

Minimum Tax and Repeated Tax Competition*

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Abstract

The possibility of cooperation through implicit contracts is analyzed in a repeated tax competition framework. It is shown that a non-binding tax floor (or ‘minimum tax’) may harm cooperation and reduce welfare.

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1 Introduction

The recommendation for countries to agree on a lower bound to admissible corporate tax rates (a ‘minimum tax’) has been made repeatedly in recent years, especially in the context of the European Union. As a prominent example, the so-called Ruding Committee (Report of the Committee of Independent Experts on Company Taxation, 1992) proposed setting a minimum corporate tax rate of 30% in the EU. The recommendation for a minimum tax is based on the

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view that countries, engaged in a competition for mobile resources like capital investment, are forced to lower their tax rates to sub-optimal levels. A minimum tax, in this view, could halt the ‘race to the bottom’ and thus make all countries better off.

This argument rests on a static theory of tax competition as presented in the first theoretical analyses of the subject.¹ In these models countries finance a public good by raising revenue from a mobile tax base (capital) at source. Departing at the uniform tax rate that maximizes global welfare, an individual country can raise its own tax revenue (and welfare) by reducing its tax rate; attracting a larger share of the global tax base at the expense of other countries. Countries thus face a collective action problem: each profit by individually lowering the tax rate but all suffer after others lowered theirs as well. As a consequence, the Nash equilibrium is not Pareto efficient, and a minimum tax that raises tax rates above the Nash equilibrium is welfare-improving.²

But is a minimum tax Pareto improving if tax competition occurs repeatedly rather than as a one-shot interaction? This appears to be a natural question since countries are indeed long-lived, if not immortal, entities. The present paper analyzes tax competition as an infinitely repeated game to address this question.

The main result of this paper is that a minimum tax above the static Nash-equilibrium tax rate may reduce the welfare of all countries. The reason is that repeated interaction allows countries to sustain cooperation through implicit contracts. Lower bounds on tax rates restrict the ability of countries to punish deviators. This makes cooperation harder to sustain.

The present work is related to three strands of literature. First, the static theory of tax competition, as described above, is understood to imply that a

¹See, e.g., Zodrow and Mieszkowski (1986), Wilson (1986) and Wildasin (1988). A detailed survey is provided by Fuest et al. (2005).

²This insight from analyses on symmetric countries generalizes for cases where countries are not very asymmetric. Asymmetry introduces redistributive issues; see, e.g., Bucovetsky, 1991; Kanbur and Keen, 1993.

minimum tax cannot be harmful (except, perhaps, at an extremely level).³ The present paper offers a reassessment of this view.

Second, this paper contributes to the small literature studying repeated tax competition. In an early study in dynamic tax competition, Coates (1993) uses a dynamic setting to introduce long-term effects of capital movements to a model with two tax instruments. Kessing et al. (2006) analyze the effect of vertical tax competition on foreign direct investment, where repeated interaction allows the parties to overcome the hold-up problem. Most related to the present analysis is the work of Cardarelli et al. (2002) who study tax harmonization sustained by implicit contracts. As a difference to the present analysis, none of these studies analyzes the effect of a minimum tax.

Finally, the argument that a minimum tax can be harmful in repeated tax competition has parallels in the study of oligopoly in industrial organization. Known in that context as the ‘topsy-turvy principle’ (see Shapiro 1989), the observation has been made that market conditions making very competitive behavior feasible may actually promote collusion.

2 The Analysis

Consider an economy with infinite time horizon with periods $s = 1, 2, \dots$. There are N identical countries. In each period each country takes a single action, setting a tax rate on a mobile tax base (capital) at source. The tax rate set by country $i \in \{1, \dots, N\}$ in period s is t_i^s , taken from the compact set $T_i \equiv [0, 1]$.

Let the one-period payoff of country i be $V_i(t_1, \dots, t_N)$. Countries discount the future by a common discount factor $\beta \in (0, 1)$. The present discounted value of payoffs for country i in period 1 is then

$$PV_i = \sum_{s=1}^{\infty} \beta^s V_i(t_1^s, \dots, t_i^s, \dots, t_N^s). \quad (1)$$

³An instance of harmful minimum taxes has, however, been described by Konrad (2009) in a one-shot setting of Stackelberg structure.

The following assumptions impose some structure on the stage game.⁴ Let $V_i(t_1, \dots, t_N)$ be twice continuously differentiable and strictly quasi-concave in all tax rates. This implies that the iso-payoff curves are convex to the origin. Also, let $V_i(t_1, \dots, t_N)$ be increasing in all t_j with $j \neq i$. The payoff of a country is increasing in the tax rate of the other countries, reflecting one of the main insights of standard tax-competition models, the so-called ‘tax base effect’: If a country increases its tax rate, leaving the tax rates in other countries unchanged, some (but not all) of its capital relocates to the other countries. Further, let $\arg \max_{t_i \in [0,1]} V_i(t_1, \dots, t_N) \in (0, 1)$ be single-valued and increasing in all t_j , $j \neq i$. Thus, reaction functions $t_i(t_{-i})$, where $t_{-i} = (t_1, \dots, t_{i-1}, t_{i+1}, \dots, t_N)$, are well-defined and tax rates are strategic complements.⁵ Below it will be convenient to use the notation $V_i(t_i, t_{-i})$.

Under these assumptions a symmetric Nash equilibrium of the stage game exists, and in what follows it will be assumed to be the unique Nash equilibrium.⁶ Let t^N denote the Nash-equilibrium tax rate. Note that the Nash equilibrium does not maximize the countries’ joint welfare: since one country’s higher tax rate has a positive external effect on all others, a concerted increase of tax rates from t^N would leave all countries better off. (Formally, $\partial V_i(t, \dots, t)/\partial t > 0$ for $t = t^N$ because $\partial V_i(\cdot)/\partial t_i = 0$ and $\partial V_i(\cdot)/\partial t_j > 0$, $j \neq i$.)

A jointly welfare-maximizing tax rate $t^C = \arg \max_{t \in [0,1]} V_i(t, \dots, t)$ exists by virtue of the boundedness of the range of possible tax rates; and by strict quasiconcavity, it is unique. Hence, it must be that $V_i(t^C, \dots, t^C) > V_i(t^N, \dots, t^N)$; that $\partial V_i(t, \dots, t)/\partial t > 0$ for all $t < t^C$; and therefore $t^C > t^N$. In what follows, t^C will be referred to as the ‘cooperative’ or ‘efficient’ tax rate.

Figure 1 depicts a simple graphic representation of the stage game. It gives an intuition why, when tax rates are strategic complements as is natural in price

⁴A similar ‘reduced-form’ approach has been taken by Konrad and Schjelderup (1999). The present setup is compatible with the properties of the standard model by Zodrow and Mieszkowski (1986).

⁵Strategic complementarity is a common feature of tax competition models; see, e.g., Wildasin (1991), Wilson (1991) and Kanbur and Keen (1993).

⁶Uniqueness is not crucial for the results of this paper, but it simplifies the exposition.

competition, the cooperative tax rate lies above the one-shot Nash equilibrium, and why an optimal deviation from cooperation lies between t^N and t^C .

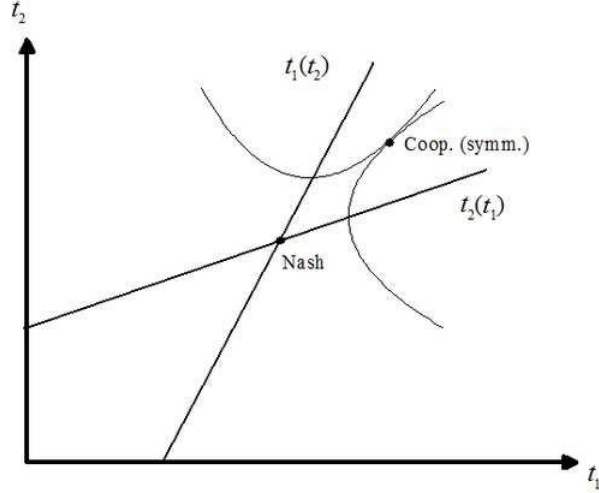


Figure 1: Reaction functions, equilibrium and cooperation in the stage game.

We introduce some more definitions to describe strategies in the repeated game.⁷ An action *profile* (t_1^s, \dots, t_N^s) describes the actions (tax rates) chosen by all countries in a given period. The set of action profiles is defined as $T \equiv \prod_i T_i$. The set of period s *histories* is given by $H^s \equiv T^s$, where T^s is the s -fold product of T , and the initial history is the null set $T^1 = \{\emptyset\}$. A history $h^s \in H^s$ is thus a list of s action profiles, identifying the tax rates chosen by all countries up to period $s - 1$. The set of all possible histories is

$$H \equiv \bigcup_{s=1}^{\infty} H^s. \quad (2)$$

A *pure strategy* for country i describes what tax rate the country would set after all possible histories; it is thus a mapping from the set of possible histories into the set of pure actions,

$$\sigma_i : H \rightarrow T_i. \quad (3)$$

⁷The concepts and definitions related to the repeated game are used in a standard way, see Mailath and Samuelson (2006, Ch 2).

Note that ‘Nash forever’, the strategy profile in which all countries set the static Nash equilibrium tax rate t^N after all possible histories in all periods $s = 1, 2, \dots$, constitutes a subgame-perfect equilibrium of the repeated game. Also, reversion to ‘Nash forever’, a strategy profile in which all countries set the static Nash equilibrium tax rate t^N in periods $s = s', s' + 1, \dots$ if a certain history $h^{s'}$ was reached, constitutes a subgame-perfect equilibrium of the subgame starting with that history.

Based on these observations, we concentrate on trigger strategies first analyzed by Friedman (1971). Such trigger strategies prescribe countries to set the cooperative tax rate as long no deviation is observed; and set the static Nash-equilibrium tax rate forever after a deviation is observed. Formally, the Friedman-type trigger strategy σ_i^F prescribes country i to set $t_i^1 = t^C$; while for periods $s > 1$:

$$t_i^s = \begin{cases} t^C & \text{if } t_j^\tau = t^C \text{ for all } j \text{ and } \tau = 1, \dots, s-1 \\ t^N & \text{else} \end{cases} . \quad (4)$$

We set out to examine under what circumstances the efficient tax rate t^C can be supported by the profile of Friedman-type trigger strategies $\sigma^F = (\sigma_1^F, \dots, \sigma_N^F)$ as an outcome of a subgame-perfect equilibrium (Proposition 1); and how the results are affected by the introduction of a lower bound on admissible tax rates (Propositions 2 and 3).

Proposition 1 *There exists a threshold discount factor $\underline{\beta} \in (0, 1)$ such that for all discount factors $\beta > \underline{\beta}$ the profile of trigger strategies $\sigma^F = (\sigma_1^F, \dots, \sigma_N^F)$ constitutes a subgame-perfect equilibrium of the infinitely repeated game. In this equilibrium, all countries set the efficient tax rate t^C in every period.*

Proof. Let t^d denote the optimal deviation of country i from cooperation, that is, $t^d = t_i(t^C, \dots, t^C)$. Then, $V_i(t^d, t^C)$ denotes the payoff of country i if $t_i = t^d$ and $t_{-i} = (t^C, \dots, t^C)$. In any given period, country i finds it optimal not to deviate if the following incentive condition holds:

$$V_i(t^d, t^C) - V_i(t^C, t^C) \leq \sum_{s=1}^{\infty} \beta^s [V_i(t^C, t^C) - V_i(t^N, t^N)], \quad (5)$$

The left hand side gives the immediate gain of deviation; the right hand side gives the cost in foregone future cooperation. Clearly, as β approaches 1, the right hand side grows without bounds, while the left hand side remains constant. Therefore, there exists a $\underline{\beta} < 1$ for which the condition holds with equality. For all $\beta > \underline{\beta}$ it will hold as strict inequality. ■

The next step is to show that a minimum tax \underline{t} in the interval $(t^N, t^d]$ reduces the sustainability of the efficient tax rate. First note that strategic complementarity implies that this interval is non-empty. Note also that the one-shot Nash equilibrium of the tax competition game with the minimum tax becomes $(\underline{t}, \underline{t})$.

Proposition 2 *The introduction of a minimum tax $\underline{t} \in (t^N, t^d]$ restricts the range of discount factors for which the efficient tax rate t^C can be supported by trigger strategies as a subgame-perfect equilibrium outcome in the infinitely repeated game.*

Proof. For a minimum tax $\underline{t} \in (t^N, t^d]$ country i finds it optimal not to deviate from the efficient tax rate if the following incentive condition holds:

$$V_i(t^d, t^C) - V_i(t^C, t^C) \leq \sum_{s=1}^{\infty} \beta^s [V_i(t^C, t^C) - V_i(\underline{t}, \underline{t})] \quad (6)$$

The only difference to inequality (1) appears in the last term. Since $\underline{t} \in (t^N, t^C)$ it follows that $V_i(\underline{t}, \underline{t}) > V_i(t^N, t^N)$; the right hand side becomes smaller for a given β . Therefore, the incentive condition is now violated for $\underline{\beta}$. There exists $\beta' \in (\underline{\beta}, 1)$ that makes the condition hold with equality. For $\beta \in [\underline{\beta}, \beta')$, in the presence of the minimum tax, it is optimal for any country to deviate from t^C in the first period. Cooperation at t^C can only be sustained for the restricted range of discount factors $[\beta', 1)$. ■

The result has a clear intuition. A minimum tax between the ‘punishment’ tax rate and the ‘temptation’ tax rate restricts the punishment for a deviation to be milder while leaving the deviation no less tempting.

A higher minimum tax $\underline{t} > t^d$ affects both the temptation and the punishment, making the assessment more complex. However, under reasonable

assumptions it is possible to show that a minimum tax is harmful even in this range.

Proposition 3 *The introduction of a minimum tax $\underline{t} \in (t^d, t^C)$ restricts the range of discount factors for which the efficient tax rate t^C can be supported by trigger strategies as a subgame-perfect equilibrium outcome in the infinitely repeated game if both $V_i(t, t)$ and $V_i(t, t^C)$ are weakly concave in t .*

Proof. Without a minimum tax, cooperation at t^C is sustainable for $\beta \geq \underline{\beta}$ (Proposition 1). It has to be shown that countries always have an incentive to deviate from t^C in the infinitely repeated game with discount factor $\underline{\beta}$ and a minimum tax $\underline{t} \in (t^d, t^C)$. Define $A(t) = [V_i(t, t^C) - V_i(t^C, t^C)]$ and $D(t) = \frac{\underline{\beta}}{1-\underline{\beta}}[V_i(t^C, t^C) - V_i(t, t)]$. For a minimum tax $\underline{t} \in [t^d, t^C]$, $A(\underline{t})$ represents the advantage of deviation from cooperation, while $D(\underline{t})$ represents the cost (or disadvantage) of deviation. Proposition 2 established that $A(t^d) > D(t^d)$. At the same time, $A(t^C) = D(t^C) = 0$. Therefore, for any minimum tax $\underline{t} = \alpha t^d + (1 - \alpha)t^C$ with $\alpha \in (0, 1)$ it holds that:

$$A(\underline{t}) \geq \alpha A(t^d) + (1 - \alpha)A(t^C) > \alpha D(t^d) + (1 - \alpha)D(t^C) \geq D(\underline{t}). \quad (7)$$

The first inequality follows from the weak convexity of $A(t)$ (implied by the weak concavity of $V_i(t, t^C)$), while the last inequality follows from the weak concavity of $V_i(t, t)$. ■

The weak-concavity assumptions are reasonable. In particular, a specification with quasilinear preferences and quadratic production functions of the tax competition model of Zodrow and Mieszkowski (1986) exhibits *strict* concavity of $V_i(t, t)$ and $V_i(t, t^C)$.

3 Conclusion

Viewing tax competition as repeated interaction reverses the common assessment of the desirability of agreements on a lower bound on admissible tax rates

(a ‘minimum tax’). If tax cooperation is sustained by implicit contracts, a minimum tax may trigger a ‘race to the bottom’ making all countries worse off. The reason is that a minimum tax restricts countries to punish deviators. Eliminating the worst possible outcomes makes the best ones harder to obtain.

The present analysis is based on powerful and simple dynamic strategies involving ‘Nash reversion’. Further research could investigate dynamic strategies that are more severe, and extend the present results to the case where countries threaten deviators with ‘optimal punishments’ of the type described by Abreu (1986).

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