.its.dot.gov/modal/modal_fhwa.htm
(c) International Bridge, Tunnel and Turnpike Association (IBTTA): http://www.ibtta.org/
http://www.ibtta.org/Events/pastpresdetail.cfm?ItemNumber=4365&navItemNumber=883

The following sections discuss application of ETC systems in raising revenues for road agencies and implementing congestion pricing. Irrespective of the system adopted, implementation contracts need to make clear and specific the public authority's requirements from the charging system. Procurement needs to be very specific regarding functional requirements of the system, but should leave the choice of technology to deliver these requirements largely in the hands of the private partner (ECMT 2006).

5.2 Urban Congestion Charges

Pricing projects in countries such as the U.K., U.S., France, Norway, Sweden, Germany, Switzerland, Singapore and Australia, have broken new ground and provided important lessons for those interested in exploring the use of pricing to address traffic congestion and transportation funding problems. Such projects have shown that pricing can lead to more efficient use of existing roads (US FHWA 2008).

On February 17, 2003, London introduced a US$8-a day congestion charge for those driving in the city center (the rate has been increased to £8.00-a day, or about US$13-a day). The scheme relies on 700 video cameras which scan the rear license-plates of cars which enter the area between 7 am and 6:30 pm during working days. This information is matched each night against a database of drivers who have paid the charge either by phone, via the internet or at shops and garages. Except for those with exemptions, anyone who fails to pay by midnight is fined about US$130. More information on the London congestion charge is available at: http://www.cclondon.com

While some road pricing schemes had to be aborted because of political opposition (e.g., Austria, Hong Kong), others are working well. Singapore has led the way in restraining traffic by price since 1975. In the 1990s, three Norwegian cities--Oslo, Bergen and Trondheim--set up charging schemes (see more details below). Rome has introduced an electronic system to control entry into its historic center. San Diego, California, has adopted dynamic road pricing, using microwave transponders to assess congestion levels and deduct fees accordingly.

In Sweden, following a trial period, the parliament decided to introduce a congestion tax in Stockholm from August 1, 2007. The congestion tax is levied on Swedish-registered vehicles that enter or exit the city center Monday to Friday between 6:30 a.m. and 6:29 p.m. During the times when the congestion tax is levied, vehicles are automatically registered at control points. Each passage entering or leaving Stockholm costs SEK 10, 15 or 20, depending on the time of day. The maximum charge per day and vehicle is SEK 60 (about US$9.00). More information on the Stockholm congestion tax is available at:

http://www.vv.se/templates/page3 17154.aspx
http://siteresources.worldbank.org/INTECAREGTOPTRANSPORT/Resources/StockholmTrialfinal.pdf

Congestion charges have also been adopted outside of Europe. For example, such strategy has been shown to effectively reduce traffic congestion in the United States (e.g., San Diego, Minneapolis, Denver, Houston), and in Singapore. Useful information on congestion pricing is provided, for example, on the U.S. Department of Transportation website at:

http://www.etc.dot.gov/index.htm

Where infrastructure is more appropriately treated as a public good, as in the case of road and inland waterway systems (other than high-density tolled motorways), costs are recovered through fuel taxes, vehicle registration fees, and other taxes rather than congestion pricing (World Bank 2008).

5.3 Toll Rings in Norway

After a long political debate, toll cordons were introduced in Norway as a source of funding for urban road improvements with the main objectives of easing congestion and improving road safety and the environment. In 1986, the Bergen toll ring was opened (this was the second such ring in the world, the first being in Singapore); the Oslo toll ring was opened in 1990, and the Trondheim toll ring was opened in 1991. In Oslo, alternatives to toll collection that were debated (and rejected) included (a) an extra fuel tax earmarked for local road improvements, and (b) an extra car ownership tax earmarked for local road investments. A reason for rejection was a general negative attitude to earmarking of taxes in Norway. Establishing toll cordon in Oslo, with 19 toll plazas, was facilitated by the city's topography, with the fiord to the south and large greenbelt areas to the north and to the east. With a few exceptions such as handicapped drivers, public transport, and ambulances, everybody has to pay toll when passing in the direction of the center of Oslo. Outbound traffic is not tolled. The operating costs are about 10 percent of the toll revenues. The toll collection uses automatic vehicle identification and there is no need for speed reduction. The operation is done by private companies under contract with the Norwegian Public Roads Administration. The link below provides more details:

www.vegvesen.no

Toll rates in Norway are available at:

http://www.autopass.no/binary?id=71526

5.4 Toll Roads in the United Kingdom

In the UK, in addition to the London congestion charges, tolls are currently being charged on the M6 Toll Road and the Dartford Crossing. Vehicles can either pay by cash or through a prepaid tag. More details on these two toll facilities are available at:

www.m6toll.co.uk
http://www.highways.gov.uk/roads/projects/4065.aspx

5.5 Heavy Goods Vehicle Charging

Several countries have introduced or are planning to introduce arrangements for charging heavy goods vehicles (HGV).

While many of the issues in road charging are institutional and political, it is essential that the technical systems work well. As reported by the UK Transport Research Laboratory -TRL (http://www.trl.co.uk), the European research program on electronic charging – INITIATIVE, has developed several designs of charging equipment incorporating microwave short-range communications, cellular radio technology, satellite positioning, and a smart card reader. Such equipment is capable of identifying when the vehicle enters a charging zone, applying the appropriate charge, and transmitting charging data to a billing center. A desirable feature for road user charging is that travelers should need only one set of on-board equipment for use with any local charging scheme.

5.6 Heavy Good Vehicles Charging in Switzerland

A distance-based charge collected electronically applies to HGVs over 3.5 tons on all roads. The fee depends on the distance driven, the total vehicle weight (e.g., tractor plus trailer), and the emission class.

For all domestic HGVs an on-board unit (OBU) is mandatory. The OBU is linked to the vehicle tachograph for distance recording. The driver is responsible for entering the total vehicle weight onto the OBU. All Swiss border stations are equipped with CEN-DSRC beacons which are used by the border recognition system to record entrance and exits, as well as for enforcement purposes. In addition, GPS is used for monitoring purposes (e.g., accuracy of distance recording, correctness of border recordings). DSRC - dedicated short-range communications - is a bi-directional communication link between the OBU and the road side equipment. For details on the CEN-DSRC standards, see for example Hjelmare (2001) or Persad, Walton and Hussain 2007.

Further information on the Swiss charging system is available at: www.lsva.ch

5.7 Heavy Goods Vehicle Charging in Germany

Since January 1, 2005, all lorries (trucks) exceeding 12 tons gross weight pay between €0.09 and €0.14 for each kilometer of road traveled on Germany's 12,000 km motorway (Autobahn) network. The toll rate is calculated on the vehicle's environmental status (engine emission levels) and the number of axles. This distance-related motorway user charge replaced the Euro vignette system for traveling through Germany.

The system is a dual one, comprising not only a manual booking option but also, for the first time ever, satellite-based automatic tolling. This system uses a combination of satellite navigation and mobile communication technology to achieve a free flow system.

Lorries using the German Autobahn network are expected to be fitted with an On Board Unit (OBU) to enable payments to be calculated via the satellite tracking system. Figure 1 shows a GPS-based OBU mounted on a truck. There are about 1.5 million trucks

identified under the scheme in Germany, of which some 40 percent is equipped with an OBU.

To guarantee the principle of non-discrimination, payments can also be made by manual booking at so-called toll terminals at petrol stations, service areas and retail outlets, or by telephone or via the internet. So the dual system with automatic and manual booking alternatives ensures that all truck drivers can use the toll road system without discrimination. It is able to handle the full tonnage booked with the manual system if the automatic system goes down. Further information is available at: www.toll-collect.de

The revenue from electronic fee collection is about 5 times higher than the revenue gained previously from the vignettes. Most of the investment goes to the federal trunk roads sector. In keeping with the Federal Government's desire to pursue an integrated transport policy, some of it is also being used to upgrade railway infrastructure and waterways. The German government contracted with "Toll Collect" to operate the charging system, which was the first of its kind in the world.

Figure1. GPS-based on board unit mounted on a truck
(Source:http://www.tollroadsnews.com/cgi-bin/a.cgi/rwXBNl0REdmcEIJ61nsxIA)

The effectiveness of the German toll system depends mainly on the number of vehicles equipped with OBU. Key features of the automatic system include:

- It recognizes a fixed toll road network (about 12,000 kilometers of motorways) and only charge tolls there. This road network may be expanded at any time by the way of data transfer via mobile communication network (GSM)
- It is able to set environmental policy through taking the pollution class into account as well as the number of axles in calculating fees
- It offers the technical prerequisites to introduce other fee classes, such as the time and place of the trip
- It operates on a free flow system, which charges toll without causing stops and traffic jams

Information on the "Toll Collect" system is available at:
http://www.toll-collect.de/pdf/benutzerinformation/web_einfuhrungstex_gb.pdf and

http://www.toll-collect.de/frontend/HomepageVP.do;jsessionid=D99B2A0AB884D72D690B4EB25D608E99

5.8 Distance-related Charging System in the Czech Republic

In the Czech Republic, the obligation of motor vehicles and trailer combinations with a total weight equal to or greater than 12 tons to have a toll sticker affixed on the windshield was cancelled as of January 1, 2007, and replaced with a distance-based toll charge based on modern microwave technology.

Vehicles that are subject to the toll must be equipped with a small electronic device - the "Premid Onboard Unit" - which communicates with the tolling system. A fee for the use of a specific road section is charged when a toll transaction occurs, i.e., when a vehicle passes under the tolling station installed on the road section.

The fee rate depends on the number of axles and the emission class of the vehicle. The amount to be paid for the use of a particular tolled section is calculated as a multiple of the applicable rate and the length of the section.

When passing through a toll gantry, an acoustic signal from the onboard unit alerts the driver that the toll has been recorded. The driver can use any lane without having to reduce the vehicle speed. The tolling process is fully automatic and requires no intervention on the part of the driver.

Enforcement stations are equipped with technology to check whether vehicles have Premid units installed, whether they are installed properly, and to check toll payments.

In addition to the stationary gantries, there are also portable devices that can be deployed for random checks. More information on the Czech system is available at: www.premid.cz

5.9 Slovakia Truck Tolling

Slovakia has established an electronic toll collection system covering 17,763 km of roads,[3] making it the longest such network in the European Union. The system is managed by the National Motorway Company, under the Slovak Ministry of Transport, Construction and Regional Development.

All vehicles over 3.5 tons are required to pay tolls on motorways and expressways, as well as first, second and third class roads. It is a distance-based model that uses

[3] Toll road network as of July 15, 2015: https://www.emyto.sk/web/guest/press;jsessionid=F0A788808C2DC68057D2418D31F7B459.liferay1

satellite technology for positioning the onboard units (based on GPS).[4] The use of onboard units, of which there are approximately 250,000 registered, is mandatory, with 72% used by foreign-registered vehicles. In 2014, toll revenue amounted to €183 million ($204 million).

In Slovakia, vehicles weighing less than 3.5 tons are charged through a vignette system. Vignettes may be bought for 10 days (for 10 EUR), one month (14 EUR), or one year (50 EUR).

More details are available at http://www.itsinternational.com/categories/charging-tolling/features/satellite-based-truck-tolling-provides-slovak-solution/

[4] On Board Unit (OBU) is an electronic technical device providing the position of a vehicle by means for the Electronic Tolling System.

VI PRIVATE FINANCE OF ROADS

Many countries and regions have a sizeable infrastructure gap. Latin America and the Caribbean, for example, requires additional infrastructure investments estimated at 2.0–2.5 percent of GDP, or $120–$150 billion a year (Serebrisky et al. 2015). Many governments do not have all such financial resources required to expand, maintain, and operate their country's infrastructure.

The road subsector is not much different from the overall infrastructure trend, and needs substantial resources. In the United States, for example, it is estimated that $55 billion will be required annually over the next 20 years simply to maintain the highway and bridges in their current condition.

In many countries, the private sector has been involved in financing infrastructure through concessions under a public-private partnership (PPP) program. Broadly defined, a concession is a legal arrangement in which a firm obtains from the government the right to provide a particular service (Kerf 1998).

The World Bank PPP Reference Guide defines PPP as a "long-term contract between a private party and a government entity for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance" (World Bank 2014b). PPPs involving new assets are often called 'greenfield' projects. PPPs used to transfer responsibility for upgrading and managing existing assets to a private company are called 'brownfield' projects.

PPP arrangements are somewhat underutilized in developing economies, where the potential financing gaps are significant and growing, and there seems to be an enormous potential for more private sector involvement in the financing and operation of highway assets in these countries.

With many countries increasingly interested in attracting private capital to infrastructure projects, institutions such as the Inter-American Development Bank and the World Bank can contribute through greater use of their guarantee power, in addition to supporting, when required, the public sector contribution to the construction cost of a PPP project through loans. Partial risk guarantees are particularly relevant in the context of seeking more private involvement in the financing of road infrastructure.

Countries such as Chile have seen motorways as an important potential means to attract private investors, especially from abroad, to ease budgetary pressures. In Europe, several countries have concessioned some motorway projects to private contractors, using tolls or availability payments out of the budget to pay the concessionaires.

Worldwide information on private participation in transport infrastructure, including roads, can be obtained through a World Bank database at: http://ppi.worldbank.org/index.aspx

Information on toll roads (both private and public) is collected by the International Bridge, Tunnel and Turnpike Association (IBTTA). The IBTTA database can be accessed at:

http://www.ibtta.org/Information/content.cfm?ItemNumber=542&navItemNumber=1238

VII TOOLKIT FOR PUBLIC PRIVATE PARTNERSHIP IN ROADS AND HIGHWAYS

The Toolkit for PPP in Roads and Highways, developed by the World Bank, with support from the Private Participation in Infrastructure Advisory Facility (PPIAF), is a multimedia product aiming at assisting policy makers and transport officials in low and middle income countries in identifying different contracting, regulatory, and funding options for engaging the private sector in road development, maintenance, operation and financing. The Toolkit addresses all types of road projects, regardless of their complexity and scope of private financing involved and irrespective of the term used to qualify them (e.g., performance-based contract, concession, franchise, BOT—build, own, transfer).

The Toolkit provides guidance to clarify public sector objectives and to set up project characteristics accordingly, in particular as regards:

(i) the tasks (scope of work) entrusted to each party;
(ii) the level of autonomy left to the private actors and the way their performance is assessed;
(iii) the possibility and implications of including several road links in a single contractual package;
(iv) the risk allocation principles and mechanisms;
(v) the cost recovery system (general, specific taxes or direct road user charges);
(vi) the financial scheme based on a Government budget, private financing or a combination of both.

A CD-ROM is available from the World Bank with the Toolkit, which can also be downloaded from:
http://www.ppiaf.org/ or
www.worldbank.org/transport

With the use of the Financial Simulation Tools, which are included in the Toolkit, it is possible to assess the minimum required toll rate to attract private investors for motorway projects, as shown by Queiroz (2007). For example, if the initial traffic volume is expected to be 20,000 vpd and the construction cost US$4 million/km, the minimum weighted average toll rate to attract private sponsors would be US$0.09/veh-km, following some basic assumptions.

VIII A FINANCIAL MODEL FOR AVAILABILITY PAYMENT PPP PROJECTS

The Toolkit, as discussed above, includes financial models that can be used for the financial assessment of PPP toll roads. Based on the Toolkit toll road graphical financial model, Mladenovic and Queiroz (2014) developed a model to assess the financial feasibility of Availability Payment (or Annuity) PPP Projects in any infrastructure subsector (e.g., roads, rail, airports, water, sanitation).

As in the original model, the Availability Payment financial model comprises five worksheets (Data Sheet, Cash Flow Graph, Debt Graph, Dividend Graph, and Summary of Assumptions and Results). Default values are provided for each parameter defining a hypothetical PPP project. The user can change the parameter values using the arrow keys (scroll bars) provided in the Data Sheet and graph sheets, to define the project to be financially assessed.

The availability payment model is particularly helpful to carry out simplified financial assessment of those PPP projects where charging the users (e.g., collecting tolls) is not an option, a situation that may occur, for example, because of political risks, users' unwillingness or incapacity to pay, or the type of project (e.g., primary schools).

IX PARTIAL RISK GUARANTEES

Guarantees, such as the World Bank partial risk guarantees (PRG), may be used to help attract private financing for roads. PRGs can cover specified risks arising from nonperformance of sovereign contractual obligations or certain force majeure events. Such guarantees are particularly relevant in the context of private financing of infrastructure; they cover specific government obligations spelled out in a support agreement (e.g., concession agreement, implementation agreement, BOT contract) with the project entity. They are appropriate for enhancing a project's limited recourse project financing, the most common method of financing concessions for transport infrastructure.

Partial risk guarantees ensure payment in the case of debt service default resulting from the nonperformance of sovereign contractual obligations undertaken by Governments or their agencies in private sector projects. Sovereign contractual obligations vary depending on project, sector, and country circumstances, and would be embodied in a support agreement negotiated between the Government and the project sponsors.

Applications of partial risk guarantees to road concessions are discussed, for example, by Matsukawa and Habeck (2007), Irwin (2007) and Queiroz (2005). More information on the World Bank guarantee program is available at:

www.worldbank.org/guarantees

X CANCELED OR DELAYED PPP ROAD PROJECTS

Some cancellations of private infrastructure projects should be expected, as the "freedom to fail" provides incentives for the private sector to be efficient (Harris et al. 2003). The projects canceled thus far represent only a small share of the projects that have encountered problems. Most problems are solved by adjusting key terms, by renegotiating contracts, or through other means short of cancellation. Even where substantial macroeconomic shocks occurred, most private infrastructure projects successfully withstood the impacts.

The relatively small number of canceled projects, the attempts by governments to reprivatize some of them, and new private projects in countries that have seen cancellations all suggest that many governments view the private sector as an efficient means of providing road infrastructure.

The website of the Private Participation in Infrastructure Advisory Facility (PPIAF) is a good source of updated information on PPP projects in developing countries:
http://ppiaf.org/

XI LESSONS LEARNED FROM PPP SUCCESSES AND FAILURES

Road and transport projects in developing economies that are economically and socially justified, but that are not, *per se*, able to attract private investors, may become feasible PPP projects if appropriate support is given to the project, particularly through financial instruments such as guarantees and subsidies. Any developing country or province may want to take advantage of one or more of the financial instruments currently available. Even more advanced economies, such as France and Spain, have granted subsidies to projects, turning them into successful PPP projects, such as the Perpignan-Figueras Rail Concession linking the two countries (Queiroz 2014).

An analysis of the experience with motorway development in several developing countries showed that any PPP project, in order to be successful, requires strong Government support and long lasting political will and engagement. The related study highlighted the following key pre-requisites for successful PPP arrangements (World Bank 2004):

- A strong political will, an appropriate and stable regulatory and legal framework, and a stable macro-economic environment
- The willingness of the public sector to provide, when required, public sector contribution (up to 40-60 percent of total project cost in some cases). Public sector support may also include the provision of existing assets as an in kind contribution, sovereign guarantees, and subsidies
- Sufficient traffic volumes to make it viable to the private sector - A new road is unlikely to be financially viable without a flow exceeding some 5,000 vehicles per day, unless the government offers a substantial subsidy to the concessionaire. By contrast, the rehabilitation of a road, particularly where there are no competing corridors, can be viable with lower traffic volumes
- A robust economic and financial appraisal of the project that asks, and endeavors to answer, three questions: is the project beneficial for society, is it commercially viable for the potential concessionaire, and is the required public sector contribution justified in terms of the additional benefits engendered by that contribution?

Risks associated with PPP programs should be adequately managed. A recent report by the Global Infrastructure Hub (GIH) presents risk matrices for several infrastructure projects, including roads, and describes how risk allocations may vary across different markets, depending on factors such as the levels of market maturity and the domestic legal systems (GIH 2016).

The main risks of PPP highway projects, in addition to changes in design during construction, which can lead to significant costs increase, are those that affect gross revenue. These revenue related risks usually reflect uncertainty in both the predictability of future traffic volumes and the willingness of road users to pay tolls, together with the possibility that expected land-use patterns do not materialize. A study of 67 toll road cases by Standard & Poor's (2002) found that actual traffic, on average, was 70 percent

of the forecast volume, with a spread of 18 percent to 146 percent. For countries without previous tolling experience, the average actual traffic was only 56 percent of the forecast, compared with 87 percent for those with previous experience. Further related research led to the development of a Traffic Risk Index (Bain 2009).

Helpful PPP resource guidance, based on lessons learned, can be found in: (i) "Public and Private Sector Roles in the Supply of Transport Infrastructure and Services: Operational Guidance for World Bank Staff" (Amos 2004); (ii) "Public-Private Partnerships in Highways in Transition Economies: Recent Experience and Future Prospects" (Queiroz 2007); (iii) "Guidelines for the Development of Successful Public-Private Partnerships" (European Commission 2003); (iv) "Granting and Renegotiating Infrastructure Concessions – Doing It Right" (Guasch 2004); and (v) "An Overview of the Brazilian PPP Experience from a Stakeholders' Viewpoint" (Queiroz, Astesiano and Serebrisky 2014).

The European Commission (EC), recognizing that countries can potentially benefit from the PPP approach to reform and upgrade infrastructure and services, has published, in addition to the "Guidelines," a Resource Book with a number of PPP case studies across countries and sectors (EC 2004). Further related information can be found on the EC website at:
http://europa.eu.int/comm/regional_policy/sources/docgener/guides/pppguide.htm

PPPs should only be considered if it can be demonstrated that they will achieve additional value compared with other approaches, if there is an effective implementation structure, and if the objectives of all parties can be met within the partnership. Regarding additional value, as an example, the UK Government (HM Treasury) has developed a value for money (VfM) framework, the application of which (including a "Quantitative Evaluation" tool) is mandatory for all PPP projects proposed in the UK. Further information regarding the UK "value for money" assessment is available on the HM Treasury website at:
http://www.hm-treasury.gov.uk/documents/public_private_partnerships/key_documents/ppp_keydocs_vfm.cfm

There has been some debate on the issue of PPP and good governance. It has been generally acknowledged that good governance in managing PPPs is essential to ensure that the private sector's involvement yields the maximum benefit for the society.

Key requirements for good governance in PPP projects include, inter alia: (i) competitively selecting the strategic private investor, (ii) properly disclosing relevant information to the public, and (iii) having a regulatory entity appropriately oversee the contractual agreements over the life of the concession (Queiroz 2013).

As noted by Sands (2006), the "insertion of commercial confidentiality clauses into PPP contracts effectively limits citizens' access to publicly owned information, thereby jeopardizing the chance of informed public debate and healthy public accountability

outcomes." While confidentiality is most commonly sought by the private sector, there have also been cases where it is required by the public sector, an example of which is the design, build, finance and operate (DBFO) highway concessions in the UK (Shaoul et al. 2006). Conversely, examples of transparency are provided, *inter alia*, by the Brazilian National Agency for Land Transport (ANTT) and the UK Transport for London, which make available key information, including copies of concession contracts managed by them, on their websites respectively at:
http://www.antt.gov.br/acpublicas/apublica2006_35/APublica2006-35.asp and
http://www.tfl.gov.uk/tfl/corporate/modesoftransport/tube/pppcontracts/3_0_2_0.asp

XII SUMMARY AND CONCLUSION

A discussion was presented of the most commonly used means to charge road users, such as fuel and lubricant taxes, vehicle taxes, and tolls, as well as the mechanisms to allocate funds for roads, whether to finance public investments or provide government support to PPP projects. Some innovative methods to raise revenues for road agencies or charging for congestion, adopted by several countries, were presented. These included the German “Toll Collect” system, the London congestion charging scheme, and the “toll rings” in Norway.

Consideration was also given to different forms of public-private partnerships, including reference to the Toolkit for PPP in Roads and Highways developed by the World Bank. Countries such as Chile have seen motorways as an important means to attract private investors, especially from abroad. In Europe several countries have concessioned motorway projects to private contractors or consortia, such as France, Italy, UK, Russia, Finland, Spain, Hungary, Croatia, and Poland.

Using the Financial Simulation model included in the Toolkit for PPP in Roads and Highways, as well as several basic assumptions regarding the micro- and macroeconomic environment, it is relatively easy to assess the minimum required toll rate to attract private investors for motorway projects.

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