

Are NIMBY's commuters?

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Abstract

This paper considers a metropolitan area where residents can commute between several jurisdictions. These residents show NIMBY behavior (Not-In-My-Backyard). They try to preserve their living quality by pushing their polluting economic activity to the neighboring jurisdictions, while keeping their labor income as commuters. This induces a race-to-the-top among jurisdictions. Fiercer competition due to a higher number of jurisdictions intensifies this race-to-the-top; commuting costs, pollution taxes, payroll taxes and bigger jurisdictions increase rather than decrease the incentive for more pollution.

Keywords: Commuting, NIMBY, inter-jurisdictional competition, environmental federalism

JEL-classification: H, Q, R

1. INTRODUCTION

We present a theoretical model that can be used to study the environmental policy of small jurisdictions. We highlight the application of the model to the occurrence of NIMBY's (not-in-my-backyard behavior) in (sub-) metropolitan jurisdictions. NIMBY behavior is often observed in projects involving local pollution^{1,2}, such as the location of waste incinerators, landfills, big industrial plants or airports, etc. We show that NIMBY behavior and a race-to-the-top among jurisdictions may originate from inter-jurisdictional commuting. Jurisdictions may set excessively stringent environmental regulations in a common labor market. As the residents of a jurisdiction can commute at a low cost, they do not fully depend on local economic activity for their income. They will try to preserve the environmental quality in their home jurisdiction by pushing polluting economic activity to neighboring jurisdictions, and keep their labor income as commuters. Moreover, this behavior is exacerbated when the rents generated by local pollution do not fully accrue to the residents, but leak (partially) to other jurisdictions. Jurisdictions may thus face a prisoners' dilemma, in which they all push for a level of local environmental quality that is too high (race-to-the-top). Further we show that local payroll taxes (i.e. source-based wage taxes), pollution taxes, positive commuting costs or bigger jurisdictions may increase the pollution level. This paper's race-to-the-top conclusion is in strong contrast to the "business tax models"³ where jurisdictions competing for capital in a world economy tend to allow for too much pollution if only a source-based capital tax is available (race-to-the-bottom). Jurisdictions fear that environmental gains will be more than offset by movement of capital to jurisdictions with lower standards. If each jurisdiction reasons the same way, all will adopt lower standards of environmental quality than they would prefer if they could cooperate in setting higher standards. The desire to coordinate policies motivates the centralized control in the US and EU over environmental policy.

Oates and Schwab (1988) presented the first theoretical objection to the race-to-the-bottom. They show that decentralized regulation may be efficient when the distorting capital taxes are

¹ Frey *et al.* (1996) define NIMBY projects as all undertakings that increase overall welfare (public good) but impose net costs on the individuals living in the host community (private bad).

² Local pollution includes e.g. noise, smell, local air pollution as dust and dirt, decrease of scenic value, etc.

³ Among others, Oates and Schwab (1988), and more generally for local public goods, Wilson (1986) and Zodrow and Mieszkowski (1986)

set to zero and a residence-based lump-sum tax can be used. This result, however, hinges on the assumption that all pollution rents are distributed back to the residents of the jurisdiction. This rent distribution assumption parallels a perfect Pigouvian emissions tax and interferes with the command-and-control policy (Levinson, 1997). Second, Wellisch (1995) observes that pollution rents are in general not confined to jurisdictions, since they are also captured by firms owned by non-residents. The residents bear the entire burden of the pollution and gain few benefits. He concludes that decentralized command-and-control regulation leads to environmental overprotection. Kunce and Shogren (2005a) also allow for non-resident ownership of polluting firms. They state, however, that local governments, facing fiscal constraints (and where no Pigouvian or first-best fiscal instruments are available), adopt capital tax structures that exacerbate inefficiencies of decentralized command-and-control, reducing the overprotection and possibly even leading to a race-to-the-bottom. In a third objection, Glazer (1999) presumes that the benefits gained from firms locating to a jurisdiction are sufficiently small and are overwhelmed by the additional environmental costs. His model for two identical jurisdictions shows that each jurisdiction tries to shift the environmental damage to the other jurisdiction. This happens even when residents of a single jurisdiction own all the firms in that jurisdiction.

Empirical evidence for a race-to-the-bottom is weak at best, and some studies rather suggest a race-to-the-top. Fredriksson and Millimet (2002) find evidence of strategic environmental policy across U.S. states but are unable to conclude if the evidence supports a race-to-the-top or race-to-the-bottom. Fredriksson and Gaston (1999), examine the votes on environmental legislation in the U.S. in state legislatures as well as at the congressional level. They find no tendency for state politicians to vote against environmental measures. List and Gerking (2000) and Millimet (2003) analyze the decentralization of environmental policy under Reagan. List and Gerking (2000) conclude that a race-to-the-bottom in environmental quality did not materialize in the 1980's. Moreover, Millimet (2003) finds strong evidence that decentralized environmental policy contributed to a race-to-the-top in abatement expenditures. Fredriksson *et al.* (2004), however, point out that the previous literature considers strategic interaction in a uni-dimensional framework. Jurisdictions may respond to a more lenient environmental policy from their neighbors not only by lowering their environmental standards, but also by lowering state-level

taxation or increasing infrastructure spending. Their result suggests that important own- and cross-policy interactions exist. They conclude that the literature covering uni-dimensional frameworks presents lower bound estimates of the degree of strategic interaction.

The previous theoretical papers focus on firm and capital mobility in the tradition of the business-tax models. NIMBY behavior and environmental quality in residential areas and commuting belts, however, have received less attention. Fischel (2001a, 2001b) argues that greater decentralization may lead to a NIMBY reaction by homeowners. A home is the largest asset most people own and owners cannot insure against devaluation by neighborhood effects. Because their assets would be devalued by pollution, local governments are cautious in admitting new industries and developments. Frey *et al.* (1996) analyze why compensation schemes dealing with NIMBY behavior frequently fail. They state that traditional economic theory of compensation is incomplete because it neglects the influence of moral principles. In political decision making, such moral considerations weaken the effects of price incentives. Levinson (1999) studies state taxes on hazardous waste disposal. Hazardous waste disposal confers few benefits on local jurisdictions and has high perceived costs. States have an incentive to set waste tax levels too high. Further, Levinson shows empirically that state hazardous waste taxes matter. He concludes that devolved environmental policy is inefficient. Fredriksson (2000) develops a political economy model for the siting of hazardous waste disposal facilities in a federal system with many small jurisdictions. He concludes that the lower government levels in federations should get the authority over siting decisions. The centralized government faces a greater obstacle in the compensation effort, as each jurisdiction has an incentive to favor capacity in the other jurisdictions. Feinerman *et al.* (2004) develop a model where the government of a two-city economy determines the location of a noxious facility. The government is subject to political pressures by city-level lobbies of landowners. In the empirical section, they assess the prospects of the political system for resolving the NIMBY conflict over locating a landfill-site in a multiple-city region in Israel. Cavailhès *et al.* (2004) study the periurban belt around poles of economic activity. They explain that households value rural amenities and hence, may live close to farmers. These households commute to their jobs.

Our paper explains how the very nature of commuting may induce a race-to-the-top/ NIMBY behavior between small jurisdictions. So far, most NIMBY studies have focused on hazardous

waste, landfills and other noxious installations. We believe that our paper is applicable to a wider range of local environmental problems. Methodologically, the model builds on the model of Braid (1996). In his analysis of tax competition in metropolitan areas, commuting takes the form of factor movement, i.e. jurisdictions compete for labor force. This approach differs from most commuting papers which focus on congestion or firm-worker matching on the labor market⁴.

Our model has three main features. First, the model has three levels. We discuss a metropolitan area in a world economy, and this metropolitan area has a number of jurisdictions⁵. These jurisdictions have Nash interactions, using local environmental quality as strategic variable. The metropolitan government is merely a referee, guaranteeing the legal order. Second, output is produced using labor and pollution. Jurisdictions produce a single good, which is sold on the world market for a normalized price of 1. We assume that pollution is local and does not cross the jurisdictional borders⁶. Third, the most important feature of the model is that Nash interactions occur in the common labor market. Residential locations are fixed⁷, but the consumers who live in one jurisdiction can commute to work in any of the other jurisdictions. Thus each jurisdiction is able to influence the wage of the common labor market.

Section 2 develops a symmetric model. Section 3 gives the socially optimal outcome. In section 4 we find that the model without taxes leads to a race-to-the-top. Section 5 discusses the effect of lump-sum, payroll and pollution taxes on the environmental policy of jurisdictions. In section 6 we look at positive commuting costs and non-identical jurisdictions. We conclude in section 7.

2. MODEL

We consider a metropolitan area in a world economy with n identical jurisdictions (indexed by i). In each jurisdiction we find a single industry, comprised of fixed number of identical polluting firms⁸. Industry output is produced using mobile labor (N_i) and local pollution (P_i). N_i is the

⁴ Papers analyzing congestion or labor market in presence of commuting include, among others, Anas and Xu (1999), Zenou (2000), De Borger and Van Dender (2003), Borck and Wrede (2005) and de Palma and Proost (forthcoming).

⁵ Jurisdictions are defined as counties, municipalities and districts in metropolitan areas.

⁶ For more on transboundary pollution see, e.g. Baumol and Oates (1988) or Silva and Caplan (1997)

⁷ This assumption is realistic in cases where transaction costs of moving are high due to the tax structure on the housing market, most European countries being examples.

⁸ The number of firms in the jurisdictions is fixed and large. Kuncze and Shogren (2005b) point out that a fixed number of firms correspond to a long-run equilibrium.

endogenous number of workers in jurisdiction i , each supplying one unit of labor; whereas N_0 represents the fixed number of residents in each jurisdiction. The residents cannot migrate to other jurisdictions. We treat pollution in a jurisdiction (P_i) as an input to local production. The pollution externalities only hurt the residents in the jurisdiction where they are created. Contrary to most of the inter-jurisdictional competition literature, this model concentrates on location choices of labor rather than on firm, capital or population mobility.

The total production of the identical firms in jurisdiction i is determined by the constant-returns-to-scale neo-classical production function $F(N_i, P_i)$, which is homogeneous of degree one. We assume that F_N , F_P and F_{NP} are positive⁹, and that F_{NN} and F_{PP} are negative. This guarantees that a perfect competition solution exists.

3. SOCIAL OPTIMUM

Social optimum requires the maximization of the residents' utility in jurisdiction 1 (U^1)¹⁰. We assume that U^1 is a strictly quasi-concave function, decreasing in aggregate emissions ($U_P < 0$), and increasing in per-capita consumption per capita ($U_C > 0$). This maximization problem is subject to 3 constraints. First, the utility of all other jurisdictions remains constant¹¹. Second, the aggregate consumption equals the aggregate production (3). Third, total labor demand equals total available labor (4). The social optimum becomes¹²

$$\max_{N_1, C_1, P_1} U^1(C_1, P_1) \quad (1)$$

Subject to
$$U^2(C_2, P_2) = \bar{U}^2 \quad (2)$$

$$F(N_1, P_1) + (n-1)F(N_2, P_2) = N_0 [C_1 + (n-1)C_2] \quad (3)$$

$$N_1 + (n-1)N_2 = nN_0 \quad (4)$$

⁹ A positive F_{NP} means that labor and pollution are complements. This is realistic with strongly aggregated inputs as in this model. For more properties of the production function $F(N,P)$, see Appendix A.

¹⁰ The representative jurisdiction is denoted as jurisdiction 1; the other jurisdictions are represented by jurisdiction 2.

¹¹ Wellisch (1995) and Kuncze and Shogren (2005a,b) use a similar approach for the social optimum. We implicitly assume perfect redistribution possibilities across jurisdictions. Under this condition, it is sufficient to maximize utility of jurisdiction 1 keeping the utilities of the other jurisdictions constant.

¹² Saveyn (2006) shows all derivations of this paper in detail.

We ignore the corner solutions (i.e. $N_1 > 0$ and $N_2 > 0$) and the following optimal conditions characterize a social optimum.

$$-N_0 \frac{U_P^i}{U_C^i} = F_P^i \quad \forall i=1,2 \quad (5)$$

$$F_N^1 = F_N^2 \quad (6)$$

Equation (5) says that the each jurisdiction chooses the consumption and pollution level such that the marginal rate of substitution between the two, summed over all jurisdictional residents equals the marginal product of environment (F_P). This corresponds to the Samuelson Rule for optimal pollution, where the left-hand side of the equation equals the marginal willingness to pay for the environment. If it did not hold in some jurisdiction, then it would be possible to change the pollution level in that jurisdiction so as to increase welfare. Equation (6) shows that the marginal product of labor is equal across jurisdictions. If this did not hold, it would be possible to increase welfare by commuters moving from a jurisdiction where the marginal product of labor is low to a jurisdiction where it is high.

4. NASH EQUILIBRIUM WITHOUT TAXES

We are interested in a symmetric Nash equilibrium¹³ with the local pollution level as the strategic variable. Following the command-and-control strategy of Oates and Schwab (1988) and Kuncce and Shogren (2005a,b), each jurisdiction sets the aggregate local pollution level, P_i . In order to derive the equilibrium, it is sufficient to consider the environmental policy of a representative jurisdiction, denoted as jurisdiction 1, subject to the exogenous environmental policy of the other $n-1$ identical jurisdictions, denoted as jurisdiction 2. The location choice of labor in the jurisdictions is endogenous.

Jurisdiction 1 chooses P_1 to maximize the utility of a representative resident (7) subject to its budget constraint (8) and taking P_2 as given. The consumption of all residents in jurisdiction 1

¹³ The Nash equilibrium is the standard equilibrium concept in fiscal competition. Its existence and uniqueness is among the most persisting problems in fiscal federalism. Most authors merely assume the existence of the equilibrium. The few authors dealing with the existence problem have encountered very demanding assumptions (e.g. Bucovetsky, 1991; Laussel and Le Breton, 1998). Bayindir-Upmann and Ziad (2005), however, relax the demanding assumptions of the Nash equilibrium, using the concept of 2nd-order locally consistent equilibrium (2-LCE) for the Zodrow and Mieszkowski fiscal competition model. The 2-LCE concept ensures that a set of local maxima is reached in equilibrium.

consists of the wage (w) and their share in the pollution rents of the metropolitan area (R_i). We assume that the residents of all jurisdictions own an equal share of all firms. Hence, the pollution rents generated in the metropolitan area are distributed equally across all residents of all jurisdictions. In this stage we have not yet incorporated the local non-environmental public goods provided by the local government. We introduce them in section 5.

$$\max_{P_i} U(C_1, P_1) \quad (7)$$

Such that
$$N_0 C_1 = N_0 w + \frac{R_1 + (n-1)R_2}{n} \quad (8)$$

The basic equilibrium conditions determine w , N_i and R_i as function of P_i ¹⁴

$$N_1 + (n-1)N_2 = nN_0 \quad (4)$$

$$w = F_N(N_i, P_i) \quad (9)$$

$$R_i = F_P(N_i, P_i) \square P_i \geq 0 \quad (10)$$

The total number of residents in each jurisdiction is fixed (4). Workers can commute between jurisdictions at zero cost¹⁵. This assures that the same endogenous net wage rate, w , prevails across all jurisdictions (9). The firms use environmental resources for production at zero cost and, hence, pollution generates pollution rents¹⁶, R_i (10). As labor can commute freely the equilibrium need to observe (4) and (9). The comparative-static derivative of labor in a jurisdiction (9) w.r.t. local pollution level and evaluated at the symmetric equilibrium gives the following result

LEMMA 1: In a symmetric Nash equilibrium (N_e, P_e), the equilibrium quantity of labor in a jurisdiction is related to the local pollution level as follows

$$\frac{\partial N_1}{\partial P_1} = -\frac{n-1}{n} \frac{F_{NP}}{F_{NN}} \quad (11)$$

No jurisdiction faces an incentive to deviate unilaterally from its equilibrium strategy by some small readjustment of its strategy variable. Whether these relaxed assumptions also apply for this model is a topic for future research.

¹⁴ The non-index subscripts denote partial derivatives.

¹⁵ For the sake of simplicity, we assume costless commuting. We relax this in section 6.

¹⁶ From the linear homogeneity of production

Equation (11) states that an increase of the local pollution level attracts more labor to jurisdiction 1. Obviously, eq. (11) becomes zero for a unique jurisdiction ($n=1$). For an infinitely high number of jurisdictions ($n \rightarrow +\infty$), it converges to $-F_{NP}/F_{NN}$, the marginal rate of substitution of pollution for labor.

We illustrate the inefficiencies arising with decentralized decision-making. In a symmetric equilibrium all endogenous variables are identical for all n jurisdictions¹⁷. The symmetric Nash-equilibrium values of the pollution levels for jurisdictions are

PROPOSITION 1: In a symmetric Nash equilibrium (N_e, P_e) , a jurisdiction, chooses a pollution level, P_e , such that

$$-N_0 \frac{U_P}{U_C} = \frac{F_P}{n} \quad (12)$$

Equation (12) shows that the decentralized environmental policy differs from the social environmental efficiency (5). In the symmetric Nash equilibrium, every jurisdiction reduces marginal environmental damage to a level that is too low. It considers only $1/n$ of the marginal product of pollution, instead of the full marginal product. The full benefits of pollution do not accrue to the residents due to two leakages. First, because firms are not fully locally owned, pollution rents leak to the other jurisdictions. Second, and more interestingly, wages leak to other jurisdictions too due to commuting. Stated differently, jurisdictions are not fully dependent on the economic activity within their borders. The residents of jurisdictions benefit little from local pollution, but they carry the full burden of the local pollution. The jurisdictions have incentives to set excessively restrictive pollution standards.

Number of jurisdictions

The degree of competition among jurisdictions depends on the number of jurisdictions, n , in the metropolitan area. A higher number of jurisdictions induce more competition. In order to make our point clear, we look at two extreme cases, a single-jurisdiction metropolitan area ($n=1$) and a metropolitan area with an infinite high number of jurisdictions ($n \rightarrow +\infty$).

¹⁷ In the symmetric equilibrium (N_e, P_e) we find that $N_0=N_1=N_2=N_e$, $R_1=R_2=R_e$ and $P_1=P_2=P_e$

COROLLARY 1: A single-jurisdiction metropolitan area, chooses an optimal pollution level, P_e , such that,

$$-N_0 \frac{U_P}{U_C} = F_P \quad (13)$$

And, in a symmetric Nash equilibrium (N_e, P_e) , a jurisdiction in a metropolitan area with an infinite number of jurisdictions, chooses a pollution level P_e , such that

$$-N_0 \frac{U_P}{U_C} \rightarrow 0 \quad (14)$$

In a single-jurisdiction metropolitan area there is no commuting and the firms are fully locally owned. Hence, there are no leakages and the local government chooses the socially efficient level of pollution (13). With an infinite number of jurisdictions, a single jurisdiction is a price-taker on the common labor market. It does not have any market power and its environmental policy does not influence the common net wage. Moreover, the pollution rents are dissipated across all jurisdictions. Hence, the leakages reduce the benefits of local pollution to zero, whereas the residents of the jurisdiction still carry the full burden of local pollution. The local government behaves like an extreme NIMBY and it sets the pollution level at zero (14).

5. NASH EQUILIBRIUM WITH TAXES

We discuss the effect of taxes on the environmental policy of jurisdictions. We look, successively, at three types of taxes, a resident-based income tax (a_i), a source-based pay-roll tax (b_i) and a pollution tax (t_i). We assume, for the sake of simplicity, that the tax revenues are distributed in a lump-sum way to the jurisdiction's residents. Implicitly, this presumes that non-environmental public goods are provided efficiently (i.e. the marginal rate of substitution between public and private consumption is 1). In the symmetric equilibrium, the tax rates are equal across the jurisdictions, $a_1=a_2=a_0$, $b_1=b_2=b_0$, $t_1=t_2=t_0$.

Income Tax

The residence-based income tax, a_i , is equivalent to a lump-sum tax since residents do not migrate and labor-leisure choice is ignored in this paper. There is no way to avoid this labor income tax. This tax does not change the basic equilibrium conditions (4), (9) and (10), and the

total income of all residents in jurisdiction 1 is identical to eq. (8). The analysis gives the same results as for the symmetric model without taxes (12). Again, a single-jurisdiction metropolitan area provides the socially efficient level of pollution (13), whereas with an infinite number of jurisdictions there is no pollution admitted (14).

Pay-roll Tax

The source-based pay-roll tax, b_i , is distorting as the pay-roll tax can be avoided through commuting. Basic equilibrium condition (9), determining the wage level, changes into

$$w = (1 - b_i)F_N(N_i, P_i) \quad (15)$$

Now, the consumption of all residents in jurisdiction 1 consists of the net wage of these residents, their share in the pollution rents of the metropolitan area and the local payroll tax revenues.

$$N_0 C_1 = N_0 w + \frac{R_1 + (n-1)R_2}{n} + b_1 F_N N_1 \quad (16)$$

Jurisdiction 1 chooses P_1 and b_1 to maximize the utility of a representative resident (7) subject to its budget constraint (16) and taking P_2 and b_2 as given. The first-order conditions for the jurisdiction's problem are

$$-N_0 \frac{U_P}{U_C} = \frac{F_P}{n} - \frac{n-1}{n} b_1 \frac{F_N F_{NP}}{F_{NN}} \quad (17)$$

$$b_1 = -\frac{F_{NN}}{F_N} N_0 \quad (18)$$

Combining (17) and (18), results in

PROPOSITION 2: In a symmetric Nash equilibrium (N_e, P_e) , a jurisdiction, using a payroll tax, chooses a pollution level, P_e , such that

$$-N_0 \frac{U_P}{U_C} = \frac{F_P}{n} + \frac{n-1}{n} F_{NP} N_0 \quad (19)$$

Equation (19) shows that the payroll tax reduces the race-to-the-top. Moreover, with $N_0 F_{NP} > F_P$, the pollution level is higher than the social efficiency. The payroll tax alleviates the leakage of

wage income through commuting, as all workers (incl. commuters) contribute to the budget of the jurisdiction where the firm is located. The leakage of pollution rents, however, persists. The payroll tax gives an incentive to increase the pollution level. The local government sets less restrictive pollution standards than with a lump-sum tax, but this may still be lower than the optimal level.

COROLLARY 2: A single-jurisdiction metropolitan area, using a pay-roll tax, chooses pollution levels, P_e , such that,

$$-N_0 \frac{U_P}{U_C} = F_P \quad (20)$$

And, in a symmetric Nash equilibrium (N_e, P_e) , a jurisdiction in a metropolitan area with an infinite number of jurisdictions, using a payroll tax, chooses pollution level P_e , such that

$$-N_0 \frac{U_P}{U_C} \rightarrow F_{NP} N_0 \quad (21)$$

A single-jurisdiction metropolitan area provides the socially efficient level of pollution (20). With an infinite number of jurisdictions, the government sets the pollution level higher than zero (21).

Pollution Tax

The pollution tax is an alternative instrument to the pollution standard. The local governments specify a tax that firms pay for pollution. The first best optimal tax for pollution becomes

$$F_P = t_i \quad (22)$$

Firms consider the pollution tax, t_i , as a parameter and pollute to the point where the marginal product of pollution equals the pollution tax. The basic equilibrium condition (10), determining the rent, changes into

$$R_i = F_P P_i - t_i P_i \quad (23)$$

The local government returns the pollution tax revenues to its residents in a lump-sum way. The income constraint for the residents becomes

$$N_0 C_1 = N_0 w + \frac{R_1 + (n-1)R_2}{n} + t_1 P_1 \quad (24)$$

This income consists of the net wage of these residents, the pollution tax revenues and their share in the pollution rents of the metropolitan area. These pollution rents, however, are zero as every jurisdiction taxes them away. Jurisdiction 1 chooses t_1 to maximize the utility of a representative resident (7) subject to its budget constraint (24). The pollution level, P_i , is not exogenously set; it is determined indirectly through the jurisdiction's choice of t_i . The symmetric values of the pollution levels for jurisdictions are

PROPOSITION 3: In a symmetric Nash equilibrium (N_e, P_e) , a jurisdiction, using a pollution tax, chooses a pollution level, P_e , such that

$$-N_0 \frac{U_P}{U_C} = F_P \quad (25)$$

We see that when all jurisdictions of the metropolitan area use a pollution tax to regulate the pollution level, these jurisdictions provide the socially optimal level of environmental quality. If the pollution tax revenues are distributed among the jurisdictional residents, the rent from local pollution is internalized. The jurisdictions have incentives to increase the pollution level. As all jurisdictions increase the pollution level, this has a positive effect on the common labor market wage. The combined effect leads to the socially efficient pollution level. We conclude that the pollution tax, t_i , is a Pigouvian instrument to realign the overprotection result of devolved environmental policy. This result is similar to the outcomes of Wellisch (1995) and Kuncze and Shogren (2005a). In these papers the pollution tax only corrects for one leakage, namely, the non-resident ownership of mobile firms. In this paper, however, the pollution tax corrects two leakages, namely, the foreign-ownership of the firms and the leakage through commuting.

6. COMMUTING COSTS AND ASYMMETRIC JURISDICTIONS

We introduce a fixed positive commuting cost ($c \geq 0$) and asymmetric jurisdictions, respectively.

Non-zero commuting cost

With a non-zero commuting cost, the commuters lose a part of the wage they earn in other jurisdictions. Hence, they prefer to look for a job in their own jurisdiction in the first place. Equations (26) and (27) describe the relations between the wages in the jurisdictions. The commuting cost spans the gap between the wages in jurisdictions. These relations hold only as

long as all wages are positive ($w_2=w_1-c \geq 0$ or $w_1=w_2-c \geq 0$). If c is high ($w_1-c < 0$ or $w_2-c < 0$), there is no longer commuting and eq. (26) and (27) do not longer hold. The wages are independent from the other jurisdictions.

$$w_1 = w_2 - c \geq 0 \quad \text{if } N_1 < N_0 < N_2 \quad (26)$$

$$w_2 = w_1 - c \geq 0 \quad \text{if } N_2 < N_0 < N_1 \quad (27)$$

If $w_2-c \geq 0$, the consumption of all residents in jurisdiction 1 consists of the wage of the residents working in jurisdiction 1, the wage of the residents working in jurisdiction 2 (if any) and their share in the pollution rents of the metropolitan area.

$$N_0 C_1 = N_1 w_1 + (N_0 - N_1)(w_2 - c) + \frac{R_1 + (n-1)R_2}{n} \quad (28)$$

If $w_2-c < 0$, the commuting cost is too high and the residents in jurisdiction 1 do not commute. Consumption in jurisdiction 1 consists of the wage of the residents working in jurisdiction 1 and their share in the pollution rents of the metropolitan area.

$$N_0 C_1 = N_0 w_1 + \frac{R_1 + (n-1)R_2}{n} \quad (29)$$

Jurisdiction 1 chooses P_1 to maximize the utility of a representative resident (7) subject to its budget constraint (28) or (29) and taking P_2 as given. The symmetric Nash-equilibrium values of the pollution levels are

PROPOSITION 4: In a symmetric Nash equilibrium (N_e, P_e) and with a positive commuting cost ($c > 0$), a jurisdiction, chooses a pollution level, P_e , such that

If $w_1=w_2-c \geq 0$,

$$-N_0 \frac{U_P}{U_C} = \frac{F_P}{n} - \frac{n-1}{n} \frac{F_{NP}}{F_{NN}} c \quad (30)$$

Or if $w_1=w_2-c < 0$,

$$-N_0 \frac{U_P}{U_C} = \frac{F_P}{n} + \frac{n-1}{n} N_0 F_{NP} \quad (31)$$

Equation (30) equals (31), if

$$c = -N_0 F_{NN} \quad (32)$$

Equations (30) and (31) are generalizations of the conventional result (12). Setting the commuting cost to zero ($c=0$) in (30) results in F_P/n . With $n=1$, we find the social optimum, the conventional result for a single-jurisdiction metropolitan area (13). Without commuting (31), there is only one leakage left, the redistribution of the pollution rents. Indeed, very high commuting costs give the same pollution levels as the equilibrium with a payroll tax (19). The policy implication is that low commuting costs (e.g. through subsidies) enhance NIMBY behavior and may lead to inefficiently low levels of pollution.

Asymmetric model

In the real world, urban areas typically consist of a central city surrounded by small suburbs. In many metropolitan areas in the US, the central city has about 25-30% of the metropolitan population (Braid, 2005). We construct an asymmetric model with jurisdiction 1 of size $\beta=m$ and $(n-m)$ jurisdictions 2 of size $\beta=1$. Basic equilibrium condition (4) changes into

$$mN_1 + (n-m)N_2 = nN_0 \quad (33)$$

The consumption of the residents in jurisdiction i (34) consists of the wage of the residents and their share in the pollution rents of the metropolitan area.

$$\beta N_0 C_i = \beta N_0 w_i + \beta \frac{R_1 + (n-m)R_2}{n} \quad (34)$$

Jurisdiction i chooses P_i to maximize the utility of a representative resident (7) subject to its budget constraint (34) and taking the pollution of the other jurisdictions as given. The Nash-equilibrium value of the pollution level for jurisdiction i is

PROPOSITION 5: In an asymmetric Nash equilibrium (N_i, P_i) , jurisdiction i of size β chooses a pollution level, P_i , such that

$$-\beta N_0 \frac{U_P^i}{U_C^i} = \frac{\beta}{n} F_P^i \quad (35)$$

Equation (35) is a generalization from the result for a symmetric model (12). Both small and big jurisdictions set their pollution level, respecting eq. (35). If jurisdiction i is of size $\beta = 1$, then we

get a result identical to the symmetric model (12). Bigger jurisdictions ($\beta > 1$) allow for more pollution. With size $\beta = n$, we get the socially optimal level of pollution, F_p . In Saveyn (2006) we show that for models with two different sizes of jurisdictions, the Nash equilibrium is independent from the size of the other jurisdictions in the metropolitan area.

The asymmetric model responds better to the reality of a metropolitan area. Here, we often observe a big core with a commuting belt or dormitory towns around it. Most economic activity happens in the core, whereas the dormitory towns care more about their living quality. Our result also suggests that we may solve NIMBY problems by bringing the jurisdictions under a common metropolitan government. This solution is an alternative to the use of taxes.

7. CONCLUSIONS

This paper helps to explain why NIMBY behavior is observed in the “green” dormitory towns or commuter belt with a high proportion of active participants in the economy. Our paper considers inter-jurisdictional competition where the jurisdictions interact through a common labor market. The main results differ in character from those of the traditional “business-tax competition models”. The inter-jurisdictional competition on the labor market leads to a race-to-the-top, as commuters prefer to work in the other jurisdictions, while preserving a high environmental quality in their home jurisdiction. Fiercer competition due to an increasing number of jurisdictions intensifies this race-to-the-top.

It is useful to discuss the policy implications of our results. First, we show that jurisdictions can (imperfectly) correct the race-to-the-top using payroll taxes and pollution taxes. The payroll tax corrects the wage leakage through commuting. The loss of pollution rents, however, persists. Although, the use of payroll taxes leads to higher pollution levels, the optimal level is not guaranteed. The pollution tax, however, is a Pigouvian instrument, leading to the socially efficient pollution levels. In most countries, the higher-governments limit the policy instruments that local governments can use, thereby possibly reducing the scope for alleviating NIMBY behavior through taxes. In e.g. Japan, Germany, Sweden and Denmark, income taxes make up most of the local tax revenue. In the US, however, only 16 out of the 50 states allow local governments to use wage or income taxes. Payroll taxes are merely used in 5 states. In the

Anglo-Saxon world property taxes are by far the most important source of local tax revenue¹⁸ (Braid, 2005). In other countries, the local tax revenues are more balanced between different taxes. In Belgium, municipalities levy, on average, around 20 different taxes. Taxes account for about 47% of the local budget; the remainder being (mainly) covered by dividends from gas and electricity utilities (9%) and transfers from higher government levels (40%). The residence-based income taxes and property taxes make up about 20% of the total municipal budget each. Taxes on firm profits or environmental taxes are relatively insignificant at the lowest government level (2% and 3% of total local budget, respectively).

Further, we find that low commuting costs enhance the NIMBY behavior of small jurisdictions. Positive commuting costs have a similar effect as the payroll tax. They limit or stop wage leakage through commuting but the leakage of pollution rents persists. This result adds to the discussion about the goods and the ills of subsidizing commuting. In many countries, commuters may not pay their full costs since transport is subsidized in many ways. Moreover, countries like Germany, France and Belgium, allow taxpayers to deduct commuting expenses from their income tax liability (Borck and Wrede, 2005).

Finally, we find that bigger jurisdictions are less prone to race-to-the-top competition. They can keep higher shares of the benefits, wages and pollution rents within their borders. One may solve the inefficiencies by fusing jurisdictions or transferring the environmental competencies to the metropolitan government. Apart from the institutional complications, it is very unlikely that this measure would solve the existence of geographically well-defined NIMBY groups within the metropolitan area.

The interesting results of this paper open the scope for future research. Empirical evidence is needed to show whether intensive commuting corresponds to a race-to-the-top in environmental quality, or, whether jurisdictions with a high share of commuters in their labor force have a different reaction function to the environmental policy of other jurisdictions. Moreover, it is an interesting task to reconcile the race-to-the-top of this paper with the race-to-the-bottom of the traditional business tax models. An obvious approach is to model explicitly the market for mobile

¹⁸ To make our main point clear, this paper does not include the capture of the market for fixed or mobile industrial property/capital.

capital in a two-level government framework, e.g. a metropolitan area with sub-metropolitan jurisdictions. The sub-metropolitan jurisdictions take into account the effect of commuting as in this paper. The government of the metropolitan area, however, considers commuting as an intra-metropolitan affair and behaves like the jurisdictions in the tax business models.

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