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Secession, Fiscal Policy, and Natural Resources

Shigeharu Sato **Tadahisa Ohno**

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Shigeharu Sato*and Tadahisa Ohno

1 Introduction

Recently, discussions on regional secessions have gained prominence worldwide. Scotland's ongoing independence debate is a prime example. What drives Scotland's desire to separate itself from England? The primary reasons for Scottish independence are as follows:

First, Scotland seeks greater autonomy in managing public policies, including healthcare, education, and welfare, which are currently under English jurisdiction.

Second, there exists a strong desire for increased control over the oil and gas reserves in the North Sea. Under the current fiscal arrangement, England ' s central government has the authority to collect all tax revenues from these resources and manage them as part of the national treasury. Scotland's quest for independence is motivated by its aim to directly control these valuable natural resources and their associated revenues.

There are several other reasons for Scotland's secession. However, the main problem is whether Scotland can obtain sufficient tax revenue stability when it becomes independent from England. Recently, regarding public finance in Scotland, a fiscal transfer from the central government has distributed almost all financial resources in Scotland.

Given these circumstances, preventing secession is crucial because it may be socially inefficient. Thus, we must consider the kinds of public, transfer, and income tax policies the government in England should implement to prevent secession.

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Buchanan and Faith (1987) analyzed income tax policy to prevent secession from the government using a model of the provision of public goods. They found that the number of sharing coalitions affected the optimal income tax level to prevent the secession of potential seceders. Although they analyzed income tax policies to prevent secession, they did not consider a fiscal transfer policy or the profit distribution of natural resources. Furthermore, they did not analyze decision making with regard to public policy.

Research is ongoing on the secession problem from a political-economic perspective. Alesina and Spolaore (1997) relate to literature on the political economy of border formation. They analyzed the forces shaping incentives for secession, focusing on the traditional trade-off between economics of scale and the heterogeneity of preferences.

Furthermore, Alesina and Spolaore (2003) and Haimanko, Le Breton and Weber (2005) analyzed transfer and compensation mechanisms between regions to avoid inefficient secessions using a voting model. The question then is whether interregional compensation mechanisms exist to ensure that potentially seceding regions are strictly better off by staying in the union.

Gradstein (2004) analyzed the efficiency of public production under a local election model of the representative in each region considering integration bargaining with secession term. Although they analyzed a regional secession problem, they focused only on the provision of public goods. In other words, they did not use the bliss point approach to analyze public and fiscal transfer policies in an integrated economy to prevent secession.

Moreover, they did not analyze the income tax policy to prevent secessions in an integrated economy. They did not use the model of the provision of public goods but analyzed the regional secession problem from the perspective of the provision of public goods. Furthermore, they did not consider the profit distribution of natural resources under secession.

The economics of secession and resource allocation are complex topics that have been explored in several studies, focusing on the interplay between natural resources, political dynamics, and economic outcomes.

Gehring and Schneider (2020) investigated the issue of Scottish independence, analyzing democratic separation and independence from the perspectives of theory and evidence, considering regional resources. They examined the correlation between regional income and the success of secessionist parties. They revealed that the Scottish National Party's share of votes increased significantly after the discovery of a large oil field off the coast of Scotland. In other words, the distribution of regional resources has been shown to affect the strength of democratic secessionist movements.

Dhillon, Krishnan, Patnam and Perroni (2020) examined the formation of new Indian states in 2001, finding that resource-rich constituencies performed worse within new states that inherited more natural resources. This suggests that political reorganization can affect the quality of state governance of natural resources.

Hosoe (2018) discussed secession problems with vital resource allocations, noting that high-value resources such as oil and minerals are often unequally distributed among regions, potentially incentivizing secessionist movements.

Chacón and Jensen (2020) explored the Southern secession movement of 1860/61, highlighting the role of political inequality among whites in facilitating secession, as well as the importance of slavery to the South's economy

Naito (2021) analyzed the behavior of sovereign states and their regions when other small, resource-rich regions attempt to secede, considering the trade-off between natural resource benefits and the loss of economic diversity.

Interestingly, although these studies largely focused on the economic aspects of secession and resources, they also highlighted political and social dimensions. For instance, Jessen (2020) provided a broader definition of secessionist conflicts, emphasizing their non-consensual nature and potential for violent hostilities. This underscores the complex interplay between economic, political, and social factors in secession movements.

In conclusion, the economics of secession and resources involve a delicate balance between the potential benefits of resource control and the costs of political reorganization. These studies collectively suggest that resource distribution, political inequality, and governance quality are crucial in determining the economic outcomes of secession movements.

Based on this research background, we analyze public, regional transfer, and income tax policies that relate to the internal exit of a resource-rich region using a model of the provision of public goods, considering the problem of the profit distribution of a natural resource under secession.

From this paper, the following conclusions were drawn: First, as resource values increase, separation is more likely to occur.

Second, as resource values increase, the utility of residents of resource-poor regions in the case of integration decreases because of increased transfers to resource-rich regions.

Third, as resource values increase, although the utility of residents in resource-rich regions increases, a discontinuous drop occurs in their utility in the vicinity of resource values, moving from integration to separation.

This represents one mechanism of the "resource curse" alluded to by Auty (2002), as evidenced by the fact that resource-rich countries exhibit low economic growth (Sachs and Warner (2001); Gylfason (2001)).

2 Model

The Case of Integration Therefore, taking region B as a minority region and region A as a majority region, we consider the possibility of secession of region B from region A. Region A implements an income redistribution policy, taxing the income in regions A and B in an integrated economy. The income tax rate in region A is t_A^I while that in region B is t_B^I in an integrated economy. Thus, the budget constraint in region A in an integrated economy is as follows:

$$n_A t_A^I (y_A + R/n_A) = g_A + T \tag{1}$$

Region A can control natural resources (for example, oil.) in region B, because region B is subordinate to region A. The per capita revenue from natural resources is R/n_A. The total transfer from region A to region B is denoted by T. The budget constraint in region

B in an integrated economy is as follows:

$$n_B t_B^I y_B + T = g_B \tag{2}$$

Considering the above discussion, we denote the utility U_A, U_B of representative citizens for each region as follows,

$$U_A^I = (1 - t_A^I)(y_A + R/n_A) + \alpha_A ln g_A + \delta_{AB}^I \tag{3}$$

$$U_B^I = (1 - t_B^I) y_B + \alpha_B ln g_B + \delta_{AB}^I \tag{4}$$

The Case of Secession Next, we consider the independence of region B from region A. In this situation, region B can gain authority over a natural resource in region B and choose a tax policy. However, region B cannot receive transfers from region A. That is, region B must provide public expenditures from its own tax revenue. The budget constraint in region A in a secession economy is:

$$n_A t_A^S y_A = g_A. \tag{5}$$

The budget constraint in region B in a secession economy is:

$$n_B t_B^S (y_B + R/n_B) = g_B. \tag{6}$$

In this situation, region A's utility function under secession is as follows:

$$U_A^S = (1 - t_A^S) y_A + \alpha_A ln g_A + \delta_A^S. \tag{7}$$

By contrast, region B's utility function under secession is as follows:

$$U_B^S = (1 - t_B^S)(y_B + R/n_B) + \alpha_B ln g_B + \delta_B^S. \tag{8}$$

When revenues from natural resources R are uncertain, we focus on the central government ' s ability to make decisions regarding the income tax rate in a secession economy.

Under these circumstances, we analyze the impact of the size of natural resources on separation and integration.

We consider a game with the following timeline: In the first stage, region A chooses the income tax rates t_A^I and t_B^I and the level of transfer T in an integrated economy. it also chooses the income tax rate t_A^S in a secession economy. Then, either higher or lower tax revenues from natural resources are realized. In the second stage, region B chooses whether to secede from region A. In the third stage, if region B chooses independence, then it also chooses an income tax rate t_B^S in its region.

We solve this game using backward induction. First, we analyze the third stage, considering the case in which region B chooses an income tax rate t_B^S in a secession economy. Region B chooses its income tax rate to maximize its welfare under secession (eq. (8)).

The first-order conditions are as follows:

$$\frac{\partial U_B^S}{\partial t_B^S} = -\left(y_B + \frac{R}{n_B}\right) + \frac{\alpha_B}{t_B^S} = 0. \tag{9}$$

Thus, the optimal income tax rate for region B is as follows:

$$t_B^S = \frac{\alpha_B}{y_B + \frac{R}{n_B}}. \tag{10}$$

Next, we analyze the second stage of region B's decision making regarding secession. If the following condition is satisfied, then region B is not independent of region A.

$$U_B^I \geq U_B^S \tag{11}$$

Explicitly,

$$\begin{aligned} &(1 - t_B^I)y_B + \alpha_B \ln(n_B t_B^I y_B + T) + \delta_{AB}^I \\ &\quad \geq (1 - t_B^S)\left(y_B + \frac{R}{n_B}\right) + \alpha_B \ln\left(n_B t_B^S\left(y_B + \frac{R}{n_B}\right)\right) + \delta_B^S. \end{aligned} \tag{12}$$

From equation (12), the optimal transfer policy is as follows:

$$T = T(R, t_B^I). \tag{13}$$

Next, we analyze the first stage wherein region A chooses income tax rates t_A^I and t_B^I in an integrated economy. Region A also chooses the income tax rate t_A^S in a secession economy. Then, either higher or lower revenues from natural resources are realized. The feasibility of resources and secession of regions are discussed below.

3 Case 3: Secession occurs when both R_H and R_L are realized.

Region A chooses the income tax rate t_A^S in a secession economy. The objective function is as follows:

$$EU_A = pU_A^S(R_H) + (1-p)U_A^S(R_L) \tag{14}$$

Here, $U_A^S(R_H)$ and $U_A^S(R_L)$ are defined as follows.

$$U_A^S(R_k) = (1-t_A^S)y_A + \alpha_A ln(n_A t_A^S y_A) + \delta_A^S, \quad k = L, H. \tag{15}$$

Both $U_A^S(R_H)$ and $U_A^S(R_L)$ have the same form, because the only dependency is on the income tax rate. Hence, we can simplify EU_A as:

$$EU_A = (1-t_A^S)y_A + \alpha_A \ln(n_A t_A^S y_A) + \delta_A^S \tag{16}$$

The first order condition is as follows:

$$\frac{\partial EU_A}{\partial t_A^S} = -y_A + \alpha_A \left(\frac{1}{t_A^S}\right) = 0 \tag{17}$$

Accordingly, the optimal tax rate is as follows:

$$t_A^{S*} = \frac{\alpha_A}{y_A} \tag{18}$$

Region A's expected utility under the optimal tax rate is:

$$EU_A^* = y_A - \alpha_A + \alpha_A ln(\alpha_A n_A) + \delta_A^S \tag{19}$$

4 Case1: Secession does not occur when both R_H and R_L are realized.

Region A's objective function is as follows:

$$EU_A = pU_A^I(R_H) + (1-p)U_A^I(R_L), \tag{20}$$

where

$$U_A^I(R_k) = (1-t_A^I)(y_A + R_k/n_A) + \ln G_1(R_k) + \delta_{AB}^I, \quad k = L, H. \tag{21}$$

Here, $G_1(R_k)$ is defined as

$$G_1(R_k) \equiv n_A t_A^I (y_A + R_k/n_A) - T(R_H, t_B^I). \tag{22}$$

The first-order condition with regard to t_A^I is as follows:

$$\frac{\partial EU_A}{\partial t_A^I} = \quad p\left\{-\left(y_A + \frac{R_H}{n_A}\right) + \alpha_A \cdot \frac{n_A\left(y_A+\frac{R_H}{n_A}\right)}{n_A t_A^I\left(y_A+\frac{R_H}{n_A}\right) - T(R_H,t_B^I)}\right\} \tag{23}$$

$$+ \quad (1-p)\left\{-\left(y_A + \frac{R_L}{n_A}\right) + \alpha_A \cdot \frac{n_A\left(y_A+\frac{R_L}{n_A}\right)}{n_A t_A^I\left(y_A+\frac{R_L}{n_A}\right) - T(R_H,t_B^I)}\right\} = 0 \tag{24}$$

where we consider $\frac{\partial T(R_H,t_B^I)}{\partial t_A^I} = 0$. Based on the above equation, the equilibrium is $t_A^{I*} = t_A^{I*}(R_H, R_L)$.

Next, we analyze the decision making regarding t_B^I.

The first-order condition for t_B^I is considers the earlier equation.

$$\frac{\partial EU_A}{\partial t_B^I} = -\alpha_A \frac{\partial T(R_H, t_B^I)}{\partial t_B^I}\left[p \cdot \frac{1}{n_A t_A^I\left(y_A + \frac{R_H}{n_A}\right) - T(R_H, t_B^I)}\right. \tag{25}$$

$$\left. +(1-p) \cdot \frac{1}{n_A t_A^I\left(y_A + \frac{R_L}{n_A}\right) - T(R_H, t_B^I)}\right] = 0 \tag{26}$$

Because $\alpha_A \neq 0$ and the logarithmic summands are never zero, we have:

$$\frac{\partial T(R_H, t_B^I)}{\partial t_B^I} = 0. \tag{27}$$

Thus, the first-order condition with regard to t_B^I implies that the transfer $T(R_H, t_B^I)$ does not change in relation to t_B^I in the given scenario. Notably, t_B^I is unrelated to t_A^I. From equation (12), we have

$$\frac{\partial T}{\partial t_B^I} = \frac{y_B(n_B t_B^I y_B + T) - \alpha_B n_B y_B}{\alpha_B}. \tag{28}$$

This equation reveals the relationship between T and t_B^I

$$t_B^I = \frac{\alpha_B}{y_B} - \frac{T}{n_B y_B}. \tag{29}$$

The equilibrium tax rates satisfying both equations are as follows:

$$t_A^{I*} = t_A^{I*}(R_H, R_L), \quad t_B^{I*} = t_B^{I*}(T(R_H, t_B^{I*})) \equiv \frac{\alpha_B}{y_B} - \frac{T(R_H, t_B^{I*})}{n_B y_B}. \tag{30}$$

Accordingly, the expected utility in region A at the equilibrium is as follows:

$$\begin{aligned} EU_A^* = \quad & p\left[(1 - t_A^{I*})(y_A + R_H/n_A)\right. \\ & \left.+\alpha_A \ln(n_A t_A^{I*}(y_A + R_H/n_A) - T(R_H, t_B^{I*}))\right] \\ & +(1-p)\left[(1 - t_A^{I*})(y_A + R_L/n_A)\right. \\ & \left.+p\alpha_A \ln(n_A t_A^{I*}(y_A + R_L/n_A) - T(R_H, t_B^{I*}))\right] + \delta_{AB}^I \end{aligned} \tag{31}$$

From the above equation, regarding the expected utility EU_A^*, the results of the comparative static analysis concerning the size of resource R_L are as follows:

$$\frac{\partial EU_A^*}{\partial R_L} = \frac{\Big((1-p)(1 - t_A^{I*})[n_A t_A^{I*}(y_A + \frac{R_L}{n_A}) - T(R_H, t_B^{I*})] + \alpha_A t_A^{I*}\Big)}{n_A\left[n_A t_A^{I*}\left(y_A + \frac{R_L}{n_A}\right) - T(R_H, t_B^{I*})\right]} > 0 \tag{32}$$

From the above equation, regarding the expected utility EU_A^*, the results of the comparative static analysis concerning the size of resource R_H are as follows.

$$\frac{\partial EU_A^*}{\partial R_H} = p\left[\frac{(1 - t_A^{I*})}{n_A} + \alpha_A \cdot \frac{\frac{t_A^{I*}}{n_A} - \frac{\partial T(R_H, t_B^{I*})}{\partial R_H}}{n_A t_A^{I*}\left(y_A + \frac{R_H}{n_A}\right) - T(R_H, t_B^{I*})}\right] \tag{33}$$

$$+(1-p)\left[\alpha_A \cdot \frac{-\frac{\partial T(R_H, t_B^{I*})}{\partial R_H}}{n_A t_A^{I*}\left(y_A + \frac{R_L}{n_A}\right) - T(R_H, t_B^{I*})}\right] \tag{34}$$

However, this sign is not defined.

5 Case 2: Secession occurs only when R_H is realized.

The objective function of region A is as follows:

$$EU_A = pU_A^S(R_H) + (1-p)U_A^I(R_L). \tag{35}$$

When the resource is R_L, equation (12) is bound but not when R_H. In these situations, we solve the tax rate t_A^S, t_A^I, t_B^I to maximize equation (35).

The first-order condition for t_A^S is as follows:

$$\frac{\partial EU_A}{\partial t_A^S} = \frac{\partial U_A^S(R_H)}{\partial t_A^S} = 0, \tag{36}$$

because $\partial U_A^I(R_L)/\partial t_I^S = 0$.

Similar to equation (18), the optimal tax rate in region A in a secession economy is as follows:

$$t_A^{S**} = \frac{\alpha_A}{y_A}. \tag{37}$$

The first-order condition of t_A^I is as follows:

$$\frac{\partial EU_A}{\partial t_A^I} = (1-p)\left[-(y_A + R_L/n_A) + \frac{n_A(y_A + R_L/n_A)}{n_A t_A^I(y_A + R_L/n_A) - T(R_L, t_B^I)}\right] = 0. \tag{38}$$

Solving for t_A^I, we have

$$t_A^I = \frac{n_A + T(R_L, t_B^I)}{n_A y_A + R_L}. \tag{39}$$

The first-order condition for t_B^I is as follows:

$$\frac{\partial EU_A}{\partial t_B^I} = -(1-p)\frac{\frac{\partial T(R_L, t_B^I)}{\partial t_B^I}}{n_A t_A^I(y_A + R_L/n_A) - T(R_L, t_B^I)} = 0. \tag{40}$$

Then we have

$$\frac{\partial T(R_L, t_B^I)}{\partial t_B^I} = 0, \tag{41}$$

where $\frac{\partial T}{\partial t_B^I}$ is calculated as follows:

$$\frac{\partial T}{\partial t_B^I} = \frac{y_B(n_B t_B^I y_B + T) - \alpha_B n_B y_B}{\alpha_B}. \tag{42}$$

Parameter	Value
y_A	100
y_B	30
α_A	30
α_B	5
n_A	20
n_B	10
δ^I_{AB}	10
δ^S_A	9
δ^S_B	3
ΔR	70
p	0.5

Table 1: Summary of parameters and their values.

The optimal tax rate satisfies the following conditions.

$$t_B^{I**} = \frac{\alpha_B}{y_B} - \frac{T}{n_B y_B}, \tag{43}$$

$$t_A^{I**} = \frac{n_A + T(R_L, t_B^{I**})}{n_A y_A + R_L}. \tag{44}$$

6 Secession decision and numerical simulations

In Stage 1, region A transfers T to region B. Depending on whether it offers $T(R_H)$, $T(R_L)$, or no transfer, the separation pattern (Cases 1, 2, or 3) can be selected. Therefore, we compare the expected utility of region A in the three cases. However, because of the complexity of the equations, we cannot compare the expected utilities; therefore, numerical simulations are used to clarify the determination of the regional secession in equilibrium.

We set the parameters, as depicted in Table 1, assuming that R_H and R_L are adjusted concurrently. Specifically, $R_H = \bar{R} + \Delta R$ and $R_L = \bar{R}$.

We begin by comparing the utilities of region A in the three cases, as depicted in Figure 1. The horizontal axis in the graph represents $\bar{R}$ and the vertical axis represents EU_A in the three cases. If $\bar{R}$ is low (Area 1), the utility of Case 1 is the highest of the three; therefore, region A wants full integration in both R_H and R_L. If $\bar{R}$ is in the middle

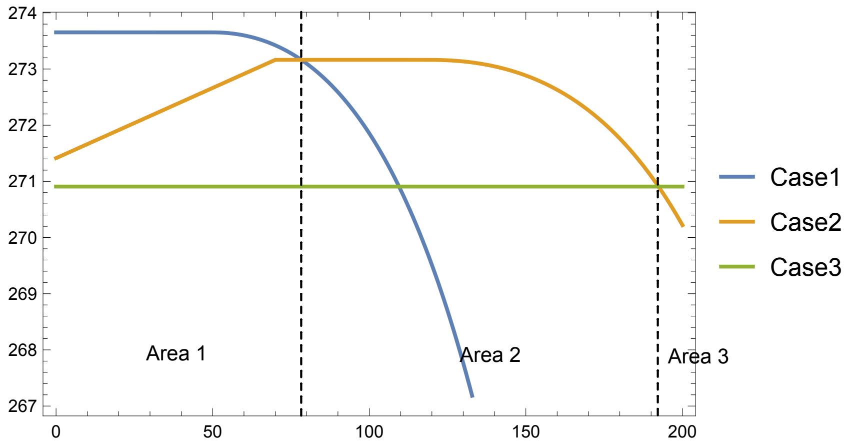

Figure 1: Region A's utilities in three cases.

(Area 2), the utility of Case 2 is the highest of the three; therefore, region A wants partial integration when R_L is realized and secedes when R_H is realized. If $\bar{R}$ is high (Area 3), the utility of Case 3 is the highest of the three; therefore, region A wants full secession when R_L is realized and secedes when R_H is realized.

Region A's utilities decline with $\bar{R}$ because the transfer T to region B increases with $\bar{R}$ as depicted in figure 4. In this diagram, in Case 2, when $\bar{R}$ is small, T is zero because the basic utility of region B increases by $\Delta_{AB} - \Delta_B$ owing to the integration.

Subsequently, we examine the utilities of region B. Figure 2 illustrates region B's expected utilities EUBi, $(i = 1, 2, 3)$ for case i. In Area 1, region A chooses Case 1 and in Area 2, region A chooses Case 2; therefore, at the boundary from Case 1 to Case 2 and beyond, the utility of region B decreases discontinuously.

Finally, we analyze tax policies as depicted in figure 4. Region A's tax rate of integration increases with resource value $\bar{R}$. In contrast, Region B's tax rate decreases because region A must pay transfers from tax revenue. Region A's tax rate of secession is independent of $\bar{R}$ and region B's tax rate decreases with $\bar{R}$.

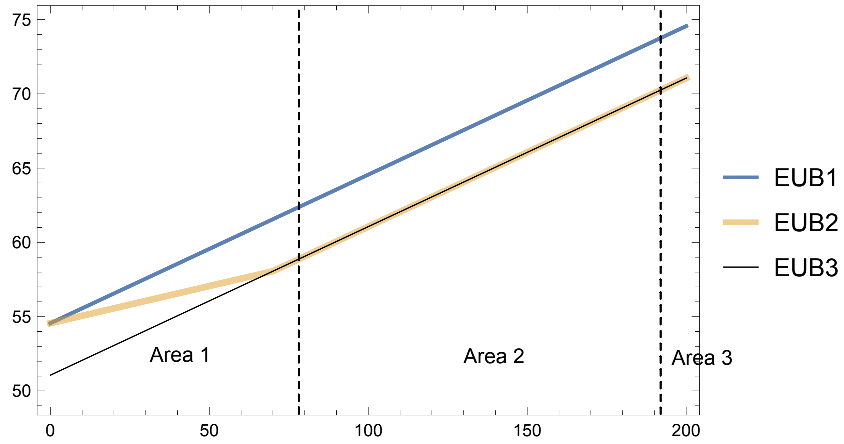

Figure 2: Region B's utilities in three cases.

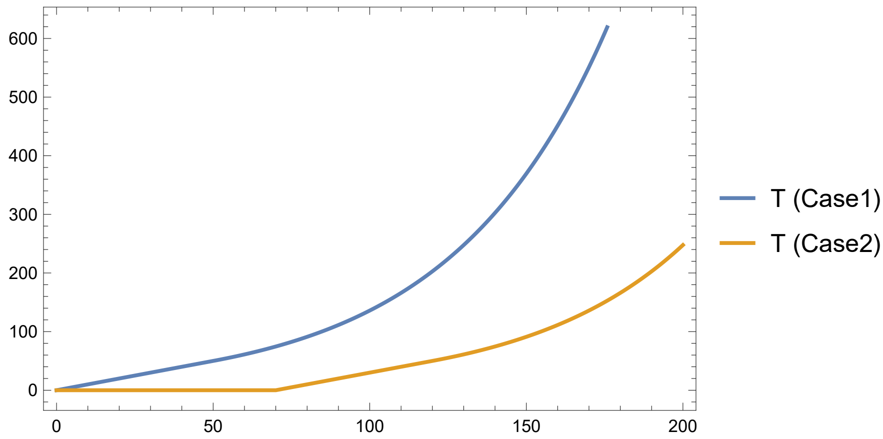

Figure 3: Transfer amount from region A to region B when integrated.

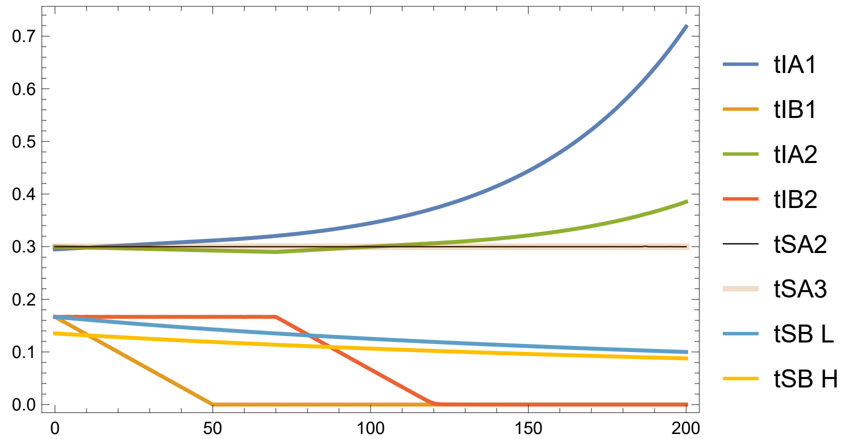

Figure 4: Tax rates in the three cases.

7 Concluding remarks

This study examines policies related to public goods, regional transfers, and income taxation in the context of an internal exit, considering the problem of profit distribution of a natural resource under secession. This paper draws the conclusions listed below. As the value of resources rises, these key effects emerge: The likelihood of separation increases. In integrated scenarios, residents of areas with fewer resources experience a decline in their well-being owing to larger transfers to resource-rich regions. Although the inhabitants of resource-rich areas witness an improvement in their utility as resource values increase, an abrupt decrease in their utility occurs when transitioning from integration to separation at certain resource value thresholds.

In this study, we assumed that the degree of authority of a natural resource is exogenous. Thus, we seek to analyze the negotiation decisions regarding the degree of authority over a natural resource. Moreover, in this study, public goods do not have spillover effects. Therefore, we consider situations in which public goods have spillover effects.

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