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ABSTRACT

Does Tax Competition Raise Voter Welfare?*

Economists who believe that government is essentially benevolent tend to regard inter-governmental competition as a source of negative externalities that lower welfare. In contrast the public choice perspective, particularly that motivated by the Leviathan model, sees such competition as potentially beneficial. This Paper considers a world consisting of politicians of both kinds – self-interested and welfare maximizing. Imperfect information prevents identification of the latter. We model the political equilibrium of the model and then examine the consequences of introducing competition for mobile resources or yardstick competition. In both cases there is a trade-off between effects on politician discipline and selection. Contrary to the existing view, we show that competition is most likely to be welfare improving for voters when it is more likely that politicians are benevolent and bad for welfare when it is most likely that politicians are of the rent seeking type.

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1 Introduction

A central tenet of market economics is that competition is good for consumers. In the case of inter-governmental competition, economists have tended to be more equivocal. This, in part, reflects the intellectual prominence of the Pigouvian tradition which sees governments as benevolent actors. In that context, competition is a source of externalities which demand greater inter-governmental *cooperation* rather than competition to solve them. Given this starting point, it is hardly surprising that those who claim that intergovernmental competition is good, do so from a public choice view that government is not benevolent. The hope is then that competition will improve incentives for government to act in their citizens' interest.

To date, the workhorse for making statements about the benefits of inter-governmental competition has been the Leviathan model of government due to Brennan and Buchanan (1980).¹ Far from being benevolent, government aims to maximize revenues which politicians use for their own ends. This model entirely emasculates the political process as *all* politicians are assumed to behave in the same way. Spending that citizens value is undertaken only as necessary to generate more revenues for the government. From that model has come the claim that welfare of voters may increase when competition disciplines Leviathan governments because revenue extraction becomes more costly.

Both approaches to the issue – the Pigouvian and Leviathan models – take an extreme position on the behavior of government. This paper re-examines the issue using a model of the political economy of government which is more balanced in its assumptions about the political process that generates politicians in office. We suppose that the world is populated by good politicians committed to serving the ends of citizens at large and bad politicians who try to line their own pockets if they are elected. While

¹They posited the idea that the government would seek to maximize the tax revenues extracted from the citizens. Moreover, because citizens find it difficult to control the behavior of (self-interested) officials, government spending and tax rates tend to exceed efficient levels. By creating downward pressure on tax rates, then, tax competition may supplement the limited constitutional means available to taxpayers to constrain their political leaders. This argument was further explored in Edwards and Keen (1996). Wilson (2000) provides an alternative model in which competition for tax bases can restrain wasteful officials and improve welfare. Like Brennan and Buchanan (1980), these papers do not consider the role of elections in disciplining governments.

citizens would prefer the Pigouvian politicians, information problems prevent them from identifying who they are and the political process is partly a selection mechanism for achieving this end. As well as affecting selection, re-election incentives also affect discipline in rent extraction, as self-interested politicians sometimes mimic the Pigouvians by reducing their rent seeking in order to enhance their chances of re-election. These selection and discipline effects driven by the electoral process are at the heart of the model and drive its results. By putting information and agency at centre stage, we have a more micro-founded approach to equilibrium political outcomes. This allows us to identify the forces that put them closer to, or further away from, the Leviathan or Pigouvian outcome.

Having set up this approach, we ask whether subjecting the government to greater competition will raise or lower the welfare of voters. We study two kinds of competition. The first is a standard notion of competition for mobile tax bases which raises the marginal cost of public funds and constrains the size of government (see Wilson (1999) for a survey).² The second is yardstick competition whereby voters in one jurisdiction make use of comparative performance evaluation, conditioning their voting behavior on policy outcomes in other jurisdictions (Besley and Case (1995b)).³

If competition is due to resource mobility across jurisdictions, we show that, without any shift in the political equilibrium, welfare must be lower – if politicians take rents, then voters would prefer that they did so using efficient forms of taxation. However, once endogeneity of the political equilibrium is taken into account, then tax competition may indeed be welfare improving. The reason for this is somewhat paradoxical to those schooled in the Leviathan model. Tax competition is welfare improving when it leads to bad

²Here, the predominant focus has been on implications of increased mobility of goods and services for tax setting by governments. In most of the literature the government's objective is typically some measure of societal welfare. The main finding is that allowing competitive determination of taxes will lead to externalities that lower social welfare in the competing countries. Competition skews taxes towards immobile bases such as labor and away from mobile bases such as capital. This increases the cost of public funds and reduces the scope for spending on public goods provision and other kinds of valuable public programs. The reasoning is essentially based on well-known inefficiencies in non-cooperative behavior in the presence of externalities.

³Besley and Case (1995) finds empirical evidence for this kind of interdependent tax setting for U.S. States. Similar results for European countries are found in Bordignon *et al.* (2001), Revelli (2001), and Schaltegger and Küttel (2001). See Brueckner (2001) for an overview of the empirical literature on strategic interactions among governments.

politicians being less willing to restrain rent seeking and hence reveal more information about themselves to voters, i.e. by improving selection. This is most likely to happen when there are sufficiently many Pigouvian politicians in the population. Otherwise, the gains from identifying Leviathan types will tend to be low. A Leviathan politician who is thrown out of office is just as likely as not to be replaced by another who wants to line his own pockets. Thus in this case, tax competition works best when the underlying political system is furthest away from the Leviathan model and leads to an increase in rent seeking! This is very different to the standard view.

The forces shaping the yardstick competition example developed here are similar. Yardstick competition generates a kind of reputational externality between incumbents. When they are expected to bad, then politicians are less likely to contain their rent seeking behavior, other things being equal. Yardstick competition now increases rent seeking when the probability of having a Leviathan government is high. But, since improved selection is also less likely in this case, competition will tend to lower voter welfare. This contrasts with the case where the probability that a Pigouvian government is in office is high. First, there will tend to be no increase in rent seeking by bad politicians who are elected, and the selection effect works in favor of voters. Overall, therefore, the yardstick competition example is also most likely to deliver benefits when the political system is closer to being Pigouvian than Leviathan. Both of these results suggest that looking at the welfare effects of tax competition in a model that assumes pure benevolence or pure Leviathan government could be extremely misleading.

Sorting out the welfare consequences of intergovernmental competition is more than of academic interest. The received wisdom is that increased economic integration among nations in recent years has increased the mobility of tax bases across national borders, with “tax competition” among governments attempting to attract mobile tax bases—particularly capital income—by lowering rates below efficient levels. Recently, international organizations have attempted to define international standards for capital taxation as a means to control tax competition. The OECD, for example, has developed guidelines for eliminating “harmful tax competition” among member nations, and is directing its efforts as well at persuading non-member states that offer “tax havens” to reform their ways.

The competing views in the academic literature do, however, also show up in the policy debate. In the original OECD (1998) report on harmful tax competition, for example, a dissenting appendix by the government of

Switzerland argued “competition in tax matters . . . discourages governments from adopting confiscatory fiscal regimes, which hamper entrepreneurial spirit and hurt the economy, and it avoids alignment of tax burdens at the highest level.” (p. 77)

The remainder of the paper is organized as follows. Section two introduces the signalling model of rent extraction and elections. It characterizes equilibrium and establishes that, due to the commitment problem facing voters, improvements in voters’ information may in some circumstances lead to increases in rent extraction and lower welfare. We then examine the effects of increases in the cost of public funds induced by tax competition. Section three extends the model to study the use of relative performance evaluation, or “yardstick competition,” by voters. Section four concludes the paper.

2 The model

Government and the economy. We study an agency model of elections, of the general type introduced by Barro (1973) and Ferejohn (1986) and employed latterly by Besley and Case (1995a,b) and Coate and Morris (1995) among others.⁴ There are two time periods; in each, the politician in office makes decisions about government spending. Between periods, there is an election in which voters choose between the incumbent and a challenger. Specifically, in each period, the politician observes the unit cost θ of providing a public good and then unilaterally chooses the quantity of the good provided G and the amount of rent diversion for private purposes, or “waste,” s . Total government spending for the period (equal to tax collections) is then $x = \theta G + s$. The cost of the public good is independently and identically distributed in each period, with $\theta \in \{L, H\}$, $H > L$, and $\Pr(\theta = H) = q$. All voters have identical preferences, deriving utility from public goods, net of the cost of government spending. When the politician provides public goods in the amount G and total spending is x , the welfare of the representative voter is $W(G, x) = G - \mu C(x)$, where C is a strictly convex, increasing function and μ is an exogenous parameter that indexes the marginal cost of public funds in a simple way. (In what follows, we will consider the impact of an increase in international tax competition that raises μ for the government.

⁴See Persson and Tabellini (2000, chapter 4) for a review of agency models in political competition.

Appendix B sketches a simple public finance model which justifies treating μ as index of the intensity of tax competition.)

Politicians may be one of two types, “good” or “bad”. Thus we label the politician’s type by $i \in \{b, g\}$. A good politician simply chooses G in each period to maximize voter welfare, and places no value on rents diverted from public spending. Given θ , therefore, the level of public goods provided by the good politician is

$$G^*(\theta, \mu) = \arg \max G - \mu C(\theta G) \tag{1}$$

We denote the associated level of spending by $x_\theta = \theta G^*(\theta, \mu)$ and of voter welfare by $W^*(\theta, \mu)$. Evidently, G^* and W^* are decreasing in μ . In contrast, a bad politician behaves strategically, choosing policies to maximize the expected, discounted sum of rents $s_1 + \beta\sigma s_2$ extracted from government, where $\beta < 1$ is a discount factor, and σ is the probability of re-election to second term. We assume that there is a maximal feasible level of government tax collections; thus $x \in [0, X]$. The determination of the re-election rule is discussed below.

Information and Timing. The types $i \in \{g, b\}$ of first-period incumbent and challenger are independent draws from an identical distribution with $\Pr(i = g) = \pi$. The incumbent then observes the first-period cost shock θ and chooses public goods provision G and rent diversion s . Voters then observe G and government spending x prior to the election at the end of the first period. However, the types of incumbent and challenger, the unit cost θ , and the level of rent diversion s are unobserved. In the second period, the politician then in office again chooses G and s given θ . There are no further elections; thus even newly elected challengers are “lame ducks” in the second period. In casting their votes in the election, therefore, voters must make an inference about the incumbent’s type based on observed performance and compare it to prior beliefs about the type of the challenger.

In this framework, elections evidently serve a role in selecting good incumbents for re-election in the second period. Moreover, as we shall see, elections may also provide incentives for bad first-period incumbents to restrain waste in government, in the hope of being mistaken for a good politician and re-elected to a second term. For two reasons, however, the outcomes that emerge in equilibrium in the model will depart from those associated with an optimal incentive contract for politicians. First, feasible contracts are restricted. The

available incentive arrangements are confined to voters' binary choice of re-election, rather than a general pay-for-performance contract. Second, voters face a commitment problem, since they cast their votes for re-election after first-period spending decisions have been made. It follows that the equilibrium re-election rule is chosen to select politicians optimally *ex post*, but it will not provide the efficient degree of *ex ante* incentives. In particular, if it were possible, voters might wish to commit to a relatively tough re-election rule that removed even fairly good incumbents from office "*pour encourager les autres*". Because of the timing of decisions, however, such a rule would not be credible to the incumbent, and would have no effect on incentives.

2.1 Equilibrium

The foregoing structure defines a game of incomplete information between the incumbent politician and the representative voter. We seek to characterize perfect Bayesian equilibria of this game.

As usual, the game is most easily solved by applying a type of backward induction. In the second period, the politician in office faces no further possibility of electoral discipline. Thus $s_2 = X$ for $i = b$ (bad politicians take maximal rents) while $s_2 = 0$ for $i = g$. Given s_2 , the politician chooses G to maximize voter welfare.

Given that second-period strategies are identical for challenger and incumbent, the sequentially rational voting rule for voters is to re-elect the incumbent if the posterior probability the incumbent is the good type exceeds the prior probability π that the challenger is good. The voter's posterior beliefs depend in turn on the equilibrium strategy of the first-period incumbent. Since the good type behaves in an essentially non-strategic way in the model, he chooses (G_H^*, x_H) with probability q and (G_L^*, x_L) with probability $1 - q$. It follows that, in any perfect Bayesian equilibrium, the voter's posterior beliefs assign probability zero to the good type at any other information set (G, x) . To economize on notation, we therefore write posterior beliefs as a function $\Pr(g|x)$ of first-period spending alone. Of course, $\Pr(g|x) = 0$ if $(G, x) \neq (G_\theta^*, x_\theta)$ for $\theta \in \{L, H\}$. In such cases, the voter always elects the challenger in the second period.

Accordingly, we can confine attention to three possible strategies for the bad incumbent, each associated with one of the three spending levels (x_L, x_H, X) that are observed with positive probability on the equilibrium path. First, b might choose $s_1 = 0$ or $s_1 = X$. Since future rents are dis-

counted ($\beta < 1$), however, the latter strategy dominates the former.⁵ Thus

$$\Pr(g|x_L) = 1$$

in any equilibrium, and the voter always re-elects when first-period spending is x_L . Beliefs conditional on observing x_H are more complicated. A bad politician who faces low true costs may, instead of taking maximal rents, choose to produce G_H^* units of the public good and spend x_H , diverting $\hat{s}(\mu) \equiv (H - L)G^*(H, \mu)$ to private rent consumption. This strategy allows type (b, L) to “pool” with type (g, H) , and doing so may be desirable, if it brings a positive probability of re-election. Accordingly, let

$$\lambda = \Pr(x = x_H | \theta = L, i = b)$$

denote the probability type (b, L) exercises restraint in this sense, and let σ denote the probability of re-election when the voter observes x_H . The posterior probability that spending x_H was generated by a good politician is

$$\Pr(g|x_H) = \frac{\pi q}{\pi q + (1 - \pi)(1 - q)\lambda}$$

A best response for voters is to re-elect with positive probability ($\sigma > 0$) only if $\Pr(g|x_H) \geq \pi$ or, equivalently, $\lambda \leq q/(1 - q)$. If the inequality is strict, then $\sigma = 1$. Further, type (b, L) prefers to exercise restraint instead of diverting maximal rents ($\lambda > 0$), only if $\hat{s} + \beta\sigma X \geq X$. When this inequality is strict, then $\lambda = 1$.

Collecting these observations, there are three possible equilibrium configurations. First, equilibrium may be *pooling*, as type (b, L) chooses $s_1 = \hat{s}$ and so is indistinguishable from type (g, H) . Second, equilibrium may be *separating*, as type (b, L) chooses $s_1 = X$ and is revealed *ex post*. Third, equilibrium may be a *hybrid* one, in which type (b, L) adopts a strictly mixed strategy on actions $s_1 = \hat{s}$ and $s_1 = X$, so that type is revealed with positive probability strictly less than one. The following result fully characterizes the possible configurations.

Lemma 1 *An equilibrium exists for all values of parameters and is generically unique.*

⁵Regardless of true costs, $s_1 = 0$ yields a payoff to the bad type of βX if re-elected and zero otherwise, while $s_1 = X$ pays $(1 + \beta)X$ if re-elected and X otherwise.

1. A pooling equilibrium, with $\lambda = \sigma = 1$, exists if and only if

$$q \geq \frac{1}{2} \ \& \ \hat{s}(\mu) \geq (1 - \beta)X \quad (2)$$

2. A hybrid equilibrium, with $\lambda = q/(1 - q)$ and $\sigma = (X - \hat{s})/(\beta X)$, exists if and only if

$$q < \frac{1}{2} \ \& \ \hat{s}(\mu) \geq (1 - \beta)X \quad (3)$$

3. A separating equilibrium, with $\lambda = 0$ and $\sigma = 1$, exists if and only if

$$\hat{s}(\mu) \leq (1 - \beta)X \quad (4)$$

In the separating equilibrium, b takes maximal rents and is detected with certainty and replaced by the challenger. (This equilibrium outcome is therefore equivalent to that which would obtain if voter could observe the cost shock directly.) In the pooling and hybrid equilibria, the incumbent is taking less than maximal rents and his type of revealed with lower probability.⁶ The latter is most likely when $\hat{s}(\mu)$ is high and the incumbent discounts the future a great deal so that he prizes rents earned in period one.

This framework is somewhat more optimistic than the standard Leviathan model of tax setting as we have allowed for a population of good as well as venal politicians. Even a very small fraction of good politicians can have a large effect on equilibrium behavior with sufficient discounting so that $\hat{s}(\mu) \geq (1 - \beta)X$, as it becomes optimal for a bad politician to mimic a good one to gain some chance of re-election.

To understand how the electoral process affects political decision-making in the model, it is useful to calculate expected voter welfare in equilibrium. As a benchmark for the analysis, suppose in contrast that politicians were removed from office each period with certainty. Expected voter welfare when type g is in office would then be $EW^* = qW_H^* + (1 - q)W_L^*$, whereas welfare with b in office would simply be $-X$, since “lame-duck” bad politicians divert maximal rents. To simplify notation, let $W^0(\mu) = \pi EW^* - (1 - \pi)X$ be the unconditional expected per-period welfare in this case. It follows that the

⁶In the pooling equilibrium, the outcome is similar to that assumed in the Leviathan model where rents are assumed to be positively related to the amount of “legitimate” public spending.

present value of expected welfare is just $(1 + \beta)EW^0(\mu)$ when there is no chance of re-election.

Welfare in equilibrium of the model differs from this expression for two reasons. First, with probability $(1 - \pi)(1 - q)\lambda$, the first-period incumbent chooses to divert rents \hat{s} instead of X , resulting in a welfare gain from “discipline” of

$$D(\mu) = W^*(H, \mu) + X \quad (5)$$

Second, since the incumbent may be re-elected, a good challenger may replace a bad incumbent, yielding a second-period welfare gain from “selection” of

$$S(\mu) = EW^*(\mu) + X \quad (6)$$

The probability this occurs is

$$\pi_2 - \pi = \pi(1 - \pi)[q\sigma + (1 - q)(1 - \sigma\lambda)] \quad (7)$$

To interpret this expression, observe that the probability of Type I and Type II errors in voters’ re-election decision, given the equilibrium strategies, are given by

$$\begin{aligned} \tilde{\alpha}(\lambda, \sigma) &\equiv \Pr(\text{re-elect}|b) = (1 - q)\lambda\sigma \\ \tilde{\beta}(\lambda, \sigma) &\equiv \Pr(\text{do not re-elect}|g) = q(1 - \sigma) \end{aligned}$$

so that

$$\pi_2 - \pi = \pi(1 - \pi)(1 - \tilde{\alpha} - \tilde{\beta})$$

That is, the expected gain in the quality of the second-period incumbent is proportional to one minus the sum of probabilities of Type I and II errors, and to the variance of i . Given this, equilibrium welfare can be written as

$$EW(\lambda, \sigma, \mu) = (1 + \beta)W^*(\mu) + (1 - \pi)(1 - q)\lambda D(\mu) + \beta(\pi_2 - \pi)S(\mu) \quad (8)$$

In summary, the possibility of re-electing incumbents can increase voter welfare both by improving average quality of office-holders (the “selection effect”) and by offering prospective incentives for low-quality incumbents (the “discipline effect”).

2.2 Intensifying tax competition

We now turn to the effect of tax competition on voter welfare. The above analysis suggests that the electoral process does indeed serve in part to discipline elected officials, restraining wasteful spending, as well as to select better officials for re-election. Nevertheless, the incentives provided through elections might be enhanced by other changes in the economic environment facing voters and officials, such as the effects of international tax competition. In this section, we consider an increase in tax competition among governments that induces an exogenous increase in the marginal cost of public funds μ . Is it the case that such a change (in the words of the Swiss government document cited above) “discourages governments from adopting confiscatory fiscal regimes”? In fact, expected rent diversion is decreasing in μ in the pooling and hybrid equilibria, since $\hat{s}(\mu) = (H - L)G^*(H, \mu)$ is decreasing in μ . By reducing the level of spending by benevolent governments, then, tax competition also restricts the amount of wasteful spending that can be undertaken by self-interested officials without fear of detection. To determine whether this effect can exceed the usual welfare cost of tax competition, we differentiate (8) to obtain the following result.

Proposition 1 *Intensification of tax competition (as represented by an increase in μ) that leaves equilibrium strategies (λ, σ) unchanged reduces voter welfare, even if it reduces rent diversion by bad politicians.*

This result holds in spite of the fact that tax competition does (sometimes) lower rent extraction by bad incumbents. This fails to deliver a benefit to voters in any of the equilibria described in Lemma 1. When the equilibrium is separating, rent seeking is maximal anyway and voters would prefer to be “robbed” efficiently. Tax competition only increases the costs of venality. In pooling or hybrid equilibrium, tax competition leads to reduced rent seeking. However, voters are worse off as the level of rent seeking is fixed by the condition that the incumbent behaves as if the high cost state has arisen. Tax competition that raises the marginal cost of public funds only makes the cost of funding public spending in this state larger.

This finding contrasts with the usual presumption of Leviathan models. The key difference is most clearly seen in a separating equilibrium. Here, increasing the inefficiency of tax setting has no effect on rent extraction, but only on “legitimate” public spending. In the Leviathan model, it is assumed that rent extraction must be related to legitimate public spending and hence

will fall when the latter falls. Hence, there could be a rent extraction benefit from increasing the efficiency of the tax base. However, even there the rent extraction advantage would have to be sufficiently intense relative to the increase in the inefficiency of the tax system.

The key assumption in Proposition 1 is that equilibrium strategies remain unchanged. However, it is clear that this need not be so. We show now that if this is not the case, then there are two competing effects to consider – the possibility that the equilibrium induces a change in strategy that leads to more information about the incumbent being revealed and the possibility that the amount of rent extracted by politicians changes.

Returning to Lemma 1, it is clear that intensifying tax competition can lead from a move from the pooling or hybrid equilibrium to a separating equilibrium. Specifically, defining $\underline{\mu}$ from $s(\underline{\mu}) = (1 - \beta)X$, then for all $\mu > \underline{\mu}$, there will be separation between the good and bad incumbents. This occurs because equilibrium rents are proportional to the size of government in the pooling or hybrid cases. As the size of government is reduced by tax competition, rent extraction possibilities are limited, making it more likely that a bad incumbent will “go-for-broke” and extract maximal rents. In this instance, all equilibrium information (about θ and the type of the politician) is revealed in equilibrium. Hence, to ascertain the welfare effects of tax competition which increases μ above $\underline{\mu}$, we need to compare full information welfare with that in the equilibrium with $\mu < \underline{\mu}$.

Comparing welfare in these cases, we find that the selection effect outweighs the discipline effect, so that welfare is higher in the separating equilibrium, if and only if $\beta\pi S(\mu) \geq D(\mu)$. Our main result on the welfare economics of tax competition is:

Proposition 2 *There exists a $\pi^* \in (0, 1)$ such that intensification of tax competition (as represented by an increase in μ) unambiguously reduces voter welfare for all $\pi < \pi^*$. For $\pi \geq \pi^*$, an increase in tax competition which moves the equilibrium from hybrid or pooling to separating may increase voter welfare if it induces a shift from a hybrid or pooling equilibrium towards a separating equilibrium.*

This result says that tax competition can enhance voter welfare only if it leads to an increase in the ability of voters to detect bad incumbents. Somewhat paradoxically, then, a sufficiently large increase in the cost of public funds may indeed increase equilibrium welfare, but only if the change

increases the amount of wasteful spending in the first period. Voter welfare will be higher from improved selection when the fraction of good types in the population π is sufficiently high. This result contradicts entirely the conventional wisdom that tax competition is most likely to increase welfare where there is a preponderance of rent seeking incumbents due, perhaps due to weak media scrutiny of election campaigns or because of poor selection of incumbent types in the population.

While we have applied this argument to analyze the effects of tax competition, its implications are far more general. Brennan and Buchanan (1980) argue that constitutional restrictions on the taxing power which appear to raise the marginal cost of public funds may in fact have salutary effects, as they restrain excessive spending by government. Our analysis suggests that, when the electorate has other means available to discipline officials, it is less likely that such fiscal constraints can increase welfare. It is important to consider the effects of fiscal constraints on the behavior of *voters*, as well as the behavior of politicians, before their effects can be assessed correctly.

3 Yardstick competition

We now turn to a second source of intergovernmental competition directly centered on the political process – yardstick competition. The basic idea behind this is that voters will compare policies in their jurisdiction with those in others before heading to the polls. This means that incumbents will be partly judged on their relative performance. Besley and Case (1995b) find some evidence for this using data from U.S. states.⁷ In standard agency settings of the kind studied by Holmstrom (1982), yardstick information is valuable – it allows the principals in an agency relationship to get a more accurate estimate of the underlying unobservables. We are interested in understanding whether this carries over to our setting.⁸

⁷The theory of yardstick competition is also studied in Hindriks and Belleflamme (2001) and Bodenstein and Ursprung (2001).

⁸If principals can control agents effectively with incentives tailored to all measurable consequences of their actions and full commitment, then improved information is valuable (Holmstrom (1979)). However, there are situations where the kinds of incentives that can be granted to agents are more limited as in the career concerns model (Dewatripont, Jewitt and Tirole (1999)). In that context, improved information need not be valuable. Similarly, Meyer and Vickers (1997) show that relative performance evaluation may increase or decrease efficiency in agency relationships when principals lack the ability to commit to a

The following example illustrates the basic logic in our setting. Suppose that the shocks to the cost of providing public services are positively correlated: then observing a tax rate in another jurisdiction of x_L will make a voter more confident that the cost shock is L in their own jurisdiction. Hence, it is now more likely that a tax of x_H in their own jurisdiction was generated by a bad incumbent. This could lead the voters to fire an incumbent whom they would have retained in the absence of yardstick information. Thus identification of bad incumbents becomes easier and selection is improved. However, improved selection may come at a cost. In the example just illustrated, a bad incumbent who knows that he will be fired if he chooses x_H when the cost of providing public services is L may now choose X instead. Thus improved selection may come at the expense of weaker discipline, i.e., higher rents.

As in the previous section, the trade-off between better *ex post* selection of politicians, while worsening *ex ante* incentives for incumbents seeking re-election is central to understanding the overall welfare effect. Depending on which of these concerns is most important, the result of yardstick competition can be better or worse for voters. Below, we show that the trade-off once again hinges on the magnitude of π , with yardstick competition being unambiguously welfare improving for voters when π is high and unambiguously welfare decreasing if π is low enough.

To see this intuitively, consider an outcome that could have been generated by a good or bad incumbent in both jurisdictions (i.e. a pooling outcome), with positive correlation in the underlying economic environments. Then as the likelihood that the foreign incumbent is bad increases, it is more likely that the outcome is generated by a bad incumbent pretending to be good. Hence, given the positive correlation between the environments being faced, it is more likely that the domestic incumbent is also bad. This undermines the bad incumbents efforts to pool with good ones and may induce bad incumbents to behave even worse if they think that they are now more likely to be removed from office. But when reputations are generally low, the value from finding out who is good or bad is also less valuable. Hence, there is increased in rent seeking by bad politicians (which generates more information about the politician's type) precisely when the value of such information is low!

To extend the model to include yardstick comparisons, suppose now that

long-term incentive contract.

here are two identical jurisdictions, labeled “domestic” and “foreign”; variables that apply to the foreign jurisdiction will be denoted by the prime symbol. To focus on symmetric equilibria of the game among incumbents and voters in the two jurisdictions, assume that the joint probability distribution function of cost shocks $\Pr(\theta, \theta')$ is symmetric, with

$$\begin{aligned}\Pr(H, H) &= \Pr(L, L) = \frac{\rho}{2} \\ \Pr(H, L) &= \Pr(L, H) = \frac{1 - \rho}{2}\end{aligned}\tag{9}$$

Moreover, we work with the case where $\rho > 1/2$, so that cost shocks in the two jurisdictions are positively correlated. To further simplify the analysis, we assume that $\hat{s} > (1 - \beta)X$, so that a separating equilibrium cannot exist. Since the marginal p.d.f. has $q = \Pr(\theta = H) = 1/2$, it follows from Lemma 1 that the unique equilibrium of the game without yardstick competition is one with pooling. We now show that, depending on the value of π , both hybrid and pooling equilibria are possible with yardstick competition.

3.1 Equilibrium strategies

When performance of foreign as well as domestic officials is observable, voters may base their decision to re-elect the incumbent or not on *relative* performance in the two jurisdictions. Voters will now condition their voting behavior on tax setting in both the domestic and foreign jurisdictions. Accordingly, let the probability of re-election in the domestic jurisdiction be $\sigma(x, x')$ when observed spending in the domestic and foreign jurisdictions are x and x' respectively. We say the voter’s strategy involves yardstick competition when re-election occurs with positive probability if spending is high in both jurisdictions, but the probability of re-election is zero if domestic spending is high and foreign spending is low. That is, a re-election rule with yardstick competition has $\sigma(x_H, x_H) = \sigma$ for some $\sigma > 0$ and $\sigma(x_H, x_L) = 0$.⁹

As before, let λ denote the probability type (b, L) chooses $s_1 = \hat{s}$. Since we look for an equilibrium in which the strategies adopted by domestic and foreign incumbents are symmetric ($\lambda = \lambda'$), the p.d.f. $\Pr(x, x'|i)$ of domestic and foreign spending conditional on type of the domestic politician can be

⁹Of course, $\sigma(x_L, x') = 1$ in equilibrium for all x' , as in the unilateral model of Section 3.

calculated as

$$\begin{aligned}\Pr(x_H, x_H|g) &= \pi \frac{\rho}{2} + (1 - \pi) \lambda \frac{1 - \rho}{2} \\ \Pr(x_H, x_H|b) &= \pi \lambda \frac{1 - \rho}{2} + (1 - \pi) \lambda^2 \frac{\rho}{2}\end{aligned}\tag{10}$$

(There are two terms in each probability because $x' = x_H$ might have been generated by a good foreign politician facing high costs or a bad foreign politician facing low costs.) Voters' posterior beliefs about the incumbent can therefore be calculated from Bayes' rule:

$$\Pr(g|x_H, x_H) = \frac{\pi}{\pi + (1 - \pi) \ell(\lambda, \rho, \pi)}\tag{11}$$

$$\ell(\lambda, \rho, \pi) = \frac{\Pr(x_H, x_H|b)}{\Pr(x_H, x_H|g)}\tag{12}$$

where $\ell(\lambda, \rho, \pi)$ is a measure of the likelihood that (x_H, x_H) was generated by a good or bad incumbent – as $\ell(\cdot)$ falls below one, the more likely it is that the policy (x_H, x_H) was generated by a good rather than a bad domestic incumbent. Key to understanding the logic of the ensuing results is the fact that $\ell(\cdot)$ is a decreasing function of π – the worse the initial reputation of the incumbent, the more likely it is that (x_H, x_H) was generated by a bad incumbent. This is because (x_H, x_H) it is more likely generated by a foreign bad incumbent with cost of L than a foreign good incumbent with a cost of H . But with positive correlation in costs, it is also more likely that the cost at home is L and hence that the domestic incumbent is bad.

A necessary and sufficient condition for an equilibrium with yardstick competition to exist is that $\Pr(g|x_H, x_L) < \pi$, so that voters prefer to remove the incumbent from office when domestic spending is high and foreign spending is low. Moreover, the equilibrium is pooling if $\Pr(g|x_H, x_H) > \pi$ for $\lambda = 1$, and is hybrid otherwise. After some tedious manipulation, these conditions reduce to a simple one, given in the following result.

Lemma 2 *Suppose that $\hat{s} > (1 - \beta)X$. Then voters use yardstick competition in equilibrium. A pooling equilibrium exists if and only if $\pi \geq 1/2$, and a hybrid equilibrium exists if and only if $\pi < 1/2$.*

To interpret this, recall that, in the absence of yardstick comparisons, the equilibrium would have bad incumbents choosing x_H when the state is $\theta = L$,

yielding a pooling equilibrium. Compared to this benchmark, the case of yardstick competition deviates in three ways. First, a bad domestic incumbent may not be re-elected when he chooses x_H , if the foreign incumbent is good and gets a low cost draw. Second, a good domestic incumbent is retained in office when costs are high, and the foreign politician chooses maximal rents. These changes to voters' strategies reflect the clear-cut information advantage from yardstick competition. Third, pooling may no longer be optimal for incumbents when the foreign incumbent has a poor initial reputation. To see this, observe that the likelihood ratio $\ell(\lambda, \rho, \pi)$ is decreasing in π , as it depends on voters' assessment of the quality of the incumbent in the *other* jurisdiction. Thus facing a foreign incumbent with a low reputation makes it relatively less likely that the (x_H, x_H) outcome is generated by a good domestic incumbent, and hence that voters will re-elect an incumbent who picks x_H . The equilibrium now has the bad incumbent reducing the probability that he chooses \hat{s} in order to raise the signaling value of the outcome x_H . A foreign incumbent with a poor reputation inflicts a reputational externality on a domestic bad incumbent and reduces his incentive to pool with a good incumbent. Moreover, this aspect of yardstick competition increases rent seeking.

3.2 Is yardstick information desirable?

Since improved information available through yardstick comparisons has countervailing effects on incentives and selection of politicians, its net impact on voter welfare is unclear. The following result shows that the reputations of politicians are key to understanding this.

Proposition 3 *There exist parameters $0 < \tilde{\pi}_a < \tilde{\pi}_b < 1/2$ such that voter welfare is lower when yardstick comparisons are available than when they are not if $\pi < \tilde{\pi}_a$, and the converse is true if $\pi > \tilde{\pi}_b$.*

This result emphasizes that voters who are better informed about the fiscal environment may be worse off in equilibrium, as bad politicians put less effort into building a reputation when they first take office. This insight explains the above result. In some circumstances (π low), voters would be better off if they could commit to ignoring the fiscal performance in the other jurisdiction in the course of a domestic election.

The result once again favors the competition when it is more likely that a randomly selected politician is good. This is because yardstick competition

retains incentives of bad politicians to curb their rent seeking and at the same time provides better selection information by comparing outcomes across jurisdictions. Yardstick competition is welfare decreasing when politicians' reputations are poor because rents are increased with little advantage from the improved information generated as most politicians who are kicked out are replaced by an incumbent of the same type.

Clearly there is more work that needs to be done to model the patchwork of real world institutions that serve a collective role in disciplining incumbent behavior in reality.¹⁰

3.3 Economic integration and the relevance of yardstick comparisons

The parameter ρ in the model can be thought of as crudely capturing the similarity of the jurisdictions whose policies are being compared by voters. Increased similarity could be the product of a prolonged period of economic integration. As ρ is increased, then there is a real sense in which yardstick competition is become more relevant.

For the most part, we expect greater relevance of yardstick competition to be welfare improving – it generates a better basis for voter inferences about the likely shocks that underpin other jurisdictions' policy choices. However, in line with the general thrust of our argument, such information can also lead to greater ill-discipline among rent-seeking politicians. In a pooling equilibrium, an increase in ρ has no effect on rent extraction, since bad politicians always choose x_H when the cost is L . However, in a hybrid equilibrium, the probability λ of exercising restraint in rent seeking is determined to keep voters indifferent between electing and not re-electing the incumbent. The equilibrium value of λ will therefore change as ρ increases. The specific consequences are described in:

Proposition 4 *An increase in economic integration as measured by ρ increases expected rent diversion in a hybrid equilibrium. Consequently, voter welfare falls in equilibrium, if initial reputation of politicians π is sufficiently low.*

¹⁰See Besley and Prat (2001) for the beginnings of an analysis of the media in this kind of context.

Thus, in a hybrid equilibrium, an increase in correlation between jurisdictions leads increased expected rent seeking by bad incumbents, because self-restraint becomes less likely to result in re-election.¹¹ Increased rent seeking can be worthwhile only if it results in better selection of incumbents. In a hybrid equilibrium, the magnitude of the improved selection effect is limited, since type (b, L) incumbents adjust their equilibrium strategies to leave voters indifferent between electing the incumbent or challenger when observed spending is high in both jurisdictions. (Nevertheless, an increase in ρ improves the voter's information in the event that maximal spending X is observed in the foreign jurisdiction, so that selection improves overall.) In contrast, pooling equilibrium strategies are unaltered as ρ increases, while selection does improve; a type (b, L) incumbent is more likely to be replaced by the challenger.

If voters use yardstick competition, increased correlation in outcomes across jurisdictions need not be beneficial. The result shows that this depends on how likely it is that politicians are bad. If politicians have good reputations, then yardstick competition is a valuable means of generating better information about the type of the incumbent. However, in a world of poor reputations, rent seeking increases with little commensurate improvement in incumbent selection.

4 Concluding Remarks

Relaxing the assumption of purely benevolent government opens up the possibility that competition between governments raises voter welfare. The analysis in this paper argues that, if the source of non-benevolence is the difficulty of screening good from bad politicians, then the welfare effects of increasing tax competition depend on two (possibly competing) effects. The first is a screening effect whereby competition can change the amount of information that voters have for sorting in good politicians. The second is a discipline effect which reflects how competition affects the amount of rents extracted from voters. We show that competition can sometimes lead to improvement in one of these dimensions while worsening the outcome in the other.

¹¹A more accurate, but perhaps less intuitive, argument is that, as ρ increases, the proportion of bad types that generate x_H must fall in order that voters be indifferent between re-electing the incumbent and replacing him with the challenger.

We have studied two different models of tax competition – that due to resource mobility which raises the marginal cost of public funds and that due to enhanced information flows across jurisdictions. In both cases, there are good reasons for thinking that inter-governmental competition may loosen fiscal discipline by bad incumbents. However, by doing so, more information is generated about incumbent quality.

Overall, we find that competition is most likely to be welfare improving for voters when the prospect of selecting a good politician is high. This is because the screening benefits from competition are likely to dominate any adverse incentive effects. This seems contrary to the spirit of the literature to date which has sought to find competition to be beneficial when we make the most pessimistic assumptions about politicians' motivations. This underlines the importance of basing the analysis on a properly micro-founded analysis of political incentives.

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5 Appendix A: Proofs of Results

Proof of Lemma 1: Here we prove the “if” part of the lemma; the converse can be verified by substitution. Suppose that (4) holds. Then $\hat{s} + \beta\sigma X \leq X$ for all $\sigma \leq 1$, so that $\lambda = 0$ is a best response. When $\lambda = 0$, $\Pr(g|x_H, x_H) = 1$ and voters strictly prefer to re-elect the incumbent when spending is high. This establishes part 3 of the result.

When $q \geq 1/2$, then $\Pr(g|x_H) \geq \pi$ for all $\lambda \leq 1$, implying $\sigma = 1$ is a best response for voters. When (4) does not hold, then $\lambda = 1$ so that only a pooling equilibrium exists. This establishes part 2. When $q < 1/2$, $\Pr(g|x_H) < \pi$ for $\lambda = 1$ (so a pooling equilibrium cannot exist) but $\Pr(g|x_H) = \pi$ when $\lambda = q/(1-q) < 1$. A strictly mixed strategy for type (b, L) is a best response if and only if $\hat{s} + \beta\sigma X = X$, which establishes part 2. \square

Proof of Proposition 1:

$$\frac{\partial EW}{\partial \mu} = q \left[(1 + \beta) + \lambda \frac{1-q}{q} (1 - \pi) \right] \frac{\partial W_g^*(H, \mu)}{\partial \mu} + (1-q) [(1 + \beta) - \lambda(1 - \pi)] \frac{\partial W_g^*(L, \mu)}{\partial \mu} < 0$$

since $\partial W_g^*(\theta, \mu)/\partial \mu < 0$ and $\lambda \leq 1$. \square

Proof of Proposition 2: The only two possible changes in equilibrium strategy are from a pooling equilibrium to a separating equilibrium or from a hybrid equilibrium to a separating equilibrium. As in the text define $\underline{\mu}$ from $s(\underline{\mu}) = (1 - \beta)X$. From Proposition 1, we know that welfare is decreasing locally along the path to $\underline{\mu}$. For $\mu > \underline{\mu}$, welfare will be at its full information value. We now make use of the following result and its corollary.

Lemma 3 *Expected welfare of voters is greater in equilibrium when unit cost θ is unobserved than in the full information case if and only if the discipline effect outweighs the selection effect, viz. if and only if $D(\mu) \geq \beta\pi S(\mu)$.*

Proof of Lemma 3: When voters have full information about θ , the equilibrium outcome is identical to that of the separating equilibrium. Using (8), it is possible to calculate expected welfare for each of the three equilibrium configurations. In the pooling equilibrium,

$$EW^p = (1 + \beta)EW^0 + (1 - \pi)(1 - q)D(\mu) + \beta\pi(1 - \pi)qS(\mu) \quad (13)$$

while in the hybrid equilibrium,

$$EW^h = (1 + \beta)EW^0 + (1 - \pi)qD(\mu) + \beta\pi(1 - \pi)(1 - q)S(\mu) \quad (14)$$

and in the separating (or full-information) equilibrium,

$$EW^s = (1 + \beta)EW^0 + \beta\pi(1 - \pi)S(\mu) \quad (15)$$

The change in equilibrium welfare due to imperfect information is therefore, for the pooling equilibrium,

$$EW^p - EW^s = (1 - \pi)(1 - q) [D(\mu) - \beta\pi S(\mu)] \quad (16)$$

and, for the hybrid equilibrium,

$$EW^h - EW^s = (1 - \pi)q [D(\mu) - \beta\pi S(\mu)] \quad (17)$$

Comparison of these expressions yields the result. \square

We now prove the Proposition. Let π^* solve $D = \beta\pi^*S$ and note $S > D > 0$ implies $\pi^* \in (0, 1)$. If $\pi > \pi^*$, then the improvement in information reinforces that in Proposition 1 and welfare must be globally decreasing in μ . However, if $\pi \leq \pi^*$, then there is discontinuous increase in welfare around $\underline{\mu}$. Thus in a neighborhood of $\underline{\mu}$, voter welfare is increasing which justifies the second claim. \square

Proof of Lemma 2: A pooling equilibrium exists if and only if $\Pr(g|x_H, x_H) \geq \pi$ when $\lambda = 1$ or, recalling (11), if and only if $\ell(1, \rho, \pi) \leq 1$. From the definitions of the conditional probabilities, this in turn holds if and only if

$$(1 - \pi)\rho + \pi(1 - \rho) \leq (1 - \pi)(1 - \rho) + \pi\rho$$

which, since $\rho > 1/2$, simplifies to $\pi \geq 1/2$.

It remains to be determined whether voters choose to re-elect the incumbent when $(x, x') = (x_H, x_L)$ or not. (Only in the latter case does an equilibrium with yardstick competition exist.) At this information set, the posterior probability the incumbent is the good type is

$$\Pr(g|x_H, x_L) = \frac{\pi}{\pi + (1 - \pi)\rho\lambda/(1 - \rho)}$$

Hence $\Pr(g|x_H, x_L) < \pi$ if and only if $\lambda > (1 - \rho)/\rho$. It is immediate this holds in the pooling equilibrium (when $\pi \geq 1/2$) since $\rho > 1/2$. It can also

be established the inequality holds in the hybrid equilibrium (when $\pi < 1/2$). To see this, observe that

$$\ell_\lambda(\lambda, \rho, \pi) = \frac{\ell}{\lambda} + \frac{\lambda}{[\Pr(x_H, x_H|g)]^2} \pi(1-\pi) [\rho^2 - (1-\rho)^2] > 0$$

since $\rho > 1/2$. Thus, since $\ell(\lambda^*, \rho, \pi) = 1$ and

$$\ell((1-\rho)/\rho, \rho, \pi) = \frac{1}{(1-\pi) + \pi\rho^2/(1-\rho)^2} < 1$$

for $\rho > 1/2$, we must have $\lambda^* > (1-\rho)/\rho$. Hence voters remove the incumbent from office when $(x, x') = (x_H, x_L)$ for all values of π . \square

Proof of Proposition 3: Analogous to (8), expected welfare of voters for any equilibrium (λ, σ) is given by:

$$EW(\lambda, \sigma, \rho) = (1 + \beta)EW^0 + \frac{1 - \pi}{2}\lambda D + \beta(\pi_2 - \pi)S$$

where $S > D > 0$ are defined as before. In this expression, the second term represents the discipline effect of elections: with probability $(1-\pi)\lambda/2$, the incumbent is type (b, L) and chooses $s_1 = \hat{s}$ instead of $s_1 = X$. The third term in the expression is the selection effect of elections. Recall that the voter re-elects when $x = x_L$ (which occurs with probability $\pi/2$) and re-elects with probability σ when $(x, x') = (x_H, x_H)$. Further, the incumbent is re-elected in state (x_H, X) if $\Pr(g|x_H, X) > \pi$. The challenger is elected with complementary probability, in which case the posterior probability the second-period incumbent is good is π . Thus π_2 , the probability that a good politician is in office during the second period, satisfies

$$\begin{aligned} \pi_2 = \frac{\pi}{2} + \left(1 - \frac{\pi}{2}\right) \pi + \pi(1-\pi)\sigma (\Pr(x_H, x_H|g) - \Pr(x_H, x_H|b)) \\ + \pi(1-\pi) \max\{\Pr(x_H, X|g) - \Pr(x_H, X|b), 0\} \end{aligned} \quad (18)$$

The conditional probabilities in state (x_H, x_H) are defined in (10). Analogously, the conditional probabilities of (x_H, X) are:

$$\begin{aligned} \Pr(x_H, X|g) &= (1-\pi) \left(\frac{\rho}{2} + \frac{1-\rho}{2}(1-\lambda) \right) \\ \Pr(x_H, X|b) &= (1-\pi) \left(\frac{\rho}{2}(1-\lambda)\lambda + \frac{1-\rho}{2}\lambda \right) \end{aligned}$$

In the absence of yardstick information, the equilibrium is pooling ($\lambda = 1$) and the probability a good official is in office in the second period is

$$\pi_2^{ny} = \pi + \frac{1}{2}\pi(1 - \pi)$$

whereas, in the equilibrium with yardstick competition, (18) simplifies to

$$\pi_2^y = \pi_2^{ny} + \pi^2(1 - \pi) \left(\rho - \frac{1}{2} \right)$$

if the equilibrium is pooling and

$$\pi_2^y = \pi_2^{ny} + \frac{1}{2}\pi(1 - \pi)^2 \max\{1 - (2 - \rho)\lambda + \rho\lambda^2, 0\}$$

if the equilibrium is hybrid. The difference in equilibrium welfare in the two cases is

$$\Delta = EW^y - EW^{ny} = (\lambda - 1)\frac{1 - \pi}{2}D + (\pi_2^y - \pi_2^{ny})\beta S$$

In the pooling equilibrium, which exists if $\pi \geq 1/2$, $\lambda = 1$, so that $\Delta > 0$. In the hybrid equilibrium, we have $\lambda < 1$ and $\pi_2^y \geq \pi_2^{ny}$, so that the first term in the expression is negative and the second is non-negative. When $\pi = 0$, however, $\pi_2^y = \pi_2^{ny} = 0$, so that $\Delta < 0$. Since Δ is continuous in π , the result follows. \square

Proof of Proposition 4: In a hybrid equilibrium, $\pi < 1/2$, and $\lambda^* < 1$ solves $\ell(\lambda^*, \rho, \pi) = 1$, so that

$$\frac{\partial \lambda^*}{\partial \rho} = -\frac{\ell_\rho(\lambda^*, \rho, \pi)}{\ell_\lambda(\lambda^*, \rho, \pi)}$$

where $\ell_\lambda > 0$ was established in the proof of Lemma 2. Observe that

$$\ell_\rho(\lambda^*, \rho, \pi) = \frac{1 + \lambda}{\Pr(x_H, x_H|g)} [(1 - \pi)\lambda^* - \pi]$$

so that $\partial \lambda^* / \partial \rho \geq 0$ if and only if $\lambda^* \geq \pi / (1 - \pi)$. Since $\ell(\pi / (1 - \pi), \rho, \pi) = \pi / (1 - \pi) < 1$ and ℓ is increasing in λ , we must have $\lambda^* > \pi / (1 - \pi)$, and the condition is established. Since welfare is decreasing in ρ through the discipline effect, and the magnitude of the selection effect is proportional to π , the net effect on welfare is negative for π sufficiently small.. \square

6 Appendix B: An Economic Environment

Suppose that there are two private goods denoted by x_1 and x_2 . Good one can be consumed abroad and good two at home or abroad. Assume that there are types of consumers one that have opportunities to purchase x_2 at a foreign price q_f and another group that can buy only at the domestic price $q_2 = p_2 + t_2$ where t_2 is the tax and p_2 is an exogenously given world price. We assume that $q_f < q_2$. The price of good one is $p_1 + t_1$. Let π be the fraction of citizens who can buy the good abroad. Preferences are

$$\phi_1(x_1) + \phi_2(x_2) + z$$

where z is a numeraire untaxed good with price of one. The indirect utility function of the two kinds of consumer is denoted by

$$V(q_1, q_2)$$

for the immobile citizens and

$$V(q_1, q_f)$$

for the mobile. Now consider a Pareto efficient tax structure to raise revenue of R . This will solve

$$\begin{aligned} & \text{Max} V(q_1, q_2) \\ \text{subject to } & V(q_1, q_f) \geq \underline{u} \\ & \text{and} \\ & t_1 x_1(q_1) + t_2(1 - \pi)x_2(q_2) = R. \end{aligned}$$

The shadow price of public funds associated with the revenue requirement of R is the Lagrange multiplier on the final constraint and we can interpret $C(R)$ as $V(p_1 + t_1^*(R), p_2 + t_2^*(R))$ where a $*$ denotes the function that solves the above program given the revenue requirement. We now show that increasing the fraction of mobile consumers is the same as an increase in $C'(R)$. To see this, observe that $C'(R) =$ the shadow price of public funds.

To solve for the effect of a change in π , observe first that t_1 can be obtained by solving $V(p_1 + t_1, q_f) = \underline{u}$ and is independent of π . Then solve for t_2 from $t_1 x_1(q_1) + t_2(1 - \pi)x_2(q_2) = R$. It is easily checked that t_2 is increasing in π . Using the first order condition for the choice of t_2 and rearranging yields:

$$\mu = \frac{1}{1 - \eta_{p_2+t_2}^{t_2}}$$

where η is the price elasticity of demand for good two. It is now straightforward to show that an increase in π increases μ through its effect on t_2 . Hence increase mobility of the tax base leads to a higher marginal cost of public funds.