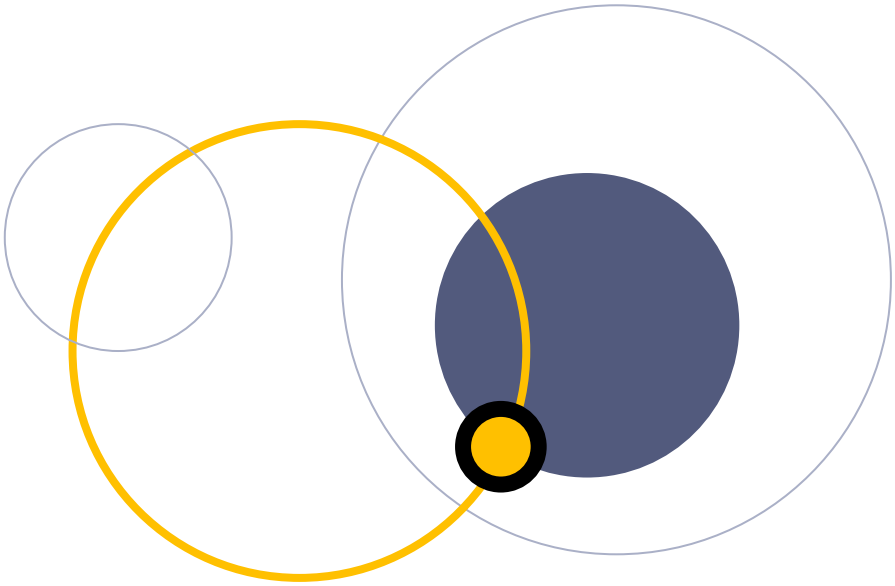
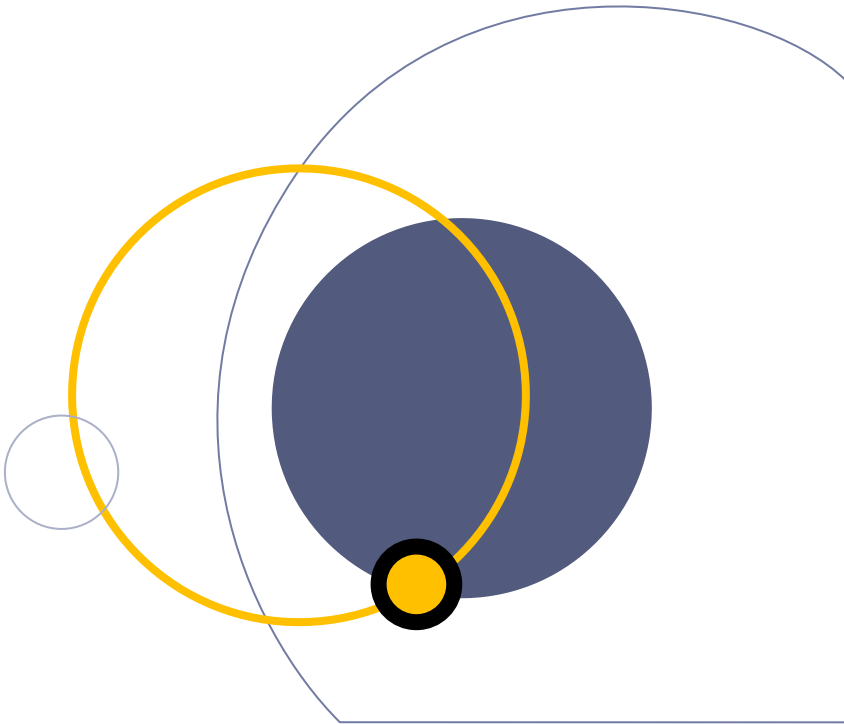


Steunpunt beleidsrelevant onderzoek 3de generatie Verkeersveiligheid

The Use of Fine Revenues from Traffic Safety Violations

Sandra Rousseau

RA-2014-002



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Dit rapport kwam tot stand met de steun van de Vlaamse Overheid, programma ‘Steunpunten voor Beleidsrelevant Onderzoek’. In deze tekst komen onderzoeksresultaten van de auteur(s) naar voor en niet die van de Vlaamse Overheid. Het Vlaams Gewest kan niet aansprakelijk gesteld worden voor het gebruik dat kan worden gemaakt van de meegedeelde gegevens.

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Gebruikte afkortingen

TSF	Traffic Safety Fund

Samenvatting

Het gebruik van opbrengsten uit verkeersboeten

De vraag of (een deel van) de opbrengsten uit verkeersovertredingen terug naar de politiediensten moeten vloeien is er een vraag die regelmatig opduikt. In deze bijdrage gebruiken we een eenvoudig conceptueel model om te onderzoeken hoe de toewijzing van opbrengsten uit verkeersboeten de beslissingen van de politiediensten kan beïnvloeden. Daarom bekijken we vijf verschillende scenario's in meer detail, één referentiescenario en vier alternatieven. Daarnaast beschrijven we ook de hoofdlijnen van het huidige programma voor de toewijzing van de opbrengsten uit verkeersovertredingen in België en vergelijken deze met de inzichten die uit het model voortvloeien.

Ten eerste willen we vermelden dat het niet nodig is om de opbrengsten uit boeten te gebruiken om de beslissingen van de politiediensten te beïnvloeden op voorwaarde dat de doelstellingen van deze diensten overeen komen met de doelstellingen vooropgesteld door de regelgever. Het blijft natuurlijk belangrijk om de politiediensten voldoende middelen te geven om deze doelstellingen effectief te kunnen nastreven. De opbrengsten uit verkeersovertredingen kunnen dan naar de schatkist vloeien om de welvaartsverliezen verbonden aan arbeidsbelastingen tegen te gaan. Als er onvoldoende steun voor dit beleidsscenario kan worden gevonden, dan kunnen de opbrengsten eventueel worden toegewezen aan een verkeersveiligheidsfonds. Het gebruik van de middelen uit dit fonds moet echter zorgvuldig worden overwogen aangezien de doelstellingen van de politiediensten niet mogen worden verstoord door een verlangen om de verwachte inkomsten zo hoog mogelijk te maken. Dus het is mogelijk om een vooraf bepaald bedrag van de middelen toe te wijzen aan politiezones om administratieve kosten te dekken of een bedrag toe te wijzen gebaseerd op bijvoorbeeld het aantal kilometer weg of het aantal inwoners in de politiezone. Hierbij is het belangrijk om er voor te zorgen dat de toewijzingsfactor niet strategisch kan worden beïnvloed door de politiediensten.

Ten tweede, als de doelstellingen die de politiediensten nastreven verschillen van de doelstellingen van de regelgever, dan kunnen de opbrengsten uit verkeersboeten worden gebruikt om beide doelstellingen te stroomlijnen. Een beleid gebaseerd op veilingen kan dan bijvoorbeeld worden gebruikt om projecten te financieren die verkeersrisico's doen dalen en die een positieve kosten-batenratio met zich meebrengen. Toewijzingsregels die afhangen van het aantal ongevallen met lichamelijke schade of van het aantal dodelijke verkeersslachtoffers in een politiezone zijn niet aangewezen aangezien ze politiediensten zowel aanzetten om hun verwachte inkomsten te maximaliseren als om het verkeersrisico te minimaliseren. Merk op dat het niet nodig om de opbrengsten uit verkeersboeten hiervoor te gebruiken, een aanpassing van de toewijzingsregels voor het algemene budget kan voldoende zijn om de doelstellingen van politiediensten en regelgever te coördineren.

Summary

The use of fine revenues

Questions are sometimes raised whether (part of) the fine revenues should flow back to police forces or not. In this contribution we use a simple model to investigate how the allocation of fine revenues can influence the decisions made by police forces. Therefore we consider five different allocation scenarios, one reference scenario and four alternatives. We also describe the actual allocation program of fine revenues in Belgium and discuss its characteristics based in the insights learned from the modeling exercise.

Firstly, we would like to note that there is no need to use fine revenues to influence decisions made by the police force, as long as the objectives pursued by police force are equal to the objectives pursued by the policy maker. Nevertheless it is still important to provide police forces with sufficient resources to pursue those objectives. Fine revenues could then be added to the federal or regional treasury so as to alleviate the welfare burden of labor taxation. However, if there is insufficient support for this kind of policy scenario, fines revenues could be earmarked and used to create a traffic safety fund. The division of these funds should then be carefully considered since the objectives pursued by the police forces should not be distorted by revenue raising incentives. Thus a preset distribution of resources based on, for instance, the number of road kilometer in the police zone or the number of inhabitants could still be considered. It is crucial that the factor determining the allocation of funds cannot be strategically influenced by the police force.

Secondly, if the objectives pursued by the police forces differ from those pursued by the policy maker, the revenues from traffic fines can be used to align both set of objectives. An auctioning program could then be used to fund projects that are reducing traffic risk and have a positive cost-benefit ratio. Allocation rules depending on the number of road accidents with injured parties or on the number of fatalities are not advisable since they give rise to a revenue maximizing objective as well as an accident minimizing objective. Note that it is not necessary to use fine revenues to achieve this alignment in objectives, a change in the budget allocation rule could also suffice.

1 Introduction

Traffic violations such as speeding and driving while under the influence of alcohol are generally acknowledged as important contributing factors to crash risks. Hence the importance of developing effective strategies to enhance road traffic compliance. More generally, Solomon (1988) specified the three E's of traffic calming as three ways that can be used to achieve compliance with traffic laws: engineering, education and enforcement. This concept of 3E's has since been the dominant approach in traffic engineering. Thus regulators can choose between several policy options to stimulate compliance, such as improving infrastructure, changing vehicle characteristics, information campaigns, regulation, monitoring and enforcement (Rousseau & Blondiau, 2013). Since drivers do not automatically take the necessary risk-reducing actions, the regulator will need to influence driver behavior in order to minimize total accident risks.

In this contribution we concentrate on the monitoring and sanctioning strategies that the regulator can use. Firstly, monitoring of traffic offenses is crucial in creating a positive probability that an offender is caught. Past empirical evidence shows that more stringent enforcement leads to higher compliance and thus reduces accident risks (Willis, 2006; SafetyNet, 2009; Allsop, 2010; Debnath et al., 2012; Rousseau & Blondiau, 2013). However, the relative effectiveness of different monitoring options (e.g. mobile vs. fixed speed cameras, police presence or average speed control) varies according to the circumstances. For the US, Joerger (2010) found that speed cameras resulted in a 27% reduction in speed in a 40 miles per hour zone in Oregon, while Huebschman et al. (2003) reported a 19% reduction in average speeds during active speed camera enforcement. For the UK, Gains et al. (2004) described that the number of vehicles that exceed the speed limit dropped 71% at fixed camera sites and 24% at mobile camera sites. Moreover, some limitations of monitoring actions have been identified. While speed camera enforcement is found to be effective in reducing speeds, the effects can be temporary and local (e.g. Elvik, 2009; SWOV, 2011). As a rule, the empirical evidence confirms that enforcement positively stimulates seat belt use, but that the size of the effect can greatly depend on the type of regulation in place (see, for instance, Campbell, 1988 and Shults et al., 2004 for a US example) and the amount of publicity associated with the enforcement actions (e.g., Williams and Wells, 2004).

Secondly, caught offenders should be sanctioned in order to deter future offenses. Typically, regulators can choose between several types of sanctions such as administrative and criminal fines, point systems, license suspension, license withdrawal, mandatory alcohol locks, and even imprisonment (Rousseau & Blondiau, 2013). Firstly, assuming drivers are risk neutral, private decisions by drivers will be optimal if the expected sanctions equal the value of the risks that a driver imposes on others (Becker, 1968; Kenkel, 1993). The faster one drives, the higher the expected damage and hence, for a given probability of detection, the more stringent the sanction should be. As mentioned by Delhaye (2007), this closely coincides with reality, since in all European countries the fine increases with the level of speeding. However, sanctions are not always determined in an optimal way since interest groups might try to influence policy or because regulators might be driven by private considerations. For example, Makowsky and Stratmann (2009) empirically estimated the influence of incentives faced by police officers and their principals (who aim to maximize votes) on the issuing of speeding tickets in Massachusetts (US). Their findings confirm that the size of the violation was not the sole determinant of the fine. Fines were also determined by the police officers' objective functions and the incentives that they faced.

While it is obviously interesting to study the optimal levels of the probability of detection as well as the optimal sanction levels, we take these aspects as given in the remainder of the text. Our study focuses on the use of the funds collected by imposing traffic fines and we do not comment on the manner these revenues are generated. Note that this does not imply that we assume that current enforcement strategies are effective nor that they are efficient.

The collection of traffic fines is a source of both revenues and expenses to governments. However, these revenues and expenses are usually not managed by the same authorities in practice. Police forces tend to bear the costs of enforcement actions, while fine revenues do not always flow back to them. Nevertheless previous studies showed that police officers have incentives to increase fine revenues. For instance, Makowsky and Stratmann (2009), examined how police budgets, officer salaries, and revenues from fines were related in Massachusetts (US). Their data showed a positive correlation between per capita police budgets and revenues from fines and forfeitures. Additionally,

minimum and maximum salaries for officers and sergeants were positively correlated with the size of per capita police budgets across municipalities. Finally, the size of the per capita police personnel budget was positively correlated with fine and forfeiture revenues. These findings were consistent with the hypothesis that police officers have incentives to increase fine revenues.

However, questions are sometimes raised whether (part of) the fine revenues should flow back to police forces or not. For instance, one of the most important controversies surrounding speed cameras concerns the allocation of fine revenues. Delaney et al. (2005, p.405), for example, note that *'opponents claim that the aim of cameras is to raise revenue rather than increase safety'*. As workable alternative, they describe a funding system that allowed police and other agencies involved in the enforcement process in the UK to have all of their camera enforcement costs refunded from a proportion of fine revenues. In 2004 this funding system was introduced nationally and it greatly expanded the use of speed cameras (Delaney et al., 2005).

On the other hand, an argument in favor of allocating fine revenues to monitoring agencies was previously developed by Jones and Scotchmer (1990) in the setting of enforcing uniform emission standards. They claim that regulatory agencies are concerned mainly with reducing harmful emissions, with little concern for firms' costs. Such a focus on benefits, to the exclusion of costs, in standard-setting and enforcement leads to inefficiencies. Jones and Scotchmer (1990) showed that the regulator can reduce these inefficiencies by limiting the enforcement agency's budget and by permitting the agency to partially self-finance from fine revenues. Such an argument could carry over to situation of road traffic enforcement if police forces only focus on reducing accident risks without taking costs into account and if the national regulator aims at balancing costs and benefits associated with traffic safety policy.

In this contribution we start by describing the actual allocation program of fine revenues in Belgium. Next we develop a simple model in order to investigate how the allocation of fine revenues can influence the decisions made by police forces. To this end we consider five different allocation scenarios, one reference scenario and four alternatives. Next we compare the actual allocation program of fine revenues in Belgium with the conceptual model. The characteristics of this program are then discussed based in the insights learned from the modeling exercise. Finally we conclude.

2 Background on the allocation of traffic fine revenues in Belgium

We start by providing some information concerning the allocation of revenues from traffic fines in Belgium. The first Traffic Fine Fund became operative in 2004 and was implemented by the Law concerning different determinants of traffic safety of 7 February 2003 [1]. The Traffic Fine Fund was replaced by the Traffic Safety Fund in 2008 (VVSG, s.d.) and was further updated in 2008 and 2009 [2]. It is noteworthy that not all revenues of traffic fines are collected in the Traffic Safety Fund (TSF). The total amount of traffic fines collected is divided by law between the federal treasury and the Traffic Safety Fund. Only the additional revenues compared to the revenues collected in 2002 are transferred to the TSF. For example, the total fine revenues are estimated to amount to 430 million euros in 2013 and of these revenues approximately two thirds are transferred to the federal treasury, while some 154 million euros are allocated to the Traffic Safety Fund (VAB, 2014).

The resources accumulated in the TSF are distributed among several parties described in art.5 and art.7 of the law of 6 December 2005 concerning the design and financing of action plans regarding traffic safety. Firstly the federal police receives part of the funds to finance, among other things, the administrative costs of processing traffic fines (art.5 §1). Secondly, the federal administration for mobility and transport ('FOD Mobiliteit en Vervoer') receives an amount to monitor the traffic safety policies adopted by police forces (art.5 §2), while the federal administration for justice ('FOD Justitie') receives funds to finance the implementation of alternative sanctions such as training events concerning drugs and alcohol awareness (art.5 §3). Thirdly, the local and federal police forces get a

[1] "Wet van 7 februari 2003 houdende verschillende bepalingen inzake verkeersveiligheid", published BS 25 February 2003.
[2] "wet van 6 december 2005 betreffende de opmaak en financiering van actieplannen inzake verkeersveiligheid", published BS 21 December 2005 and updated by the "programmawet" of 8 June 2008 (published BS 16 June 2008) and that of 23 December 2009 (published BS 30 December 2009).

predetermined part of the money available in the TSF (art.5 §1). Finally, the remainder is divided among the three regions in Belgium (that is, Flanders, Wallonia and Brussels-Capital) based on the proportion of offenses that were detected in each region (art.7). The regions then split up the funds between the local police zones depending on the size of a zone, the decrease in the number of fatalities and/or road accidents with injured parties and the amount of road kilometers in a police zone (art.7).

As an example, federal and local police forces received some 99 million euro financial support from the TSF in 2013. Approximately 94 million euros were allocated to the local police forces, while the federal policy received some 5 million euros (VVSG, s.d.). Moreover, the allocation of a remaining part of funds by the regional governments (art. 7) has not been implemented up to now.

The funds obtained from the TSF constitute only part of revenues for local police forces. A recent report by Belfius (2012) states that 8.2% of the federal transfers comes from the Traffic Safety Fund. The study also provides an overview of the different revenue sources for those local police forces (see table 1). Transfers from the municipalities are the largest revenue source, followed by federal transfers (including TSF).

	in 1000 euros	in % of total revenues
Performances	21 396	0.8%
Transfers	2 574 761	98.8%
Federal	*987 953*	*37.9%*
Municipal	*1 586 808*	*60.9%*
Debt	9 821	0.4%
Total	**2 605 978**	**100 %**
Flanders	1 330 396	
Wallonia	805 693	
Brussels	469 889	

Table 1: Revenues for local police zones in Belgium in 2012 (Belfius, 2012)

Next, it is important to note that this allocation system is currently being revised in order to take the sixth institutional reform in Belgium into account (VCRV, 2013). This reform consists of a redistribution of competences from the federal level to the regional level and will become effective on 1 January 2015. The current reform affects several competences including traffic related ones[3]. While the federal government will remain competent for the division of the funds acquired in the TSF, part of the fines revenues (namely those resulting from regionalized traffic offenses) will be redirected directly to the regions. The TSF will then receive the complete sum of fine revenues from non-regionalized traffic offenses in exchange (VCRV, 2013). Thus, the share of fine revenues going to the federal treasury will most likely decrease.

3 A simple model

We develop a simple model to understand how fine revenues can influence the decisions made by enforcement authorities such as police forces. While we need to make a number of simplifying

[3] Regarding traffic safety financing, the following articles of law are especially relevant: articles 9 and 10 of the law of 6 January 2014 concerning the sixth institutional reform regarding the topics determined in article 78 of the Constitution ('Wet van 6 januari 2014 betreffende de Zesde Staatshervorming met betrekking tot de aangelegenheden bedoeld in artikel 78 van de Grondwet') published in BS 31 January 2014.

assumptions (see section 3.1 and 3.2 for more details), this model will nevertheless allow us to gain insights into the main impacts associated with a number of different distribution scenarios.

To start we want to mention road user behavior. According to standard rational choice theory, road users comply with traffic regulations if the expected utility of law-abiding actions is greater than the expected utility associated with violating the law (Becker, 1968). Enforcement actions can lead to both specific deterrence and general deterrence (Homel, 1988; Shavell, 1991). General deterrence follows from the overall level of monitoring and sanctioning activities, while specific deterrence follows from an individual's personal experience with monitoring and sanctioning actions. Since we focus on the allocation of fine revenues and only implicitly on the generation of these revenues, we do not explicitly model road user behavior and assume speeding decisions are exogenous.

3.1 Reference scenario

As a starting point, we assume that the fine revenues from detected traffic safety violations are added to the general government budget. This budget is used by the government for financing any activities that are agreed upon by the political process. Since the main source of income for the government comes from labor taxes (e.g. Decoster, 2010), the revenues generated from fines could replace part of the revenues generated from labor taxation. As a rule, such a replacement is considered to be highly welfare improving since labor taxes severely distort the labor market (Browning, 1976; Barrios et al., 2013). For example, Barrios et al. (2013) estimated that in the European Union each euro of public spending financed through labor taxation costs 1.90 euro. Thus each euro of public spending entails a welfare loss of 90 cents.

We now look at the decisions regarding traffic safety enforcement made by a police force under these conditions. We assume that the main objective of a police force is to minimize accidents risks by stimulating compliance with traffic law. The size of these accident risks is influenced by the seriousness of the offenses committed by the road users. We distinguish two types of offenses: serious traffic offenses which are associated with large accident risks and minor traffic offenses which are associated with small accident risks. Note that this definition of minor and serious offenses does not necessarily coincide with legal definitions of minor and serious offenses.

The police can then implement different enforcement actions in order to reduce accident risks from traffic offenses. We assume that these enforcement actions can be aimed at minor offenses or at serious offenses respectively. However, spillover effects are likely to occur and enforcement actions targeted at one type of offenses will also, to some extent, influence the occurrence of the other type of offenses. These enforcement actions focus on the detection of offenders, since we assume that the structure of the fine is determined by binding legislation and cannot be changed by the police force. Still, we assume that two types of fines are available: a low fine for minor offenses and a high fine for serious offenses. These assumptions reflect the typically structure of fines for traffic offenses in European countries (see, for instance, Delhaye, 2007). Finally, implementing enforcement actions is costly. Again we assume that costs depend on the type of offense. Moreover, costs are assumed to increase as accident risks decrease and more offenders are caught or deterred. Since resources are typically limited, we also assume that the police force is constrained in the choice of enforcement actions by the budget that is available.

This decision problem is graphically represented in Figure 1.

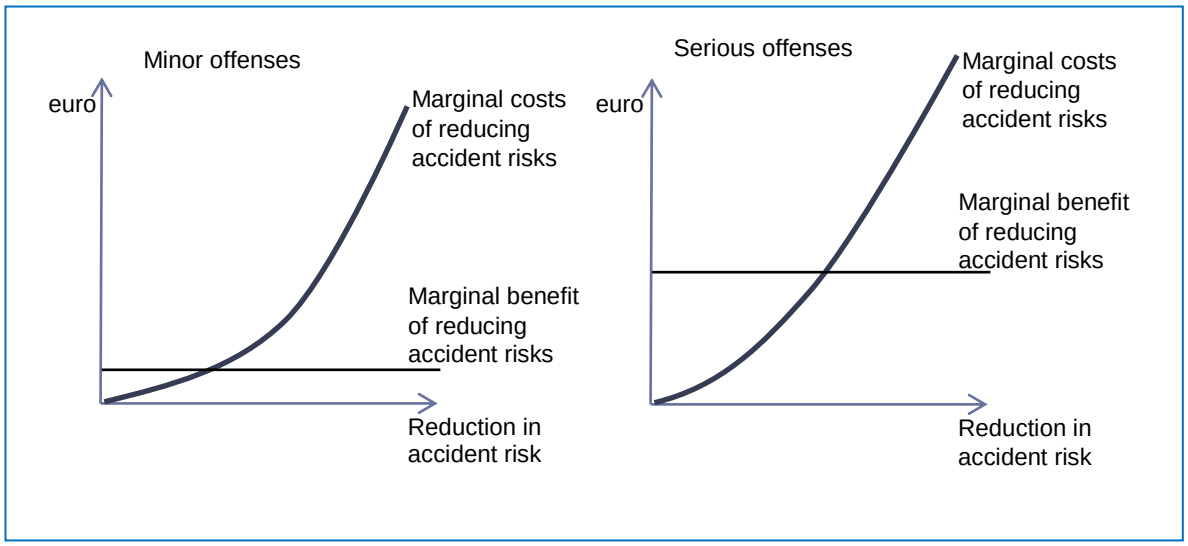

Figure 1: Reducing accident risk by reducing the number of minor and serious offenses

We use the following notation to formalize the conceptual model:

a_M	= number of enforcement actions to reduce minor offenses
a_S	= number of enforcement actions to reduce serious offenses
$C_M(a_M)$	= cost of enforcement actions to reduce minor offenses
$C_S(a_S)$	= cost of enforcement actions to reduce serious offenses
F_M	= fine level for minor offenses
F_S	= fine level for serious offenses ($F_S > F_M$)
$M(a_M, a_S, F_M)$	= number of minor offenses
$S(a_M, a_S, F_S)$	= number of serious offenses
$R(M,S)$	= accident risk
B	= available budget

The decision problem of the police force can then be represented as follows:

$$\min_{a_M, a_S} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big)\right]$$

Subject to $C_M(a_M) + C_S(a_S) \leq B$

This problem implies the following lagrangian function (with λ the Lagrange multiplier associated with the budget constraint):

$$\min_{a_M, a_S, \lambda} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big) + \lambda[C_M(a_M) + C_S(a_S) - B]\right]$$

The corresponding Kuhn-Tucker conditions are:

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_M} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_M} + \lambda\frac{\partial C_M}{\partial a_M} = 0$$

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_S} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_S} + \lambda\frac{\partial C_S}{\partial a_S} = 0$$

$$[C_M(a_M) + C_S(a_S) - B]\lambda = 0$$

Firstly, if the budget constraint is not binding $(\lambda = 0)$, the police will implement enforcement actions as long as these actions keep reducing the accident risks associated with traffic safety offenses. This implies that they will also implement actions that are welfare reducing. The focus is only on the benefits of the actions (i.e. the reduction in accident risks) and the cost side is ignored. In this instance, the police force will also implement actions of which the social costs outweigh the social benefits.

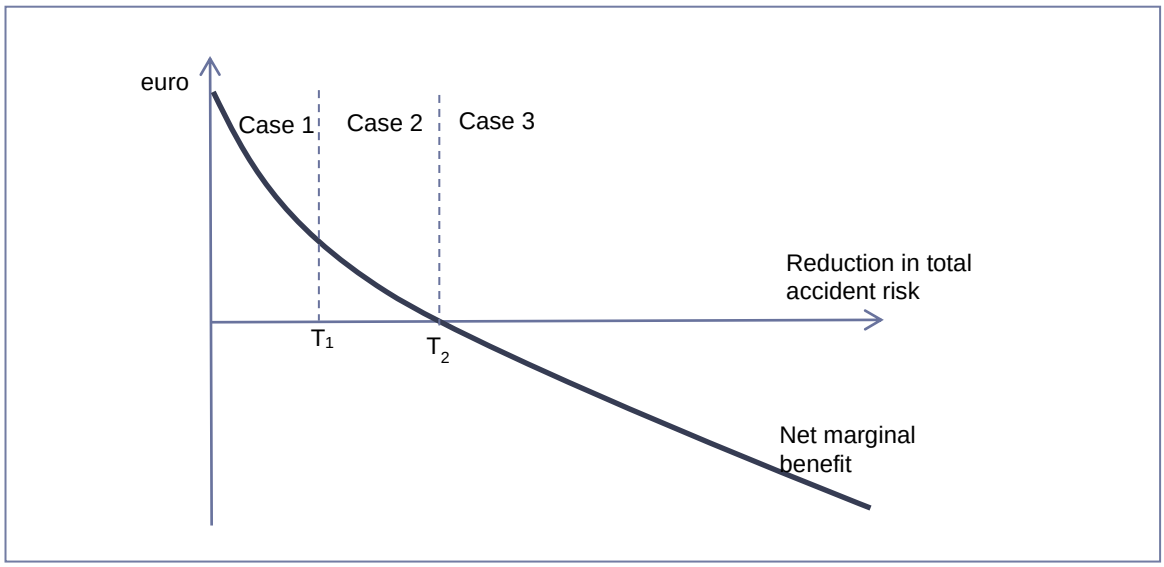

Figure 2: Net marginal benefit associated with accident reductions

Secondly, if the budget constraint is binding $(\lambda > 0)$, the costs side is no longer ignored since λ represents the opportunity cost of using the available monetary funds. We can distinguish three relevant cases (see Figure 2). In Figure 2 we present the net marginal benefit of actions to reduce accident risks by subtracting the marginal costs of these actions from their marginal benefits. When the available budget is very limited, the police force will only focus on serious offenders (case 1). As more funds become available, actions to deter both serious and minor offenders will be taken and these actions will be welfare improving (case 2). However, when the budget becomes even more abundant, the costs of additional enforcement actions will outweigh the benefits of additional reductions in accident risks and these additional actions will be welfare reducing (case 3).

3.2 Restitution of fine revenues to police forces

Next we investigate how the decision process changes when fine revenues are no longer added to the general governmental budget, but are redistributed to the police force. Depending on the distribution rule, the impact on the objective function will be different. The selection of the different resources is inspired by the possibilities listed in art.5 and art.7 of the law of 6 December 2005 concerning the design and financing of action plans regarding traffic safety.

We assume that a region consists of *n* police zones. The revenues from all traffic fines collected in those different police zones are gathered in a Traffic Safety Fund. Next we consider four different scenarios concerning the redistribution of these funds:

1) The funds are split equally between the police zones. So each zone receives an equal share of the fine revenues.

2) Each police zone receives the fine revenues it collected itself.

3) Each police zone receives a share of the funds depending on the number of accidents that occurred in that zone in the previous year.

4) Each police zone receives a share of the funds depending on the number of fined traffic offenders.

The decision problem faced by the police force is changed in each of these scenarios. We now look at each scenario separately and we discuss how incentives change and what the likely consequences of these changes are. The total amount of resources available in the Traffic Safety Fund are defined by

$$V = \sum_{i=1}^{n} [p_{Mi} M_i F_M + p_{Si} S_i F_S]$$

with p_{Mi} the probability of catching a minor offender in police zone *i* and p_{Si} the probability of catching a serious offender in police zone *i*. The share awarded to each police zone is represented by *D*.

3.2.1 Scenario 1

In the first scenario we assume that the funds are split equally between the police zones. So each zone receives an equal share of the fine revenues *V*, that is $D = V/n$. In a static setting, the decision problem of the police force can now be represented as follows:

$$\min_{a_M, a_S} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big) \right]$$

Subject to $C_M(a_M) + C_S(a_S) \leq B + \frac{V}{n}$

This problem implies the following lagrangian function (again with λ the Lagrange multiplier associated with the budget constraint):

$$\min_{a_{Mi}, a_{Si}, \lambda} \left[R\big(M(a_{Mi}, a_{Si}, F_M), S(a_{Mi}, a_{Si}, F_S)\big) + \lambda \left[C_M(a_{Mi}) + C_S(a_{Si}) - B - \frac{1}{n} \sum_{i=1}^{n} [p_{Mi} M_i F_M + p_{Si} S_i F_S] \right] \right]$$

In the remainder of the discussion we do not write the index *i* to denote the police zone in order to simplify notation. Also we define:

$$\frac{\partial V}{\partial a_M} = \frac{\partial p_M}{\partial a_M} M F_M + p_M \frac{\partial M}{\partial a_M} F_M + \frac{\partial p_S}{\partial a_M} S F_S + p_S \frac{\partial S}{\partial a_M} F_S$$

$$\frac{\partial V}{\partial a_S} = \frac{\partial p_M}{\partial a_S} M F_M + p_M \frac{\partial M}{\partial a_S} F_M + \frac{\partial p_S}{\partial a_S} S F_S + p_S \frac{\partial S}{\partial a_S} F_S$$

The corresponding Kuhn-Tucker conditions are then:

$$\frac{\partial R}{\partial M} \frac{\partial M}{\partial a_M} + \frac{\partial R}{\partial S} \frac{\partial S}{\partial a_M} + \lambda \frac{\partial C_M}{\partial a_M} - \lambda \frac{1}{n} \frac{\partial V}{\partial a_M} = 0$$

$$\frac{\partial R}{\partial M} \frac{\partial M}{\partial a_S} + \frac{\partial R}{\partial S} \frac{\partial S}{\partial a_S} + \lambda \frac{\partial C_S}{\partial a_S} - \lambda \frac{1}{n} \frac{\partial V}{\partial a_S} = 0$$

$$\left[C_M(a_M) + C_S(a_S) - B - \frac{1}{n} \sum_{i=1}^{n} [p_{Mi} M_i F_M + p_{Si} S_i F_S] \right] \lambda = 0$$

We can now compare this solution with the basic solution presented in the previous section. Firstly, if the budget constraint is not binding $(\lambda = 0)$, nothing changes and the police will still implement enforcement actions as long as these actions keep reducing the accident risk associated with traffic safety offenses. Recall that this implies that they will also implement actions that are welfare reducing.

Secondly, if the budget constraint is binding $(\lambda > 0)$, we find that costs and benefits from enforcement actions are weighted differently. Now, the additional cost of an extra enforcement action is not only compared with the decrease in accident risk, but also with the expected increase in the available budget. Thus the police force has an additional incentive to implement enforcement actions. However, this additional incentive is driven by a desire to increase fine revenues and not by a desire to decrease accident risks as such. The police force will now also consider the extent to which enforcement actions are able to generate revenue through increasing the number of caught and fined offenders. As can be seen from the optimality conditions, increasing enforcement actions and thus increasing the probability of catching offenders has two opposing effects: an increase in the probability of catching offenders increases not only the number of imposed fines for a given number of offenders, but it also increases deterrence and thus reduces the total number of offenders on the road.

So, as long as the fixed part *(B)* of the budget available to the police force remains the same, the redistribution of fine revenues will lead to more enforcement actions and lower accident risks. However, the relative focus of additional enforcement actions on minor offenders versus serious offenders does not necessarily lead to the highest possible reduction in accident risks since revenue raising incentives now also play a role. Furthermore, since the budget allocation is more generous in this scenario, the probability increases that enforcement actions that are welfare reducing are implemented. Finally, if the fixed part of budget is decreased and replaced by the rebate of fine revenues, the division between actions focusing on minor offenders and those focusing on serious offenders is even more likely to become distorted compared to the basic model. The size and direction of this distortion depends on the relative size of the model parameters and can lead to a larger emphasis either on actions focusing on minor offenders or on actions focusing on serious offenders. The net effect depends on the relative weight of the reduction of accident risk and of the increase in the available budget associated with additional actions focusing on minor versus serious offenses.

3.2.2 Scenario 2

In the second scenario, we assume that each police zone receives the fine revenues it collected itself, that is:

$$D = p_{Mi} M_i F_M + p_{Si} S_i F_S.$$

In a static setting, the decision problem of the police force can now be represented as follows:

$$\min_{a_M, a_S} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big) \right]$$

Subject to $C_M(a_M) + C_S(a_S) \leq B + p_{Mi} M_i F_M + p_{Si} S_i F_S$

This problem implies the following lagrangian (with λ the Lagrange multiplier associated with the budget constraint):

$$\min_{a_{Mi}, a_{Si}, \lambda} \left[R\big(M(a_{Mi}, a_{Si}, F_M), S(a_{Mi}, a_{Si}, F_S)\big) + \lambda [C_M(a_{Mi}) + C_S(a_{Si}) - B - p_{Mi} M_i F_M + p_{Si} S_i F_S] \right]$$

The corresponding Kuhn-Tucker conditions for this decision problem are:

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_M} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_M} + \lambda \frac{\partial C_M}{\partial a_M} - \lambda \frac{\partial V}{\partial a_M} = 0$$

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_S} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_S} + \lambda \frac{\partial C_S}{\partial a_S} - \lambda \frac{\partial V}{\partial a_S} = 0$$

$$[C_M(a_M) + C_S(a_S) - B - p_{Mi} M_i F_M + p_{Si} S_i F_S]\lambda = 0$$

When we compare this solution with the first scenario, we see that revenue raising incentives have increased by a factor *n*. The police force has greater control over its budget in this second scenario since all fine revenues can be kept. Thus the findings from the first scenario become more explicit.

Firstly, if the budget constraint is not binding $(\lambda = 0)$, nothing changes and the police will still implement enforcement actions as long as these actions keep reducing the accident risk associated with traffic safety offenses.

Secondly, if the budget constraint is binding $(\lambda > 0)$, we find that costs and benefits from enforcement actions are weighted differently. Now, the additional cost of an extra enforcement action is compared to the decrease in accident risk but also to the expected increase in the available budget. Thus the police force has an additional incentive to implement enforcement actions. As long as the fixed part (B) of the budget available to the police force remains the same, the redistribution of fine revenues will lead to more enforcement actions and lower accident risks. However, the combination of additional enforcement actions focusing on minor or on serious offenders again does not necessarily lead to the highest possible reduction in accident risks due to the additional emphasis on raising revenue. Furthermore, if the fixed part of budget is decreased and replaced by the fine revenues, the division between actions focusing on minor offenders and those focusing on serious offenders is even more likely to be distorted compared to the basic model.

Thus, if a police force gets the funds it collected itself, revenue maximizing will become relatively more important and reducing accident risks will become relatively less important.

3.2.3 Scenario 3

In the third scenario, each police zone receives a share of the funds depending on the number of accidents that occurred in that zone in the previous year. We define the number of road accidents by A(M,S). Thus, besides a number of factors outside the control of the police force such as vehicle mechanical problems and bad weather, the number of accident depends on the number of minor traffic offenders as well as the number of serious traffic offenders. Road user behavior has been highlighted as the key contributor to road accidents in previous studies (see, for instance, Biswas et al., 2006; Fernandes et al., 2010). The impact of serious offenses on the number of accidents is assumed to be larger than the impact of minor offenses. Note that the share of funds received by a police zone does not only depend on the number of accidents, but also on the total size of the available funds V.

In a static setting, the decision problem of the police force can now be represented as follows:

$$\min_{a_M, a_S} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big)\right]$$

Subject to $C_M(a_M) + C_S(a_S) \leq B + D(A(M,S), V)$

This problem implies the following lagrangian:

$$\min_{a_{Mi}, a_{Si}, \lambda} \left[R\big(M(a_{Mi}, a_{Si}, F_M), S(a_{Mi}, a_{Si}, F_S)\big) + \lambda[C_M(a_{Mi}) + C_S(a_{Si}) - B - D(A(M,S), V)]\right]$$

The corresponding Kuhn-Tucker conditions are then:

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_M} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_M} + \lambda\frac{\partial C_M}{\partial a_M} - \lambda\left[\frac{\partial D}{\partial A}\frac{\partial A}{\partial a_M} + \frac{\partial D}{\partial V}\frac{\partial V}{\partial a_M}\right] = 0$$

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_S} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_S} + \lambda\frac{\partial C_S}{\partial a_S} - \lambda\left[\frac{\partial D}{\partial A}\frac{\partial A}{\partial a_S} + \frac{\partial D}{\partial V}\frac{\partial V}{\partial a_S}\right] = 0$$

$$[C_M(a_M) + C_S(a_S) - B - D(A(M,S), V)]\lambda = 0$$

Firstly, if the budget constraint is not binding $(\lambda = 0)$, nothing changes and the police will still implement enforcement actions as long as these actions keep reducing the accident risk associated with traffic safety offenses. Secondly, if the budget constraint is binding $(\lambda > 0)$, we find costs and

benefits from enforcement actions are weighted differently. The incentive to reduce accident risks increases, even though an incentive to raise revenue remains. Thus, if a police force gets funds depending on the number of accidents that occurred in its territory, the division between actions focusing on minor offenders and those focusing on serious offenders is likely to become distorted compared to the basic model. The size and direction of this distortion depends on the relative size of the model parameters and can lead to a larger emphasis on actions focusing on minor offenders as well as on actions focusing on serious offenders

3.2.4 Scenario 4

In the fourth scenario, each police zone receives a share of the funds depending on the number of fined traffic offenders. We define the number of fined offenders as $O = p_M M + p_S S$ and thus the share of funds that a police zone receives now equals $D(O,V)$. Note that the share of funds received by a police zone does not only depend on the number of caught offenders, but also on the total size of the available funds *V*.

In a static setting, the decision problem of the police force can now be represented as follows:

$$\min_{a_M, a_S} \left[R\big(M(a_M, a_S, F_M), S(a_M, a_S, F_S)\big)\right]$$

Subject to $C_M(a_M) + C_S(a_S) \leq B + D(O,V)$

This problem implies the following lagrangian:

$$\min_{a_{Mi}, a_{Si}, \lambda} \left[R\big(M(a_{Mi}, a_{Si}, F_M), S(a_{Mi}, a_{Si}, F_S)\big) + \lambda[C_M(a_{Mi}) + C_S(a_{Si}) - B - D(O,V)]\right]$$

The corresponding Kuhn-Tucker conditions are then:

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_M} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_M} + \lambda\frac{\partial C_M}{\partial a_M} - \lambda\left[\frac{\partial D}{\partial O}\frac{\partial O}{\partial a_M} + \frac{\partial D}{\partial V}\frac{\partial V}{\partial a_M}\right] = 0$$

$$\frac{\partial R}{\partial M}\frac{\partial M}{\partial a_S} + \frac{\partial R}{\partial S}\frac{\partial S}{\partial a_S} + \lambda\frac{\partial C_S}{\partial a_S} - \lambda\left[\frac{\partial D}{\partial O}\frac{\partial O}{\partial a_S} + \frac{\partial D}{\partial V}\frac{\partial V}{\partial a_S}\right] = 0$$

$$[C_M(a_M) + C_S(a_S) - B - D(O,V)]\lambda = 0$$

Firstly, if the budget constraint is not binding $(\lambda = 0)$, again nothing changes and the police will still implement enforcement actions as long as these actions keep reducing the accident risk associated with traffic safety offenses. Secondly, if the budget constraint is binding $(\lambda > 0)$, we find that costs and benefits from enforcement actions are weighted differently. Since each minor offender caught has the same impact on the total number of offenders fined (O) than each serious offender caught, this creates a bias towards actions that are more likely to detect minor offenders. However, each minor offender caught will generate less fine revenues than each serious offender caught. The final choice between targeting minor or serious offenses therefore depends on the relative parameter values. Nevertheless, it is likely that the division between actions focusing on minor offenders and those focusing on serious offenders is distorted compared to the basic model. The size and direction of this distortion again depends on the relative size of the model parameters and can lead to a larger emphasis on actions focusing on minor offenders as well as on actions focusing on serious offenders

4 Belgian traffic safety fund: Comparing theory with practice

We now have a closer look at the allocation of traffic fine revenues in Belgium in order to compare the insights obtained from the conceptual model with the approach in reality. Next, we also discuss an alternative to allocate funds.

4.1 Comparison

We can now analyze the Belgian strategy of redistributing fine revenues based on the insights obtained from the previously discussed model scenarios. It is clear that elements of more than one model scenario can be identified in the Belgian approach. Firstly, part of the revenues goes to the federal treasury. This element corresponds to the basic model presented in section 3.1. If these revenues lead to a reduction in labor taxation, considerable welfare gains can be obtained since labor taxation significantly distorts the labor market. Moreover, this particular use of fine revenues does not influence the objectives pursued by the police forces. So, as long as the goals set by the police force coincide with the goals set by the national regulator, the enforcement actions implemented by the police force will be optimal. Obviously, if police forces work towards different objectives than those preferred by the national regulator, enforcement decisions will not be optimal from the national regulator's point of view. Other financing schemes may then be needed to align those different sets of objectives.

Secondly, we see that part of the fine revenues is assigned to the federal police and to two federal administrations to cover administrative costs. As long as these amounts are constant over time (ignoring indexation), the objectives pursued by the parties involved remain untouched. A similar interpretation holds regarding the fact that local and federal police forces each receive a preset part of funding from the TSF.

Thirdly, we discuss the observation that the remainder of the funds are distributed among the three regions depending on the proportion of offenses discovered in each region. This setup resembles the fourth model scenario discussed in section 3.2.4. In this instance, it is likely that the division between actions focusing on minor offenders and those focusing on serious offenders is distorted. Incentives to raise revenues gain importance. Moreover, minor offenses and major offenses are weighted equally in such a setting.

Fourthly, we focus on the way regional regulators divide their share of funds among the different local police zones. This division depends on the size of the police zone, the decrease in the number of fatalities and/or road accidents with injured parties and the amount of road kilometers in the police zone. The dependence of the budget allocation rule on the size of the police zone and the number of road kilometers in a particular zone is not likely to create any significant distortions. However, the dependence on the number of road accidents with injured parties and on the number of fatalities does create distortions in the objectives pursued by the police force. This setup is discussed in the third model scenario presented in section 3.2.3. Again the balance between actions targeted at minor offenders and those targeted at serious offenders is affected. While the incentive to reduce accidents risks increases, an incentive to raise revenues emerges.

4.2 An alternative approach

Further, it seems worthwhile to point to an alternative allocation approach, namely auctioning. Auctions are a method frequently used in procuring commodities for which there are no well-established markets (e.g., Klemperer, 2002). As Latacz-Lohmann and Van der Hamsvoort (1997) put it *'auctions are the main quasi-market institution used to arrange the provision of public-type goods by private enterprises'*. Auctions are of particular interest to the allocation of traffic fine revenues for at least two reasons. First, the item being traded, the provision of traffic safety, is a public-type non-market good which has no standard value. For this reason there can be substantially incomplete information about the value, benefits and importance of the risk-reducing characteristics associated with a particular traffic related project. Second, traffic safety issues typically include private information. Local police forces have a clear view of the costs associated with traffic safety projects and their impact on their budgets, whereas a central (federal or regional) administration often knows more about the risk-reducing benefits associated with the traffic safety measures in a specific police zone. A central administration can more easily employ experts in several scientific fields (such as auction design or traffic safety), has more data available and can include interactions with other police zones in its policy judgments.

An auction is a market-based mechanism that provides buyers and sellers with a forum for the trade of goods and services within a predefined framework of guidelines (Rousseau & Moons, 2008). If these auction rules are well designed, the allocation of the traded good can be efficient. Auctions attain allocative efficiency under the following two conditions: resources are allocated to bidders with the

highest valuations and bidders' valuations reflect the social values of resources (that is, their returns when used for production in competitive end markets). Early work on auction consist of the seminal papers of Friedman (1956) for the case of a single strategic bidder, and Vickrey (1961) for the equilibrium game theoretical approach. Survey articles that offer an insight in the theoretical literature on auctions are, for example, McAfee and McMillan (1987) and Klemperer (1999 and 2002).

Beside goods, auctions can also be used to allocate contracts for financing projects. Such a program would entail a multiple-item auction in order to grant more than one contracts to participants. For instance, Rousseau and Moons (2008) discuss the potential of auctions for allocating conservation contracts. In this setting, the roles of bidders and auctioneers are quite different from their parts in 'classic' auctions. The bidders would now offer to implement particular traffic safety enhancing actions and their bids would indicate the minimal amount of funds (subsidies) they would require as compensation for the costs associated with those actions. These bidders can be local or federal police forces, but also other stakeholders could be allowed to bid within the program. Thus projects by other administrations or organizations that would reduce road accident risks could be financed by the funds available in the Traffic Safety Fund.

The objective of the auctioneers is now either to minimize the amount spent in order to reach a specified traffic safety objective or to maximize the accident risk reduction associated with the awarded contracts within a given budget. Such an auctioning program (with a call every four or six months for example) could be used to fund projects that are reducing traffic risk and have a positive cost-benefit ratio. These projects can include investments in speed cameras, financing of one-off targeted monitoring actions, building specific databases, redesigning high-risk road sections, financing information campaigns or educational programs.

For such multiple contract auctions a discriminatory first-price sealed-bid auction can be used. In a first-price, sealed-bid auction each bidder independently submits a single bid, without seeing others' bids, and the contract is awarded to the bidder who request to lowest cost subsidy. The winner receives his bid (i.e. requested cost subsidy). A discriminatory auction format implies that bidders are not judged solely on the level of their bid but also on the quality of the traffic safety project they propose. After correcting for the value (i.e. increase in traffic safety) offered, the *n* lowest bidders are rewarded and receive the payment stated in their bids. In the case with no budget constraints, optimal auction design requires the use of a reserve price (i.e. a maximum acceptable bid or bid cap) to induce participants to reveal their bids truthfully (Myerson, 1981).

This approach would allow to align the objectives of the regional regulator with those of the local police force. It would allow to award funds to other stakeholders. Finally, if optimally designed, it creates incentives to use the funds in an efficient way. Thus it can lead to a considerable welfare gain from implementing traffic safety projects.

5 Conclusion

Firstly, we would like to note that there is no need to use fine revenues to influence decisions made by the police force, as long as the objectives pursued by police force are equal to the objectives pursued by the policy maker. Nevertheless it is still important to provide police forces with sufficient resources to pursue those objectives. Fine revenues could then be added to the federal or regional treasury so as to alleviate the welfare burden of labor taxation.

However, if there is insufficient support for this kind of policy scenario, fines revenues can be earmarked and used to create a traffic safety fund. The division of these funds should then be carefully considered since the objectives pursued by the police forces should not be distorted by revenue raising incentives. Thus a preset distribution of resources based on, for instance, the number of road kilometer in the police zone or the number of inhabitants could still be considered. It is crucial that the factor determining the allocation of funds cannot be strategically influenced by the local police force.

Secondly, if the objectives pursued by the police forces differ from those pursued by the policy maker, the revenues from traffic fines can be used to align both set of objectives. An auctioning program could then be used to fund projects that are reducing traffic risk and have a positive cost-benefit ratio. Allocation rules depending on the number of road accidents with injured parties or on the number of

fatalities are not advisable since they give rise to a revenue maximizing objective as well as an accident minimizing objective. Note that it is not necessary to use fine revenues to achieve this alignment in objectives, a change in the budget allocation rule could also suffice.

Moreover, we would like to observe that using fine revenues as a structural source of police funding can potentially lead to adverse effects. If funds are used in an efficient and effective manner, the number of traffic offenses will go down and thus the fine revenues collected will decrease. Bjornskau and Elvik (1992) have noted that it is difficult for the police force to credibly commit to continued, stringent road traffic enforcement, when compliance levels are increasing. Alternative sources for financing police activities are therefore needed in the long run.

Finally, the question of how to use fine revenues most effectively is not confined to road safety enforcement, but is also relevant in other settings. For instance, the allocation of fines revenues resulting from environmental offenses can influence the decisions of administrations and regulators (e.g. Jones and Scotchmer, 1990). Moreover, it can also lead to undesirable incentives such as bribery and corruption (e.g. Garoupa and Klerman, 2002) by stimulating revenue raising behavior.

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