RULES VERSUS DISCRETION IN MODERN ROAD FINANCING

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ABSTRACT

Road infrastructure has traditionally been financed from sources of general taxation, including fuel excise duties, although motorway tolls have a role in some countries. Lately, urban road tolls have been introduced, for example in London and Stockholm, mainly with the focus to curb congestion. In the ongoing review of the EU Transport policy "A sustainable future for transport: Towards an integrated, technology-led and user friendly system" (COM (2009)279) a move towards a more self-financing transport infrastructure system is foreseen as the competition for general tax revenues are increased from other sectors of society. However, the implementation of a common European framework for charging heavy goods vehicles which includes pricing of externalities has been delayed in the council since its presentation in 2008. Numerous possible arguments, as fear of monopoly power of neighbours, for a single Member State to delay the implementation have been discussed in the literature.

However, the current judgement of the policy will also depend on the belief of policy makers future actions. Since the pioneering work of Kydland and Prescott (1977) and Barro and Gordon (1983) a variety of studies have examined possible solutions to the commitment problem in monetary policy that results in a high-inflationary policy. Rogoff (1985) showed that to delegate responsibility to a conservative central bank gives an effective solution.

This paper analyzes possible future reforms on transport financing by applying the theory discussed above which highlights the dynamic trust problem. New financing and pricing practices in the transport sector is seen to be affected by the same dynamic trust problem. It is conceivable that a new price instruments (taxes, congestion taxes or kilometre tax) is perceived to have several purposes - to internalize externalities and generate tax revenue or solve equity goal - and that the government has incentive to change the policy once the system is introduced. Unless the government can be bound to a policy over time, resulting dynamic trust problem will block the implementation of an optimal policy. A possible solution is a stand alone Transport Financing Authority.

Keywords: Road pricing, Time-inconsistency

1. INTRODUCTION

Road infrastructure has traditionally been financed from sources of general taxation, including fuel excise duties, although motorway tolls have a role in some countries. Lately, urban road tolls have been introduced, for example in London and Stockholm, mainly with the focus to curb congestion. In the ongoing review of the EU Transport policy "A sustainable future for transport: Towards an integrated, technology-led and user friendly system" (COM (2009)279) a move towards a more self-financing transport infrastructure system is foreseen as the competition for general tax revenues are increased from other sectors of society.

Internalisation of the external cost of transport has been an important part of the European transport policy for a long time although the practical implementation has been slow. A new proposal for a common directive on pricing of heavy goods vehicles was put forward in 2008 (COM(2008) 436/3). The proposal was supported with underlying cost functions summarised in the so called Handbook (Maibach et.al.2008) which includes suggestions regarding congestion, accident, air pollution, noise and greenhouse gas costs as well as additional factors for mountainous areas. These cost functions have been used as caps in the directive. However, an agreement has still not been reached in the council on the proposed Directive. Member States seems to argue for lower caps on cost components, discuss factors for mountainous areas and congestion cost is still a contested topic.

Underlying arguments for this reluctant behaviour can be found in studies on tax exporting in road pricing. There are a number of studies on parallel network structures studying various aspects of pricing of parallel congestible roads, see for instance Braid (1986), Verhoef et al. (1996), De Palma and Lindsey (2000) and de Borger et al. (2006). There are also several studies addressing pricing in serial networks, see for instance Levinson (2001), de Borger et al. (2006) and Agrell and Pouyet (2006).

However, the current judgement of the policy will also depend on the belief of policy makers future actions. Since the pioneering work of Kydland and Prescott (1977) and Barro and Gordon (1983) a variety of studies have examined possible solutions to the commitment problem in monetary policy that results in a high-inflationary policy. Rogoff (1985) showed that to delegate responsibility to a conservative central bank gives an effective solution. The basic problem is that the government can be expected to have incentive to change policies over time (in the usual application from low to high inflation). As long as government can't commit to a policy over time agents will act based on the assumption that the policy may change. A number of studies have demonstrated that equity and environmental policy in addition to monetary policy give rise to these problems (Abrego and Perroni (2002), Helm et al (2004) and Marsiliani and Renstrom (2000)).

Based on the outline of Helm et al (2004) we develop a model of time inconsistency in road pricing policy where the haulier industry, depending on its expectation, will invest in externality reducing vehicle technology. It is conceivable that a new price instruments (taxes, congestion taxes or kilometre tax) is perceived to have several purposes - to internalize externalities and generate tax revenue or solve equity goal - and that the government has

incentive to change the policy once the system is introduced. Unless the government can be bound to a policy over time, resulting dynamic trust problem will block the implementation of an optimal policy.

After this introduction, section 2 presents a simple model and the time inconsistency problem while and section 3 develops possible future reforms to solve the time inconsistency problem. Section 4 concludes.

2. THE MODEL OF TIME INCONSISTENT TRANSPORT POLICY

Freight transport (Q) on road is modelled in a stylised way with constant elasticity where α is a constant, P the price of transport and ε the elasticity.

$$Q=\alpha P^{-\varepsilon} \quad (1)$$

The transport generates an externality e (per kilometre) which consists of road damage, air pollution, noise, congestion and accident cost. A haulier can reduce these externalities with new technology (more axles, emission technology, silent tyre, new logistic concepts or safer vehicles) which, however, comes at an increasing production cost, c ,such that the relationship between externalities and cost is:

$$e = \beta\, c^{-\gamma} \quad (2)$$

The total externality X is:

$$X = eQ \quad (3)$$

The government sets the tax t per unit externality to achieve its policy. The production cost of the firm is represented by c and the average cost of the firm is thus c+et. Firms choose technology to minimize expected cost E(c).

$$E(c) = E(t) + c = t\,\beta\, c^{-\gamma} + c \quad (4)$$

The optimal cost and externality technology for a given tax level is simply:

$$c = (\gamma\, \beta E(t))^{1/(1+\gamma)}$$
$$e = \beta\, (\gamma\, \beta E(t))^{-\gamma 1/(1+\gamma)} \quad (5)$$

We define the welfare in three parts, consumer surplus D(P), tax revenues tX and cost due to the externality h(X) where m is the marginal benefit of public funds.

$$W = D(P) + m\, tX - h(X) \quad (6)$$

To commit or not commit?

If the government commit to the externality tax t in advance, the development may be expressed as; first, the government announces and commit to the tax t, and secondly, the industry forms its expectation of the tax rate and makes it choice of technology (based on 5). The maximizing solution (dW/dt=0) to the welfare expression (6) gives the optimal tax rate t*. If the government retains the right to change the tax rate ex post the steps in the development may be; first the industry forms expectation about the future tax rate E(t) and from this choose the optimal technology, and secondly, the government choose the tax rate based on this choice of technology.

We may focus on two parts of equation 6 above; the effect on tax revenue and the effect on the externality. Let $h(X)=X^{\eta}$ be the disutility of externality. First, under discretion the industry will not change their technology and the tax and externality will only enter the function through the quantity Q.

$$\frac{dr}{dt} = e\alpha P^{-\varepsilon}\left(1 - te\varepsilon P^{-1}\right) \tag{7}$$

$$\frac{dh}{dt} = -\varepsilon\eta e^{\eta}\alpha^{\eta}P^{-\varepsilon\eta-1} \tag{8}$$

Under commitment, technology change will in addition affect the result of the tax and externality (subscript d denotes the discretion solution 7 and 8);

$$\frac{dr}{dt} = \left(\frac{dr}{dt}\right)_d + t\alpha P^{-\varepsilon}\frac{de}{dt} \tag{9}$$

$$\frac{dh}{dt} = \left(\frac{dh}{dt}\right)_d + \eta e^{\eta-1}\alpha^{\eta}P^{-\varepsilon\eta}\frac{de}{dt} \tag{10}$$

After technology is chosen the externality is less responsive to the tax rate $(dh/dt)_1 < (dh/dt)_o$ as de/dt<0. The optimal externality tax will be lower ex post than ex ante. On the other hand, tax revenues are more responsive than they were before investment, such that $(dr/dt)_1 > (dr/dt)_o$. The optimal revenue tax will be higher ex post than ex ante. The difference between the two situations, commitment or discretion, arises because the marginal effect of the tax is different before and after technology choice.

$$\frac{dW}{dt} = \left(\frac{dW}{dt}\right)_d + \frac{de}{dt}\alpha P^{-\varepsilon}\left(mt - \eta e^{\eta-1}\alpha^{\eta-1}P^{-\eta}\right) \tag{11}$$

We start with an optimal discretion solution $(dW/dt)_d = 0$ and conclude that with a low marginal benefit of tax revenue (small m) dW/dt>0 and thus the tax level under discretion is lower than under commitment. On the other hand, if m is large, dW/dt<0 and the tax level under

discretion is higher than under commitment. Consequently, once the tax t* has been announced and the industry has adopted with new technology the government will ex post, if m is large, have an incentive to increase the tax rate, and if m is small, have an incentive to reduce the tax rate and prices to improve welfare. This is the time-inconsistency problem.

3. DELEGATION

Kydland and Prescott (1977) showed that the outcome in a rational-expectations equilibrium where the government cannot commit to policy in advance results in lower welfare than the outcome in an equilibrium where the government can commit. The reform of central banks in many countries in the 1990s has its origin in this model. We have seen that the Government in our model under some assumptions may have incentives to change the policy once it has been introduced and the industry has adapted to the new circumstances. To strengthen the commitment we can consider different forms of delegation of the decision power in the spirit of Barro and Gordon (1983) and Rogoff (1985).

Reputation is one explaining factor on how governments avoid dynamic inconsistency. As governments know that they can do better in the long run than in the short run they can build up a reputation that makes the public believe their long run intentions. To use the law is another example to solve the dynamic inconsistency problem. However, the law needs to make a trade off between the cost of dynamic inconsistency and the benefits of flexibility. A model with an important policy implication is if the preferences of the policymaker are limited in the form of, for example, a conservative central banker. If the policymaker is more conservative and puts more weigh on (inflation in the original model) the outcome of the single period game will result in a smaller loss for society. The development of central bank regulation the last decade in some countries is one way to ensure the influence of conservative central banker's preferences.

Numerous solutions thus exist. We consider below delegation in the form of i) focus on one measurable objective or ii) appoint people with another weight on tax revenue (m) and externality compared to the government.

Single objective

The problem with time inconsistency arises because one measure is used to achieve two objectives, tax revenues and reduce externalities. A target can be set on the agency for one objective, to reach the externality $\hat{E}$. The objective function of the agency would be to maximize something like $(E-\hat{E})^2$. The agency sets the tax t to fulfil this objective. The optimal $\hat{E}$ set by the government is the optimal level following the commitment solution.

With a definition of one single objective (the inflation rate in the original models) the agency does not face a trade off between tax revenue and externalities and would thus not have any problem with time inconsistency.

The problem behind this model is of course to find on single accepted measure of externality. However, to measure inflation into one single digit is, at least, a problem of the same magnitude, which is “solved”. So one development could possibly be further develop the underlying cost functions, as presented in the Handbook, and develop a clear objective of transport agencies responsible for setting prices.

Conservative central Transport Financing Authority

An alternative solution is to define an authority with preferences that differ from the preferences the government is expected to have. The body will be independent and decide on the level of the tax.

If the problem with time inconsistency arises because m is small, and the government will reduce the taxes, a conservative agency should put a higher weight on the externality. An environmental conservative policy maker could thus be appointed.

On the other hand, if it is expected that m is large, and thus taxes may be increased once the policy is introduced, a conservative agency could be appointed with a lower weight on externality. The externality is an aggregate of road damage, air pollution, noise, congestion and accident cost and it is not clear what kind of policy maker we are looking for but the arguments for lower externalities are usually put forward by the industry.

Before it is possible to develop the approach further it is necessary to understand what the underlying empirical fact behind a possible time inconsistency problem in road pricing policy is; a low or high benefit of tax revenue.

4. CONCLUSION

This short paper presents a simple model of time inconsistency in road pricing policy inspired by work in monetary policy literature. The model suggests that reason for the delay in implementation of a road pricing policy can (partly) be found in a problem of time inconsistency as it can be expected that the government, once the policy is at place, will change its behaviour. The simple model can be further developed to be more aligned to the cost functions of relevant externalities in the transport sector.

Based on this observation of time inconsistency we borrow the approaches from the monetary literature and briefly discuss different forms of delegation of decision power to solve, or reduce, the problems. We conclude that the definition of a single digit target, as inflation rate, for the level of externality is difficult to find, or imagine could be developed. The remaining solution is around the development of an institution similar to a conservative central bank. Such a conservative body need to have other weights on the benefit of tax revenues and reducing externalities than what the government is expected to have. A more developed model in the first part could further guide the development of such a body.

REFERENCES

Abrego, L. and C. Perroni (2002). Investment subsidies and time-consistent environmental policy. Oxford Economic Papers, 54, 617-635.

Barro R.J. and D. B. Gordon (1983) A Positive Theory of Monetary Policy in a Natural Rate Model Journal of Political Economy 1983 91:4, 589

Braid R. M. (1986): "Duopoly pricing of congested facilities", Department of Eco-nomics Columbia, Working Paper No. 322.

Calthrop, E., B De Borger, S Proost (2006) Externalities and partial tax reform: does it make sense to tax road freight (but not passenger) transport? University of Antwerp

COM(2008) 436/3: DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures

De Borger B., Dunkerley F. and Proost S. (2006): "The interaction between tolls and capacity investments in serial and parallel transport networks", Working Paper no 2006-7, K.U.Leuven-Center for Economic Studies.

De Borger B., Dunkerley F. and Proost S. (2007): "Strategic investment and pricing decisions in a congested transport corridor", Journal of Urban Economics 62.

De Borger B., Proost S. and Van Dender K. (2005): "Congestion and tax com-petition on parallel network", European Economic Review, 49/8, 2013-2040.

De Palma A. and Lindsey R. (2000): "Private Toll Roads: a Dynamic Equilibrium Analysis", Annals of Region Science 34, 1, 13-35.

European Commission (2009) “A sustainable future for transport: Towards an integrated, technology-led and user friendly system” COM(2009) 279 final, Brussels, 17.6.2009

Helm, D., C.Hepburn, R.Mash (2004), Time-inconsisten environmental policy and optimal delegation, Oxford University Department of Economics, Discussion Paper 175.

Kydland F. and E. Prescott (1977) Rules Rather than Discretion: The Inconsistency of Optimal Plans Journal of Political Economy 1977 85:3, 473

Levinson D. (2001): "Why States Toll - An Empirical Model of Finance Choice", Journal of Transport Economics and Policy, 35, 2, 223-238.

Levinson, D. (1998) An Economic Analysis of Network Deployment and Application to Road Pricing, California PATH Working Paper, UCB-ITS-PWP-98-1

Maibach, M., Schreyer, C., Sutter, D., van Essen, H.P., Boon, B. H., Smokers, R.,Schroten, A., Doll, C., Pawlowska, B. and Bak, M. (2007). Handbook on estimation of external cost in the transport sector Internalisation Measures and Policies for All external Cost of Transport (IMPACT). Delft, CE, 2007.

Marsiliani, L. and T.I.Renström (2000). Time inconsistency in environmental policy: tax earmarking as a commitment solution. Economic Journal, 110, C123-C138.

Rogoff, K. (1985) The optimal degree of commitment to an intermediate monetary target. Quarterly Journal of Economics, 100 (1985), pp. 1169-90

Verhoef E., Nijkamp P. and Rietveld P. (1996): "Second-Best Congestion Pric-ing: The Case of an Untolled Alternative", Journal of Urban Economics 40, 279-302.