博士論文

Essays on Political Economics

(政治経済学に関する研究)

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Contents

Acknowledgements

I would like to thank Michihiro Kandori for his discussions and advice. And I would like to thank Hikaru Ogawa, Daiki Kishishita, Taku Masuda, and Susumu Sato for their joint works and discussions. I was financially supported by JSPS Grant-in-Aid for JSPS Research Fellows (16J02563). All remaining errors are my own.

Chapter 1. Introduction

From the 2000s through the present time, the political and economic environment in Japan and in the world has changed significantly. For example of the political change in Japan, Liberal Democratic Party in Japan lost the Lower House election in 2009 and the administration of the Democratic Party in Japan was established, and some regional political parties, for example, Osaka Restoration Association and Tax Cuts Japan, had influence from the 2010s. Overlooking the world, in America, Donald Trump who is called one of the famous populists won The United States presidential election of 2016 and the administration of the President Donald Trump has been established, and on June 2016, United Kingdom decided to exit European Union by United Kingdom European Union membership referendum and under referendum campaign activity, supporters of exiting EU and opponents criticized each other violently. For instance of the economic change, the globalization of the economy which means the free trade agreement, for example Trans-Pacific Partnership Agreement, has been discussed around the world.

When we summarize the above discussion of the change of the political and economic environment, the three keywords are found:

1. Negative Campaign;
2. Populism;
3. Globalization.

In Japan, from the Lower House election in 2009, the negative campaign has been often seen. Overlooking the world, in America, representative candidates, for example Donald Trump and Hillary Clinton often used negative campaign about the opponent. The nature of negative campaign is that populists who propose the extreme policy often use the negative campaign, for instance Toru Hashimoto who was the representative of Osaka Restoration Association in Japan and Donald Trump who is the President of the United States.

The above keywords 1 and 2 (Negative Campaign and Populism) are considered as having a bad influence for the welfare. However, whether Negative Campaign and Populism are having a bad influence or not is not obvious and has been examined. Therefore, in this paper, we study the welfare impact of the Negative Campaign and the Populism policy, in particular the right-wing populism under the globalization which represents each country faces on international tax competition.

To analyze the above purposes, this paper consists of four essays on Political Economics. The chapter 2 and 3 consider the relationship between negative campaign and the voters' welfare and information transmission. The chapter 4 considers the relationship between the right-wing populism and the world or the populist country's welfare under the globalization which represents international tax competition. The chapter 5 considers the relationship between capital tax coordination and the globalization which means the connection of international capital market.

The chapter 2 whose title is "Informative Campaigning in Multidimensional Politics: A Role of Naïve Voters".[1] In this chapter, we construct a model in which an incumbent and a challenger decide whether to focus on policy or ability in electoral campaigning, and a media outlet then decides whether to gather news. We show that a candidate's strategy on which issue to focus on (i.e., campaign messages) can be a signal about her/his private information. In particular, negative campaigning against the incumbent's ability serves as a signal of the incumbent's low ability in separating equilibria. Interestingly, separating equilibria exist only when sophisticated and naïve voters coexist. This implies that the existence of naïve voters can enhance information transmission.

The chapter 3 whose title is "Game Theoretic Analysis of Positive and Negative Campaign for Policy". This chapter constructs and analyzes election model which two candidates choose the degree of policy, positive and negative campaign for policy to maximize their own probability of winning an election. We obtain three interesting result. First, symmetric equilibrium policy is extremer than voters' welfare maximization policy. This results from candidates' incentive to advertise exaggeratingly their own upside since voters' awareness is imperfect. Second, increasing voters' awareness for policy decreases the degree of innovation and voters' welfare. In Japan Election, the youth are not interested in election because he considers youth voice does not reach politics. However, we consider all of voters should monitor candidates' policy to improve welfare. Finally, negative campaign for policy should not be regulated because voters' welfare in no regulating this is more than in regulating. Past literature consider downside of negative campaign. However, we take an example which negative campaign for policy should not be regulated.

The chapter 4 whose title is "When Populism Meets Globalization: Analysis of Tax Competition".[2] This chapter's content is the following: The preference for extreme economic policy is a feature of populism. We study the causes and consequences of the extreme reduction of tax rates---a feature of right-wing populism---in the age of globalization. To this end, we construct a two-country asymmetric tax competition model in which the residents in one of the two countries do not know their policymaker's type.

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[1] This chapter is joint work with Daiki Kishishita who belongs to the Graduate School of Economics, The University of Tokyo.
[2] This chapter is joint work with Daiki Kishishita who belongs to the Graduate School of Economics, The University of Tokyo.

When politicians' reputation (i.e., reelection) concerns are high, a politician who implements extremely low taxation acquires a good reputation and thus a populist taxation policy arises. We show that globalization alters the properties of this populism. In particular, under tax competition, populism can improve welfare in terms of either the populist country or the whole world, whereas that is not the case in a closed economy.

The chapter 5 whose title is “International Capital Market and Repeated Tax Competition”.[3] In this chapter, we propose an infinitely repeated game of tax competition with an endogenous capital supply. Our results show that the larger the capital supply elasticity to interest rates, the easier it is for interregional tax coordination within a country to be achieved. The capital supply elasticity is lower when countries are less integrated into the international capital market, and vice versa. Thus, our finding suggests that the regions in the country with a lower (higher) degree of integration in the global market are less (more) likely to achieve tax coordination.

[3] This chapter is a joint work with Professor Hikaru Ogawa who belongs to Faculty of Economics, The University of Tokyo.

Chapter 2. Informative Campaigning in Multidimensional Politics: A Role of Naïve Voters.

1. Introduction

Voters are not necessarily familiar with all the relevant policy issues or candidates' characteristics. Thus, to maintain the responsiveness of a representative democracy, information transmission from agents such as candidates to voters is highly important. Political campaigning (e.g., advertising, speeches, and debates) is one of the significant paths of such information transmission. However, campaigns may not convey truth because information is often soft and there are conflicts of interests. Our study examines the information transmission through campaigns when candidates can tell a lie.

In particular, we examine how the choice of campaign strategies conveys information to voters. The amount of campaigns resources (e.g., the length of a speech) is limited, and thus a candidate cannot convey her/his opinions on all the relevant issues. Thus, s/he must decide what issue to focus on in political campaigning. This is the key element of campaign strategies, and candidates rely on different strategies. One example is the 1996 U.S. presidential election in which William J. Clinton was the incumbent and Robert J. Dole was a challenger. During the first presidential debate, on October 6, 1996, each candidate took a very different strategy. Dole attacked Clinton's character, while Clinton continually shifted the discussion away from personal attacks to policy issues (Benoit 2007). This suggests that a candidate strategically chooses what issue to emphasize based on private information. Therefore, a candidate's decision on what issue to focus on (i.e., campaign messages) could be a signal about her/his private information.

To investigate this signaling role, we construct a model consisting of voters, an incumbent, a challenger, and a media outlet. There are two issues in the election: policy and ability. A candidate's ability is realized only after s/he has a government seat. Thus, the challenger's ability is unobservable to all the players while the incumbent's ability is known to both candidates. Voters do not know even the incumbent's ability. Each candidate allocates a fixed amount of resources to campaigns on policy and campaigns on the incumbent's ability (i.e., s/he decides which issue to focus on). The media outlet then decides whether to gather news on the incumbent's ability. Finally, voters vote for one of the two candidates. Voters are divided into sophisticated and naïve voters. A sophisticated voter knows which one's policy benefits her/himself, and s/he is sophisticated in that s/he updates her/his belief taking into account candidates' strategic incentives. In contrast, a naïve voter does not know whose policy is good, and is just persuaded by campaigns.

We show that whether candidates focus on policy or ability can be a signal about the incumbent's ability. In other words, separating equilibria where the campaign is informative exist under several conditions. In addition, in every such equilibrium, the challenger focuses on the incumbent's ability if and only if the incumbent's ability is low. Since campaigns on the incumbent's ability can be regarded as negative campaigns, this result implies that the challenger's negative campaigns arise as a signal of the incumbent's low ability.

In the model, messages are costless, and thus the game is a cheap-talk game. However, messaging changes naïve voters' behaviors, reducing the game to a costly signaling game. To see this, consider how campaigns on policy and campaigns on ability persuade naïve voters. When the challenger persuades a naïve voter that her/his policy is good, the voter is simultaneously persuaded through logic that the incumbent's policy is bad, as long as these policies are about the same issue and differ in content. Logically, if the challenger's policy is desirable, the incumbent's policy must be undesirable. In contrast, when the challenger succeeds in persuading a naïve voter that the incumbent's ability is low, the voter is not persuaded that the challenger's ability is high. It is logically possible that both candidates have a low ability. Therefore, campaigns on policy mobilize more naïve voters than campaigns on ability do. This implies that it is costly for a challenger to focus on the incumbent's ability.[1] As a result, the cheap-talk game becomes a costly signaling game given naïve voters' behaviors. Therefore, the challenger's campaign strategy can be a signal about the incumbent's ability.

Based on this mechanism, we show that an increase in the number of naïve voters can enhance information transmission. The candidates can persuade naïve voters even if the truth is different from what they argue in their campaigns. Thus, it seems that the existence of naïve voters will make candidates conduct campaigns that are not based in truth. Nonetheless, it is not the case. Without naïve voters, there is no informative equilibrium because their existence creates the cost of campaign strategies. In the mechanism described above, focusing on the incumbent's ability is costly for the challenger since this campaigning has a smaller effect on the naïve voters than campaigning on policy. Therefore, the existence of naïve voters is crucial to create an informative equilibrium.

Notice that this mechanism is still not enough to create separating equilibria. The net benefit of focusing on the incumbent's ability for the challenger must depend on the actual incumbent's ability. However, the cost of campaigning shown in the above is independent of it. Thus, so that what issue to emphasize is a credible signal, its benefit must depend on the incumbent's ability. It is here that mass media plays a role. Suppose that the challenger focuses on the incumbent's ability in spite of the incumbent's high ability. The mass media comes to suspect that the incumbent's ability is low and begins to gather news. Then, the mass media finds out the truth with some probability and reports it. After the news is reported, the challenger cannot win the election since sophisticated voters will realize the incumbent's high ability. Thus, as long as the incumbent's ability is high, the challenger may not win an election even if s/he focuses on the incumbent's ability. As a result, the benefit of focusing on the incumbent's ability is smaller when the incumbent's ability is high than that when the incumbent's ability is low. This makes the negative campaign a credible signal.

[1] This is consistent with the empirical result that policy is a more frequent topic of campaign messages than character and winners are more likely to focus on policy than character (Benoit 2007).

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the model. Section 4 derives equilibria. Section 5 discusses an extension. Section 6 concludes.

2. Related Literature

There are three approaches to describing information transmission through political campaigning, depending on whether voters are sophisticated and whether information is soft. In the first approach, campaigns persuade only naïve voters (Baron 1994; Grossman and Helpman 1996). In contrast, the second approach considers a situation in which voters are sophisticated and information is soft (Potters, Sloof, and Van Winde 1997; Prat 2002a, b). In the last approach, information is hard (Coate 2004a, b; Ashworth 2006).

The second approach mainly began with Prat (2002a, b). His model relies on the following three properties: (i) it is interest groups, not candidates that send a signal; (ii) it is not a campaign message but the amount of campaign spending that matters; and (iii) voters are sophisticated. It is meaningless for an interest group to provide campaign funds to a candidate who is unlikely to win an election. Thus, the interest group provides campaign funds only with a candidate who seems to have high competence. Therefore, the amount of campaign spending is informative. However, this mechanism does not work when candidates send messages.[2] Finally, this mechanism relies on the rationality of voters. If voters are naïve, even a candidate whose characteristics are negative can win an election after a large amount of campaigning.

Our model combines this second approach with the first approach: campaigning sends a signal to sophisticated voters while it persuades naïve voters. This new approach makes three distinct contributions to the literature, which parallel (i)–(iii) above.

First, we show that even a candidate can send a signal.[3] This result is related to the work by Daley and Snowberg (2011) showing the role of a candidate's fund-raising as a signal. In their model, a candidate's ability is negatively correlated with the cost of fund-raising. Thus, raising a high amount of campaign contributions is a signal of high ability. Hence, the mechanism creating the signal is different. Further, whereas the information a candidate sends is about her/his type in their model, that is the opponent's type in our model.

The second contribution is to show that messages campaigns convey (i.e., what issue a candidate focuses on) can be informative.

The third contribution is to show that an increase in the number of naïve voters does not necessarily undermine information transmission through campaigning. The last two

[2] A candidate's objective is not to provide a campaign for a candidate who is likely to win an election, but to win an election. In addition, campaigns cost nothing for candidates, since interest groups provide the funds. Thus, this mechanism does not work.

[3] Potters, Sloof, and Van Winde (1997) show that a candidate can send a signal, but the cost of sending a signal is exogenously given (i.e., cost is an ad hoc assumption).

contributions are discussed in detail below.

■ **Strategic choice of campaign issues:** Though the traditional literature has not sufficiently examined information transmission through candidates' decisions on what issue to emphasize, there is recently a growing literature about it (e.g., Polborn and David 2006; Hao and Li 2013; Egorov 2015; Zhang 2016; Bhattacharya 2016; Dragu and Fan 2016; Shipper and Woo 2017). Polborn and David (2006), Hao and Li (2013), Bhattacharya (2016), and Shipper and Woo (2017), like our study, analyze negative campaigning.[4]

These existing studies (i) assume that voters are naïve or (ii) assume the exogenous condition under which information campaigns argue is transmitted [5] (i.e., assume a kind of hard information). In contrast, our model includes Bayesian updaters, and assumes that information transmission depends on players' strategies and information is soft.

There is only one study that employs similar assumptions (Zhang 2016). However, her focus is different from ours. In her setting, there is no trade-off between campaigns on issues: revealing information about one issue does not imply not revealing information about another. In reality, campaign resources are limited, and thus allocation matters. Our study accounts for this by analyzing the allocation of resources given a fixed budget.

■ **Naïve voters:** We show that an increase in the number of naïve voters can enhance information transmission. Thus, the existence of naïve voters can play a positive role in enhancing voters' welfares. To our knowledge, there is no such discussion in political campaign literature.[6]

In the literature of cheap talk games, Ottaviani and Squintani (2006) and Kartik, Ottaviani and Squintani (2007) examine the possibility of a naïve receiver. They show that the larger the probability is that a receiver is naïve, the more information is transmitted. In their model, there is a correlation between the sender's ideal point and that of the receiver, and this plays a crucial role in creating an informative equilibrium. In contrast, there is no such correlation in our model (i.e., no common interests). Nonetheless, information can be transmitted.

In addition, Grillo (2016) analyzes electoral campaigning where voters have reference dependence utilities with loss aversion. He shows that such an anomaly can push candidates to be truthful. Our study is different from his study as follows. First, we focus on irrationality regarding not attitudes toward uncertainty but strategic reasoning. Second, we consider campaigning in multidimensional politics whereas he considers campaigning in one dimensional politics. We, therefore, present a new mechanism in which campaigns are

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[4] Studies on the strategic choice between positive and negative campaigning include Skaperdas and Grofman (1995), Harrington and Hess (1996), Polborn and David (2006), Lovett and Shachar (2011), Hao and Li (2013), and Kasamatsu (2017).

[5] For example, Egorov (2015) assumes that the truth is revealed only when both candidates campaign on the same issue. This does not mean that updating does not matter. Each candidate can hide information, and so voters update their belief based on whether information is revealed.

[6] Even beyond the literature of campaigns, studies showing a positive role of voters' irrationality are limited. Several studies (Ashworth and De Mesquita 2014; Levy and Razin 2015; Lockwood 2017) show such possibilities, but the irrationalities they focus on are different from ours.

informative owing to anomalies/ irrationalities of voters.[7]

■ **Mass media and challenger's message:** One key ingredient to create a credible signal is the mass media. Though political campaigning and the mass media have been considered to be related to each other, this is the first study that explicitly shows the role of the mass media in making campaigning informative.[8] In particular, the novelty of our modeling is that a media outlet's decision on whether to gather news endogenously depends on candidates' campaign strategies. Outside of political campaign literature, two papers show that a filibuster by the opposition party can convey information about the majority party thanks to the mass media (Stone 2013; Kishishita 2017). We introduce a setting similar with that of Kishishita (2017), and create a role of the mass media as watchdog though the context is different.

3. The Model

There exist two candidates (incumbent A and challenger B), sophisticated voters, and naïve voters. Voters are a continuum of measure one. Sophisticated voters know whose policy is best and update their beliefs using the Bayes rule. They are informed and Bayesian rational. The fraction of sophisticated voters is $\gamma \in (0, 1)$. Naïve voters do not know a good policy and are persuaded by campaigns naïvely. They are uninformed and Bayesian irrational. The fraction of naïve voters is $1 - \gamma$.

3.1. Candidates' Characteristics

Candidate $k \in \{A, B\}$ is characterized using two dimensions: her/his ideal policy x_k and her/his ability θ_k. There is a policy issue which is central to the election. Each candidate cannot commit policy as in the citizen candidate model. Thus, the policy implemented by a candidate is her/his ideal policy. The value of x_k is common-knowledge and $x_A \neq x_B$.

θ_k is candidate k's ability. Since how well a candidate can do as the policymaker is unclear before s/he obtains a seat, a candidate's ability is revealed only after s/he becomes a policymaker. In particular, the challenger's ability is unobservable to all the players, including the challenger. The incumbent's ability has already been revealed and both candidates know the ability, although voters do not. θ_k takes either $g \in \mathbb{R}^+$ (high ability) or 0 (low ability) with an equal probability. The values of θ_A and θ_B are independently determined, and the prior is common knowledge.

3.2 Voters' Utility

Let the set of voters be I. Each voter votes for one of the two candidates. Voter $i \in I$ has an

[7] Furthermore, multiple senders send a message about the same state in our model, while in their model, each candidate knows only her/his own ability so that the game has only one sender.

[8] Polborn and David (2006) and Bhattacharya (2016) implicitly assume fact checking by the mass media to verify their information revelation protocol. There, the mass media is not modeled as a self-interested player, and its endogenous decision is not incorporated.

ideal policy $\hat{x}_i \in \{x_A, x_B\}$ and feeling toward the incumbent $\varepsilon_i \in \mathbb{R}$. Here, $\hat{x}_i = x_A$ with probability $\rho \in (0,1)$ and $\hat{x}_i = x_B$ with probability $1-\rho$. ε_i follows an IID whose distribution function is Φ and density function is ϕ. For any $\varepsilon > 0, \phi(\varepsilon) = \phi(-\varepsilon)$. In addition, ε_i is determined independently of $\hat{x}_i$, and voter i knows the value of ε_i.

Since each voter has no strategic power, we consider sincere voting. Voter i's payoff when candidate k wins given x_k and θ_k is

$$u_i(k) = -\alpha v(x_k, \hat{x}_i) + \beta\theta_k + \mathbf{1}\{k = A\}\varepsilon_i.$$ [9]

Here, $\alpha, \beta \in \mathbb{R}^+$, $v(x_k, \hat{x}_i) = 0$ if $\hat{x}_i = x_k$, and $v(x_k, \hat{x}_i) = d \in \mathbb{R}^+$ if $\hat{x}_i = x_{-k}$. $\mathbf{1}\{k = A\}$ is the indicator function which takes one when $k = A$.

If the expected value of $u_i(k)$ is higher than that of $u_i(-k)$, voter i votes for candidate k. When voter i is indifferent between both candidates, s/he votes for incumbent A with probability 1/2. We assume that $\alpha d > \beta g/2$. Since αd is the loss when a bad policy is implemented, and $g\beta$ is the benefit when a candidate with high ability is elected, this assumption means that the importance of ability for voters is smaller than twice the importance of policy. This assumption holds as long as the importance of ability is not too large compared to the importance of policy.

3.3 Sophisticated Voters

Each sophisticated voter i knows the value of $\hat{x}_i$ because s/he has sufficient knowledge. On the contrary, even sophisticated voters do not know the value of θ_A, since it is private information. Thus, they infer it based on each candidate's campaign strategy (C^A, C^B). Let the belief about the probability that $\theta_A = g$ given (C^A, C^B) be $\pi(C^A, C^B)$. Assume that sophisticated voters and the media outlet have the same belief given (C^A, C^B).

Sophisticated voter i decides whom to vote for based on $\hat{x}_i$ and π. The number of sophisticated voters whose $\hat{x}_i = x_A$ and who vote for incumbent A is

$$\gamma \times \rho \times \Phi(\alpha d + \beta(\pi(C^A, C^B) - 0.5)g),$$

and the number of sophisticated voters whose $\hat{x}_i = x_B$ and who votes for incumbent A is

$$\gamma \times (1-\rho) \times \Phi(-\alpha d + \beta(\pi(C^A, C^B) - 0.5)g).$$

3.4 Naïve Voters

Since naïve voters have only limited knowledge, each naïve voter i does not know the value of $\hat{x}_i$.[10] In addition, like sophisticated voters, s/he does not know the incumbent's ability. In addition, naïve voters are persuaded perfectly by the candidates' campaigns.

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[9] We consider a politician's ability that is irrelevant to the implementation of the policy central in the election. In the U.S. presidential election, that corresponds to ability as the commander-in-chief. In the U.S. House of Representatives election that corresponds to ability for pork barrel. The incumbent's ability for pork barrel is not necessarily hard information and candidates can tell a lie (Grimmer, Westwood, and Messing 2014).

[10] For example, suppose that trade liberalization is the central issue in an election. This model illustrates that a naïve voter does not know the effect of trade liberalization on her/his economic situation and thus s/he does not know whether trade should be liberalized.

3.5 Campaigning

Each candidate has a fixed amount of campaign resources. A candidate's objective is to maximize her/his expected number of obtained votes.[11] To this end, each candidate decides whether to focus on policy or ability in campaigning. In other words, each candidate determines the fraction of campaigns s/he spends on policy (e.g., the fraction of time devoted to campaigning policy in speeches) C^k and the fraction of campaigns s/he spends on ability $1 - C^k$. In particular, each candidate chooses $C^k \in \{C_H, C_L\}$, where $0 < C_L < C_H < 1$.[12] $C^k = C_H$ (C_L) represents that candidate k focuses on policy (ability).

Campaigns on policy persuade a naïve voter that the voter's ideal policy is the candidate's policy. The challenger's (incumbent's) campaigns on ability persuade a naïve voter that the incumbent's ability is low (high). Notice that the challenger cannot persuade voters that her/his ability is high because the ability has not been realized.

The fraction of voters a candidate persuades is given by $p_k(C^k, C^{-k}) \in (0, 1)$ and $n_k(1 - C^k, 1 - C^k) \in (0, 1)$. Candidate k persuades $p_k(C^k, C^{-k}) \times 100$ percent of naïve voters that candidate k's policy is good. Further, candidate A (B) persuades $n_A(1 - C^A, 1 - C^B) \times 100$ $(n_B(1 - C^B, 1 - C^A) \times 100)$ percent of naïve voters that the incumbent's ability is high (low). Therefore, the challenger's campaigns on ability are negative campaigns on the incumbent's ability. We assume that p_k and n_k satisfy the following regular conditions.

ASSUMPTION 1

i. *(Symmetry)* $p_k(x, y) = p_{-k}(x, y) = p(x, y)$ and $n_k(1 - x, 1 - y) = n_{-k}(1 - x, 1 - y) = n(1 - x, 1 - y)$ for $k \in \{A, B\}$, and $x, y \in \{C_H, C_L\}$.

ii. *(Full persuasion)* For $k \in \{A, B\}$, $p_k(C^k, C^{-k}) + p_{-k}(C^{-k}, C^k) = 1$ and $n_k(1 - C^k, 1 - C^{-k}) + n_{-k}(1 - C^{-k}, 1 - C^k) = 1$ for $C^k, C^{-k} \in \{C_H, C_L\}$.

iii. *(Monotonicity)* For $k \in \{A, B\}$, $p_k(C_H, C^{-k}) > p_k(C_L, C^{-k})$ and $n_k(1 - C_H, 1 - C^{-k}) < n_k(1 - C_L, 1 - C^{-k})$ for $C^{-k} \in \{C_H, C_L\}$, and $p_k(C^k, C_H) < p_k(C^k, C_L)$ and $n_k(1 - C^k, 1 - C_H) > p_k(1 - C^k, 1 - C_L)$ for $C^k \in \{C_H, C_L\}$.

(i) The effect of campaigns on naïve voters is the same across candidates, (ii) all the naïve

[11] The vote share affects post-election policy making though candidates win the election with half of all votes. Alternatively, maximizing the winning probability under aggregate uncertainty about voters' preferences would be qualitatively similar to maximizing the vote share in our framework.

[12] In reality, voters could not distinguish a small difference in C^k (i.e., they would observe only whether a candidate focuses on policy or ability). Thus, the binary choice is meaningful.

voters are persuaded by campaigns on policy (ability), and (iii) a candidate succeeds in persuading a larger number of naïve voters on any given dimension as the amount of campaigns about the dimension s/he (the opponent) provides increases (decreases).

3.6. Mass Media

There is one media outlet that observes the value of θ_A with probability $\delta \in (0, 1)$ by spending cost m.[13] The outlet reports the news if and only if it observes the truth.[14] It cannot report news that is not true. Only sophisticated voters receive information through the news.

In addition, only news reporting the incumbent's low ability is profitable.[15] If the outlet reports such news, it obtains revenue $a \in \mathbb{R}^+$. If not, it obtains zero revenue. Thus, when the outlet reports news on the incumbent's low ability, its profit is $a - m$. The outlet gathers news by spending cost m if and only if the expected profit is non-negative. We assume that $a > m/\delta$, giving the media outlet an incentive to gather news when $\pi(C^A, C^B) = 0$.

This setting implies that news about the incumbent's low ability is profitable even after people already know that the incumbent's ability is low through campaigning. Here, we implicitly assume that news conveys not only whether the incumbent's ability is high, but also information about how and why the incumbent ability is low, which cannot be obtained from the campaign. Thus, news is still valuable for voters.

3.7. Timing of the Game

1. Nature chooses the value of θ_A and each candidate observes it.
2. Each candidate simultaneously chooses $C^k \in \{C_H, C_L\}$. The media outlet and sophisticated voters observe $\{C^k\}_{k\in\{A,B\}}$.
3. The media outlet decides whether to spend costs m and gather news. If it spends costs, it observes the value of θ_A with probability δ and reports the value of θ_A to sophisticated voters.
4. Each voter votes for either the incumbent or the challenger.

The solution concept is a sequential equilibrium[16] and we focus on pure strategies.

[13] The following setting is similar to that of Kishishita (2017) and originally based on that of Besley and Prat (2006).

[14] Thus, news is hard information and the media outlet does not withhold the news. The former has been widely assumed (e.g., Besley and Prat 2006; Warren 2012). The latter implies no possibility of media capture by candidates. However, even under the possibility of media capture (Besley and Prat 2006), the result would hold under some conditions. This is because the logic behind Kishishita's results (2017) can be applied, which argues that the opposition party's whistleblowing through a filibuster is robust against media capture.

[15] Many empirical studies show that negative news tends to be reported more than positive news (e.g., Harrington 1989; Patterson 1997; Soroka 2006; Soroka 2011). Studies of individuals' disproportionate attentiveness to negative versus positive information (e.g., prospect theory) provide explanation for this tendency. Even if news on the incumbent's high ability is profitable, the result holds as long as the revenue of reporting such news a' is so small that $\delta a' < m$ holds.

[16] Strategies and belief systems constitute a sequential equilibrium if and only if each player's strategy is sequentially rational given the beliefs, and beliefs of sophisticated voters and the media outlet are consistent with

4. Equilibrium

To begin with, we examine naïve voters' voting behaviors. Then, we derive the conditions for the existence of two classes of separating equilibria. Next, we prove that the other separating equilibria do not exist and characterize the condition for the existence of separating equilibria. Finally, we eliminate pooling equilibria using the intuitive criterion.

4.1. Voting Behaviors of Naïve Voters

We derive the number of naïve voters who vote for the incumbent given (C^A, C^B). From Assumption 1, naïve voters are divided into four types: those who believe that (1) the incumbent's policy and ability are good; (2) the challenger's policy and the incumbent's ability are good; (3) the incumbent's policy is good but her/his ability is low; and (4) the challenger's policy is good and the incumbent's ability is low.

The fraction of those who vote for the incumbent among (1) is $\Phi(\alpha d + 0.5\beta g)$, among (2) is $\Phi(-\alpha d + 0.5\beta g)$, among (3) is $\Phi(\alpha d - 0.5\beta g)$, and among (4) is $\Phi(-\alpha d - 0.5\beta g)$. We denote each of these by Φ_{HH}, Φ_{LH}, Φ_{HL}, and Φ_{LL} respectively. We obtain the following lemma.

LEMMA 1 $\Phi_{HH} > \Phi_{HL} > \Phi_{LH} > \Phi_{LL}$ holds.

PROOF Since Φ is strictly increasing, $\Phi_{HH} > \Phi_{HL}$ and $\Phi_{LH} > \Phi_{LL}$ holds. In addition, $\alpha d - 0.5\beta g > \alpha d + 0.5\beta g$ since $\alpha d > 0.5\beta g$. Thus, $\Phi_{HL} > \Phi_{LH}$ holds. ■

The number of naïve voters who are in group (1) and vote for the incumbent is $(1-\gamma)p(C^A, C^B)n(C^A, C^B)\Phi_{HH}$, the number of naïve voters who are in group (2) and vote for the incumbent is $(1-\gamma)\left(1-p(C^A, C^B)\right)n(C^A, C^B)\Phi_{LH}$, the number of naïve voters who are in group (3) and vote for the incumbent is $(1-\gamma)p(C^A, C^B)\left(1-n(C^A, C^B)\right)\Phi_{HL}$, and the number of naïve voters who are in group (4) and vote for the incumbent is $(1-\gamma)\left(1-p(C^A, C^B)\right)\left(1-n(C^A, C^B)\right)\Phi_{LL}$.

We finally obtain the total number of naïve voters who vote for the incumbent:

$$(1-\gamma) \times \underbrace{\left[\begin{array}{c} p(C^A, C^B)n(C^A, C^B)(\Phi_{HH} - \Phi_{LH} - \Phi_{HL} + \Phi_{LL}) + p(C^A, C^B)(\Phi_{HL} - \Phi_{LL}) \\ +n(C^A, C^B)(\Phi_{LH} - \Phi_{LL}) + \Phi_{LL} \end{array}\right]}_{\equiv F(C^A, C^B)}.$$

Hereafter, we impose the following assumption.

ASSUMPTION 2 The following inequality (*) holds:

$$\left(\frac{\Phi_{HL} - \Phi_{LH}}{\Phi_{LH} - \Phi_{LL}} + 1\right)\left(p(C_H, C_H) - p(C_L, C_H)\right) > n(1 - C_L, 1 - C_H) - n(1 - C_H, 1 - C_H).$$

---

the strategies. Naïve voters' belief can be inconsistent with the strategies.

$p(C_H, C_H) - p(C_L, C_H)$ is the marginal change in the fraction of naïve voters who are persuaded that a candidate's policy is good after the candidate increases his/her campaigning on policy. Similarly, $n(1 - C_L, 1 - C_H) - n(1 - C_H, 1 - C_L)$ is the marginal change in the fraction of naïve voters who are persuaded that a candidate's argument about the incumbent's ability is true after the candidate increases his/her campaigning on ability. Inequality (*) holds as long as the latter is not much larger than the former. Since it is unnatural that both are totally different, Assumption 2 is not that restrictive at all. Indeed, the following example in which p and n are symmetric satisfies Assumption 2.

EXAMPLE When $p(x, y) = n(x, y)$, and $C_H + C_L = 1$, inequality (*) holds.

From the next lemma, Assumption 2 guarantees that campaigning on ability is less efficient than campaigning on policy. The omitted proofs are contained in Appendix B.

LEMMA 2 Under Assumptions 1 and 2,

$$F(C_H, C_H) - F(C_L, C_H) = F(C_H, C_L) - F(C_L, C_L) = F(C_H, C_L) - F(C_H, C_H) = F(C_L, C_L) - F(C_L, C_H) > 0.$$

From Assumption 1, the effect of focusing on policy is the same independently of the opponent's campaign strategy, and the effect of focusing on policy is the same as that of the challenger's focusing on the incumbent's ability. This is the first part of Lemma 2.

Moreover, from Assumption 2, these effects are positive. This is the second part of Lemma 2. It means that campaigning on policy is more efficient than campaigning on ability in terms of mobilizing naïve voters, and thus it is better to focus on policy.

The reason is that policy and ability have different attributes. When the two candidates propose different policies on the same issue, the fact that one candidate's policy is good implies that the other candidate's policy is bad. For example, suppose that trade reform is a central issue in an election. One candidate will implement trade protection while the other will implement trade liberalization. In such a case, if a voter believes that trade protection is good, s/he also believes that trade liberalization is bad. Thus, when a candidate succeeds in persuading a voter that his/her policy is good for the voter, it also implies that the voter is persuaded that the opponent's policy is bad. In contrast, such an effect does not exist in campaigning on ability. Even if a candidate has a high ability, it does not mean that the other candidate has a low ability since both can have high abilities. Thus, campaigning on ability is less efficient than campaigning on policy. This is consistent with the empirical result that policy is a more frequent topic of campaign messages than character, and winners are more likely to focus on policy than character (Benoit 2007).

4.2. Negative Campaign Equilibrium [I]

We derive the condition for the existence of an equilibrium in which (i) the challenger focuses on the incumbent's ability if and only if the incumbent's ability is low, and (ii) the incumbent focuses on policy independently of her/his own ability. From now on, we call this class of equilibria *negative campaign equilibrium [I]*.

The strategies and belief system in this equilibrium must satisfy the following.

(1) $C^A = C_H$ *for any* θ_A.

(2) *If* $\theta_A = g$, $C^B = C_H$. *If* $\theta_A = 0$, $C^B = C_L$.

(3) *The media outlet and sophisticated voters' belief after observing* (C^A, C^B)*:*

$$\pi(C_H, C^B) = \begin{cases} 1 \text{ if } C^B = C_H \\ 0 \text{ if } C^B = C_L \end{cases}.$$

(4) *When* $(C^A, C^B) = (C_H, C_L)$, *the media outlet gathers news. When* $(C^A, C^B) = (C_H\ C_H)$, *the media outlet does not gather news.*[17]

(5) *Sophisticated voter* i *votes for the incumbent (the challenger) if*

$$\alpha[v(x_A, \hat{x}_i) - v(x_B, \hat{x}_i)] + \beta[\pi(C^A, C^B) - 0.5]g$$

is positive (negative). S/he votes for the incumbent with probability 0.5 *if this is zero.*

Given this, we obtain the condition for the existence of negative campaign equilibrium [I].

PROPOSITION 1 *There exists a separating equilibrium in which (i)* $C^B = C_L$ *if and only if* $\theta_A = 0$, *and (ii)* C^A *is independent of the value of* θ_A, *if and only if* $\underline{\gamma} \leq \gamma \leq \overline{\gamma}$, *where*

$$\underline{\gamma} \equiv \frac{F(C_H, C_L) - F(C_H, C_H)}{F(C_H, C_L) - F(C_H, C_H) + [\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]};$$

$$\overline{\gamma} \equiv \frac{F(C_H, C_L) - F(C_H, C_H)}{F(C_H, C_L) - F(C_H, C_H) + (1-\delta)[\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]}.$$

In addition, $\underline{\gamma}, \overline{\gamma} \in (0, 1)$.

Therefore, negative campaigning on the incumbent's ability can be a signal of the incumbent's low ability. To make a message a signal, sending the message must be costly. Here, campaign messages change naïve voters' behaviors. From Lemma 2, campaigning on ability is less efficient than campaigning on policy at mobilizing naïve voters. In this sense, it is costly to focus on the incumbent's ability. As a result, negative campaigning on the incumbent's ability can be a credible signal.

Proposition 1 also characterizes the number of sophisticated voters for the existence of

[17] When $\theta_A = g$, the media outlet cannot obtain news about the incumbent's low ability. Thus, it does not gather news when $\pi = 1$. When $\pi = 0$, it gathers news because $\delta a > m$.

negative campaign equilibrium [I]. The challenger's emphasis of the incumbent's ability can be a signal because campaigning on ability is costly in terms of mobilizing naïve voters. Thus, the effect of campaigning on naïve voters creates the cost. Therefore, some fraction of naïve voters is essential. In the result, there is an upper bound of the number of sophisticated voters, which represents this positive role of naïve voters. If the number of naïve votes is quite large, the cost of campaigning on ability could be too large for the challenger to focus on ability even when the incumbent's ability is low. Thus, the number of naïve voters should be smaller than a value. Therefore, there is also a lower bound of the number of sophisticated voters.

Finally, we examine the role of the mass media. Though campaigning on ability is costly for the challenger, this is not enough to become a credible signal. The cost of focusing on the incumbent's ability is independent of the incumbent's actual ability. However, its net benefit must depend on the incumbent's ability. To this end, the mass media is necessary. Suppose that the challenger focuses on the incumbent's ability in spite of the incumbent's high ability. Then, the mass media tries to gather news and finds the truth with some probability. As a result, the news on the incumbent's high ability is reported, and sophisticated voters find that the challenger's message is wrong. In other words, the challenger's lie is detected and the number of her/his obtained votes is likely to be quite small even if s/he focuses on the incumbent's ability. Therefore, the benefit of such a campaign strategy is smaller for the challenger under the incumbent's high ability than under the low ability. For this reason, separating equilibria can be constructed. The role of the mass media can be seen in the value of $\bar{\gamma}$. When $\delta = 0$, $\bar{\gamma} = \underline{\gamma}$, and thus negative campaign equilibrium [I] is almost impossible to be constructed.

4.3. Negative Campaign Equilibrium [II]

We next examine another class of separating equilibria, where negative campaigning on the incumbent's ability is a signal of the incumbent's low ability. That is the equilibrium in which (i) the challenger focuses on the incumbent's ability if and only if the incumbent's ability is low and (ii) the incumbent focuses on her/his own ability if and only if the incumbent's ability is high. We call this class of equilibria *negative campaign equilibrium [II]*. The difference from the previous equilibrium is that both candidates send signals in this equilibrium.

Define $p^* \equiv 1 - m/(\delta a)$. Note that $p^* \in (0, 1)$. This is the threshold value of p where the media outlet spends cost m if and only if $\pi \leq p^*$. In this equilibrium, the strategies and belief system are as follows:

(1) If $\theta_A = g$, $C^A = C_L$. *If* $\theta_A = 0$, $C^A = C_H$.

(2) If $\theta_A = g$, $C^B = C_H$. *If* $\theta_A = 0$, $C^B = C_L$.

(3) The media outlet and sophisticated voters' belief after observing (C^A, C^B)*:*

$$\pi(C^A, C^B) = \begin{cases} 1 \text{ if } (C^A, C^B) = (C_L, C_H) \\ 0 \text{ if } (C^A, C^B) = (C_H, C_L) \\ p_{HH} \text{ if } (C^A, C^B) = (C_H, C_H) \\ p_{LL} \text{ if } (C^A, C^B) = (C_L, C_L) \end{cases}.$$

(4) When $(C^A, C^B) = (C_L, C_H)$, the media outlet gathers news. When $(C^A, C^B) = (C_H, C_L)$, the media outlet does not gather news. When $(C^A, C^B) = (C_H, C_H)$ ($(C^A, C^B) = (C_L, C_L)$), the media outlet gathers news if and only if $p_{HH} \le p^*$ ($p_{LL} \le p^*$).

(5) Sophisticated voter i votes for the incumbent (the challenger) if

$$\alpha[v(x_A, \hat{x}_i) - v(x_B, \hat{x}_i)] + \beta[\pi(C^A, C^B) - 0.5]g$$

is positive (negative). S/he votes for the incumbent with probability 0.5 if this is zero.

Given this, we obtain the condition under which the strategies and beliefs above constitute a sequential equilibrium.

LEMMA 3 The strategies and beliefs above constitute a sequential equilibrium if and only if the following condition holds:

(1) p_{HH} satisfies either (1-1) or (1-2):

(1-1) $p_{HH} \le p^*$, and $\gamma \ge \gamma_M^-(p_{HH}) \equiv \max\{\gamma_1^-(p_{HH}), \gamma_2^-(p_{HH})\}$

(1-2) $p_{HH} > p^*$, and $\gamma \ge \gamma_M^+(p_{HH}) \equiv \max\{\gamma_1^+(p_{HH}), \gamma_2^+(p_{HH})\}$.

(2) p_{LL} satisfies either (2-1) or (2-2):

(2-1) $p_{LL} \le p^*$, and $\gamma \le \gamma_m^-(p_{LL}) \equiv \min\{\gamma_1^-(p_{LL}), \gamma_2^-(p_{LL})\}$

(2-2) $p_{LL} > p^*$, and $\gamma \le \gamma_m^+(p_{LL}) \equiv \min\{\gamma_1^+(p_{LL}), \gamma_2^+(p_{LL})\}$.

Here,

$$\gamma_1^-(p) \equiv \frac{F(C_H, C_H) - F(C_L, C_H)}{F(C_H, C_H) - F(C_L, C_H) + (1-\delta)\left[\rho\left(\Phi_{HH} - \Phi(\alpha d + (p-0.5)\beta g)\right) + (1-\rho)\left(\Phi_{LH} - \Phi(-\alpha d + (p-0.5)\beta g)\right)\right]};$$

$$\gamma_1^+(p) \equiv \frac{F(C_H, C_H) - F(C_L, C_H)}{F(C_H, C_H) - F(C_L, C_H) + \rho\left(\Phi_{HH} - \Phi(\alpha d + (p-0.5)\beta g)\right) + (1-\rho)\left(\Phi_{LH} - \Phi(-\alpha d + (p-0.5)\beta g)\right)};$$

$$\gamma_2^-(p) \equiv \frac{F(C_H, C_H) - F(C_L, C_H)}{F(C_H, C_H) - F(C_L, C_H) + (1-\delta)[\rho(\Phi(\alpha d + (p-0.5)\beta g) - \Phi_{HL}) + (1-\rho)(\Phi(-\alpha d + (p-0.5)\beta g) - \Phi_{LL})]};$$

$$\gamma_2^+(p) \equiv \frac{F(C_H, C_H) - F(C_L, C_H)}{F(C_H, C_H) - F(C_L, C_H) + \rho(\Phi(\alpha d + (p-0.5)\beta g) - \Phi_{HL}) + (1-\rho)(\Phi(-\alpha d + (p-0.5)\beta g) - \Phi_{LL})}.$$

In addition, $\gamma_1^-(p), \gamma_1^+(p), \gamma_2^-(p), \gamma_2^+(p) \in (0,1)$ holds.[18]

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[18] The role of the mass media examined in negative campaign equilibrium [I] is also seen in negative campaign equilibrium [II]. Suppose that $\delta = 0$. Since the media outlet does not gather news, $\gamma_M^+(p_{HH}) \le \gamma \le \gamma_m^+(p_{LL})$ must hold to sustain the equilibrium from Lemma 3. Such γ exists only when $p_{HH} = p_{LL} = 1$. Moreover, in this case, $\gamma_M^+(p_{HH}) = \gamma_m^+(p_{LL}) = \underline{\gamma}$. In summary, when $\delta = 0$, negative campaign equilibrium [II] does not exist so long as $\gamma \ne \underline{\gamma}$.

If and only if there exist p_{HH} and p_{LL} satisfying the conditions in Lemma 3, negative campaign equilibrium [II] exists. Thus, it suffices to derive the necessary and sufficient condition under which there exist p_{HH} and p_{LL} satisfying the conditions in Lemma 3. For this purpose, we obtain several lemmas. Define

$$\gamma_M(p)\big(\gamma_m(p)\big) \equiv \begin{cases} \gamma_M^-(p)\ \big(\gamma_m^-(p)\big) \text{ if } p \leq p^* \\ \gamma_M^+(p)\ \big(\gamma_m^+(p)\big) \text{ if } p > p^* \end{cases}.$$

LEMMA 4 $\gamma_1^+(p)$ and $\gamma_1^-(p)$ ($\gamma_2^+(p)$ and $\gamma_2^-(p)$) are increasing (decreasing) in p. In addition, there is a unique solution $\hat{p}$ satisfying $\gamma_M(\hat{p}) = \gamma_m(\hat{p})$.

LEMMA 5 The following equation holds:

$$0.5[\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]$$
$$= \rho[\Phi_{HH} - \Phi(\alpha d + (\hat{p} - 0.5)\beta g)] + (1-\rho)[\Phi_{LH} - \Phi(-\alpha d + (\hat{p} - 0.5)\beta g)]\,.$$

PROOF From the definition of γ_1 and γ_2, this is straightforwardly obtained. ■

We finally obtain the condition for the existence of negative campaign equilibrium [II].

PROPOSITION 2

(a) Suppose that $\hat{p} > p^*$*. There exists a separating equilibrium in which (i) when* $\theta_A = 0$*,* $(C^A, C^B) = (C_H, C_L)$*, and (ii) when* $\theta_A = g$*,* $(C^A, C^B) = (C_L, C_H)$*,*

1. *if and only if* $\gamma_1^+(\hat{p}) \leq \gamma \leq \gamma_1^-(p^*)$*, when* $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$*, and*
2. *if and only if* $\gamma = \gamma_1^+(\hat{p})$*, when* $\gamma_1^+(\hat{p}) \geq \gamma_1^-(p^*)$*.*

(b) Suppose $\hat{p} \leq p^*$*. There exists a separating equilibrium, in which (i) when* $\theta_A = 0$*,* $(C^A, C^B) = (C_H, C_L)$*, and (ii) when* $\theta_A = g$*,* $(C^A, C^B) = (C_L, C_H)$*,*

1. *if and only if* $\gamma_1^+(p^*) < \gamma \leq \gamma_1^-(\hat{p})$*, when* $\gamma_1^-(\hat{p}) > \gamma_1^+(p^*)$*, and*
2. *if and only if* $\gamma = \gamma_1^-(\hat{p})$*, when* $\gamma_1^+(p^*) \leq \gamma_1^-(\hat{p})$*.*

When $\hat{p} > p^*$ and $\gamma_1^+(\hat{p}) \geq \gamma_1^-(p^*)$, or $\hat{p} \leq p^*$ and $\gamma_1^+(p^*) \leq \gamma_1^-(\hat{p})$, the equilibrium exists only when $\gamma = \gamma_1^+(\hat{p})$ (i.e., the equilibrium almost always does not exist). The meaningful cases are those under which $\hat{p} > p^*$ and $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$, or $\hat{p} \leq p^*$ and $\gamma_1^+(\hat{p}) > \gamma_1^-(p^*)$. In such cases, the condition for the existence of the equilibrium is, again, given by the interval of the value of γ.

	$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$
$\boldsymbol{C^B}$	C_H	C_L	$\boldsymbol{C^B}$	C_H	C_L	$\boldsymbol{C^B}$	C_H	C_L
$\boldsymbol{C^A}$	C_H	C_H	$\boldsymbol{C^A}$	C_L	C_L	$\boldsymbol{C^A}$	C_H	C_L
Case 1			**Case 2**			**Case 3**		
	$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$
$\boldsymbol{C^B}$	C_H	C_L	$\boldsymbol{C^B}$	C_L	C_H	$\boldsymbol{C^B}$	C_L	C_H
$\boldsymbol{C^A}$	C_L	C_H	$\boldsymbol{C^A}$	C_H	C_H	$\boldsymbol{C^A}$	C_L	C_L
Case 4			**Case 5**			**Case 6**		
	$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$
$\boldsymbol{C^B}$	C_L	C_H	$\boldsymbol{C^B}$	C_L	C_H	$\boldsymbol{C^B}$	C_H	C_H
$\boldsymbol{C^A}$	C_H	C_L	$\boldsymbol{C^A}$	C_L	C_H	$\boldsymbol{C^A}$	C_H	C_L
Case 7			**Case 8**			**Case 9**		
	$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$		$\boldsymbol{\theta_A = g}$	$\boldsymbol{\theta_A = 0}$
$\boldsymbol{C^B}$	C_H	C_H	$\boldsymbol{C^B}$	C_L	C_L	$\boldsymbol{C^B}$	C_L	C_L
$\boldsymbol{C^A}$	C_L	C_H	$\boldsymbol{C^A}$	C_H	C_L	$\boldsymbol{C^A}$	C_L	C_H
Case 10			**Case 11**			**Case 12**		

Table 1: Candidates of Separating Equilibria

4.4 Characterization and Existence of Separating Equilibria

So far, we have focused on two classes of separating equilibria. However, other separating equilibria may exist. Table 1 shows 12 candidates of separating equilibria. We show the non-existence of the other separating equilibria and characterize the condition about the fraction of sophisticated voters under which a separating equilibrium exists.

Consider a candidate of equilibria similar to negative campaign equilibrium [I] except that the incumbent chooses C_L independently of her/his ability. Suppose the incumbent's ability is low. This low ability is uncovered by the challenger's campaign. Given this, the incumbent has no incentive to choose the costly campaign strategy. Thus, there is no such equilibrium.

LEMMA 6 There is no sequential equilibrium where $C^A = C_L$ independently of θ_A, and $C^B = C_H$ if and only if $\theta_A = 0$.

We next obtain the lemma about the non-existence of an equilibrium in which the challenger focuses on the incumbent's ability issue if and only if the incumbent's ability is high. Since campaigning on ability is costly, the challenger has no incentive to do so when the information makes sophisticated voters think the incumbent's ability is high.

LEMMA 7 There is no sequential equilibrium where $C^B = C_L$ if and only if $\theta_A = g$.

We next obtain the following two lemmas which show that there is no equilibrium where only the incumbent's campaign message is informative.

LEMMA 8 There is no sequential equilibrium where $C^A = C_H$ if and only if $\theta_A = g$ while the challenger's campaign is independent of θ_A.

LEMMA 9 There is no sequential equilibrium where $C^A = C_L$ if and only if $\theta_A = g$ while the challenger's campaign is independent of θ_A.

This is because the mass media does not work as the watchdog. Suppose the incumbent sends a signal that her/his ability is high despite actually having a low ability. Since the challenger does not send any information, the mass media believes that the incumbent's ability is high. It thus does not gather news because there is no possibility of finding profitable news. Therefore, the incumbent can perfectly deceive sophisticated voters. As a result, the incumbent's campaign strategy is not informative.

Finally, we obtain the lemma showing there is no equilibrium where the challenger's campaign strategy is informative, and the incumbent focuses on her/his ability only when her/his ability is high. Since campaigning on ability is costly, the incumbent has no incentive to focus on ability when it conveys negative information about the incumbent.

LEMMA 10 There is no sequential equilibrium where $C^A = C_L$ if and only if $\theta_A = 0$, and $C^B = C_L$ if and only if $\theta_A = 0$.

Given these lemmas, only negative campaign equilibria [I] and [II] can constitute a separating equilibrium. Therefore, in any separating equilibrium, negative campaigning on the incumbent's ability arises as a signal of the incumbent's low ability.

PROPOSITION 3 *If a separating equilibrium exists, it must be either negative campaign equilibrium [I] or [II].*

PROOF From Lemma 6, Case 2 in Table 1 cannot constitute any equilibrium. From Lemma 7, Cases 5-8 cannot constitute any equilibrium. From Lemma 8, Cases 9 and 11 cannot constitute any equilibrium. From Lemma 9, Cases 10 and 12 cannot constitute any equilibrium. From Lemma 10, Case 3 cannot constitute any equilibrium. Therefore, we obtain the result. ■

Propositions 1- 3 give us the characterization of separating equilibria. Our remaining task is to derive the condition for the existence of a separating equilibrium. To this end, we examine the magnitude relation between the upper and lower bounds of γ derived in Propositions 1 and 2. We obtain the following lemma about this relation.

LEMMA 11 For any $p \in (0,1)$, $\gamma_1^+(p), \gamma_2^+(p) > \underline{\gamma}$ and $\gamma_1^-(p), \gamma_2^-(p) > \overline{\gamma}$.

Therefore, the upper and lower bounds of γ for the existence of negative campaign equilibrium [II] are higher than those for the existence of negative campaign equilibrium [I]. The key is that both candidates send signals in negative campaign equilibrium [II]. To see this, consider the challenger's deviation incentive when the incumbent's ability is high. In this case, the challenger has an incentive to focus on ability. When only the challenger sends a signal, this deviation succeeds, since sophisticated voters believe the challenger's lie as long as the mass media's monitoring does not succeed. On the contrary, when both candidates send signals, sophisticated voters find that either one is telling a lie after the challenger's unilateral deviation. Thus, sophisticated voters do not fully believe the challenger's message. As a result, the challenger's deviation incentive is smaller when both send signals than when only the challenger sends a signal. Since the existence of naïve voters creates a cost of campaigning on ability, the necessary number of naïve voters is lower as this deviation incentive becomes smaller. Therefore, the upper bound of γ is higher in negative campaign equilibrium [II] than negative campaign equilibrium [I].

We next examine the lower bound of γ. Consider the challenger's deviation incentive when the incumbent's ability is low. Since campaigning on ability is costly, the challenger has an incentive to focus on policy even if the incumbent's ability is low. When only the challenger sends a signal, sophisticated voters fully believe that the incumbent's ability is high after this deviation. Thus, the loss due to focusing on policy is large. On the contrary, when both candidates send signals, after the deviation, sophisticated voters think that either one deviates and do not fully believe that the incumbent's ability is high. Thus, the loss due to focusing on policy is smaller in this case than when only the challenger sends a signal. Therefore, in order to prevent this type of deviation, the cost of campaigning on ability must be small when both candidates send signals. As a result, the necessary number of sophisticated voters is higher (the lower bound of γ is higher) in negative campaign equilibrium [II] than negative campaign equilibrium [I].

In addition, we obtain an additional result depending on the value of δ.

LEMMA 12 Fix p^* and $\hat{p}$. If and only if $\delta \geq 0.5$, $\gamma_1^+(\hat{p}) \leq \overline{\gamma}$. Further, there is $\bar{\delta} \in [0,1)$ such that if and only if $\delta \geq \bar{\delta}$, $\gamma_1^+(p^*) \leq \overline{\gamma}$.[19]

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[19] $\bar{\delta}$ depends on p^* and thus δ. The second part of Lemma 12 does not argue that $\gamma_1^+(p^*) \leq \overline{\gamma}$ is more likely to hold as δ increases. Fix the value of p^*, and consider the set $K(p^*) \equiv \{(\delta, a/m) | \, 1 - m/(\delta a) = p^*\}$. The implication of the second half is that for $(\delta, a/m)$ and $(\delta', a'/m') \in K(p^*)$ such that $\delta > \delta'$, $\gamma_1^+(p^*) \leq \overline{\gamma}$ is more likely to hold under $(\delta, a/m)$ than under $(\delta', a'/m')$.

Finally, we obtain the condition for the existence of a separating equilibrium.

THEOREM 1 *Suppose that either (i)* $\hat{p} > p^*$ *and* $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$*, or (ii)* $\hat{p} \leq p^*$ *and* $\gamma_1^+(\hat{p}) > \gamma_1^-(p^*)$ *holds. Then, at least one separating equilibrium exists if and only if the following condition is satisfied:*

1. *When* $p^* < \hat{p}$ *and* $\delta \geq 0.5$, $\underline{\gamma} \leq \gamma \leq \gamma_1^-(p^*)$ *is satisfied.*
2. *When* $p^* < \hat{p}$ *and* $\delta < 0.5$, *either* $\gamma_1^+(\hat{p}) < \gamma \leq \gamma_1^-(p^*)$ *or* $\underline{\gamma} \leq \gamma \leq \overline{\gamma}$ *is satisfied*
3. *When* $p^* \geq \hat{p}$ *and* $\delta \geq \bar{\delta}$, $\underline{\gamma} \leq \gamma \leq \gamma_1^-(\hat{p})$ *is satisfied.*
4. *When* $p^* \geq \hat{p}$ *and* $\delta < \bar{\delta}$, *either* $\gamma_1(p^*) \leq \gamma \leq \gamma_1^-(\hat{p})$ *or* $\underline{\gamma} \leq \gamma \leq \overline{\gamma}$ *is satisfied.*

PROOF Combining Propositions 1-3, and Lemmas 11 and 12, we have this argument. ■

As in Proposition 2, when neither (i) nor (ii) holds, negative campaign equilibrium [II] almost always does not exist (γ satisfying the conditions is one point). In this case, the condition for the existence of a separating equilibrium is almost the same as that for the existence of negative campaign equilibrium [I]. Therefore, in the theorem above, we focus on the case where either (i) or (ii) holds. Then each condition for the existence of negative campaign equilibrium [I] and [II] is represented by the interval of γ. One question is whether both intervals overlap (i.e., whether the condition for the existence of a separating equilibrium is also represented by a single interval). There are some cases where the two intervals do not overlap. That is 2 and 4 in Theorem 1. However, so long as δ is high, the two intervals overlap and, as a result, the condition for the existence of a separating equilibrium is characterized by a single interval. That is 1 and 3 in Theorem 1.

4.5 Equilibrium Refinements

While we have examined separating equilibria, pooling equilibria exist as in the next lemma. Throughout this section, we assume $p^* < 0.5$ (the media outlet does not gather news in pooling equilibria).

LEMMA 13 There is a sequential equilibrium where $(C^A, C^B) = (C_H, C_H)$ independently of θ_A.

Thus, we need to examine the condition under which negative campaign equilibria [I] and [II] are unique plausible equilibria. To this end, we extend the intuitive criterion (Cho and Kreps 1987) to the case where there are two senders. See Appendix A for its definition.

As in Lemma 13, there is a pooling equilibrium in which both candidates choose C_H independently of the incumbent's ability. The first task is to derive the condition under which this equilibrium violates the intuitive criterion. Let

$$I(\delta) \equiv F(C_H, C_L) - F(C_H, C_H) \\ +\rho\Phi(\alpha d) + (1-\rho)\Phi(-\alpha d) - (1-\delta)[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] - \delta[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}].$$

LEMMA 14 Sequential equilibria, in which $(C^A, C^B) = (C_H, C_H)$ independently of θ_A, do not satisfy the intuitive criterion if and only if the following condition holds.

1. When $I(\delta) > 0$, $\gamma_L < \gamma < \gamma_H$ and $\gamma \leq \gamma_H{}'$ hold.
2. When $I(\delta) \leq 0$, $\gamma_L < \gamma \leq \gamma_H{}'$ holds.

Here,

$$\gamma_L \equiv \frac{F(C_H, C_L) - F(C_H, C_H)}{F(C_H, C_L) - F(C_H, C_H) + \rho(\Phi(\alpha d) - \Phi_{HL}) + (1-\rho)(\Phi(-ad) - \Phi_{LL})};$$

$$\gamma_H \equiv \frac{F(C_H, C_L) - F(C_H, C_H)}{I(\delta)} \quad (\text{if } I(\delta) > 0);$$

$$\gamma_H{}' \equiv \frac{F(C_H, C_L) - F(C_H, C_H)}{F(C_H, C_L) - F(C_H, C_H) + \rho\big(\Phi(\alpha d) - \Phi(\alpha d + (p^* - 0.5)\beta g)\big) + (1-\rho)\big(\Phi(-\alpha d) - \Phi(-\alpha d + (p^* - 0.5)\beta g)\big)}.$$

In addition, γ_L, $\gamma_H{}' \in (0,1)$, and $\gamma_H > 0$.

We derived the condition under which the pooling equilibria in Lemma 13 violate the intuitive criterion. This is not enough because there may exist another pooling equilibrium: $(C^A, C^B) = (C_L, C_L)$ independently of θ_A. From the next lemma, such equilibrium does not exist under the condition in Lemma 14.

LEMMA 15 There is no sequential equilibrium in which $(C^A, C^B) = (C_L, C_L)$ independently of θ_A if the condition in Lemma 14 is satisfied.

Therefore, the condition in Lemma 14 is the condition for eliminating pooling equilibria. However, if no negative campaign equilibrium exists under this condition, there is no γ for which only negative campaign equilibria satisfy the intuitive criterion. To avoid such cases, we need a condition about the value of δ, given by the following lemma.

LEMMA 16 There is $\bar{\bar{\delta}} \in [0,1)$ such that for any $\delta \in (\bar{\bar{\delta}}, 1)$, $\min\{\gamma_1^-(p^*), \gamma_1^-(\hat{p})\} > \gamma_L$.
PROOF γ_L is independent of δ whereas $\min\{\gamma_1^-(p^*), \gamma_1^-(\hat{p})\}$ is increasing with δ. In addition, as $\delta \to 1$, $\min\{\gamma_1^-(p^*), \gamma_1^-(\hat{p})\} \to 1$. Thus, as $\delta \to 1$, $\min\{\gamma_1^-(p^*), \gamma_1^-(\hat{p})\} > \gamma_L$. By combining these facts, we complete the proof. ■

Under the condition in Lemma 16, we finally obtain the following theorem.

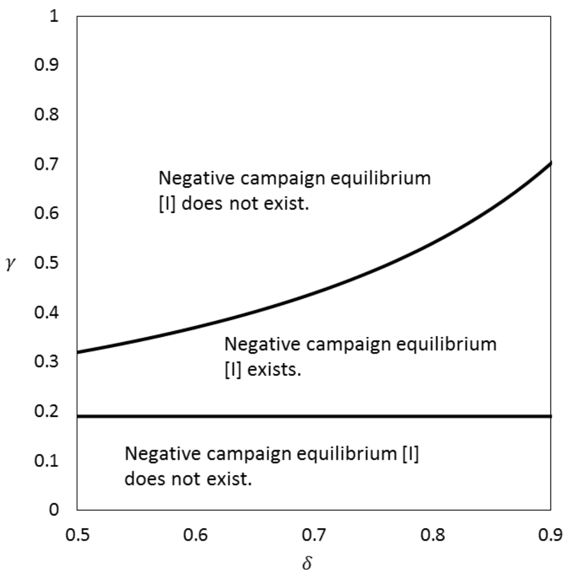
THEOREM 2 *Assume that* $\delta > \bar{\bar{\delta}}$ *and* $I(\delta) > 0$. *In addition, suppose that either (i)* $\hat{p} >$

p^*, $\delta \geq 0.5$, and $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$, or (ii) $\hat{p} \leq p^*$, $\delta \geq \bar{\delta}$, and $\gamma_1^+(\hat{p}) > \gamma_1^-(p^*)$ holds. Then, at least one separating equilibrium in which the challenger chooses C_L if and only if $\theta_A = 0$, satisfies the intuitive criterion, and all the other equilibria do not satisfy the intuitive criterion, if and only if the following conditions hold.

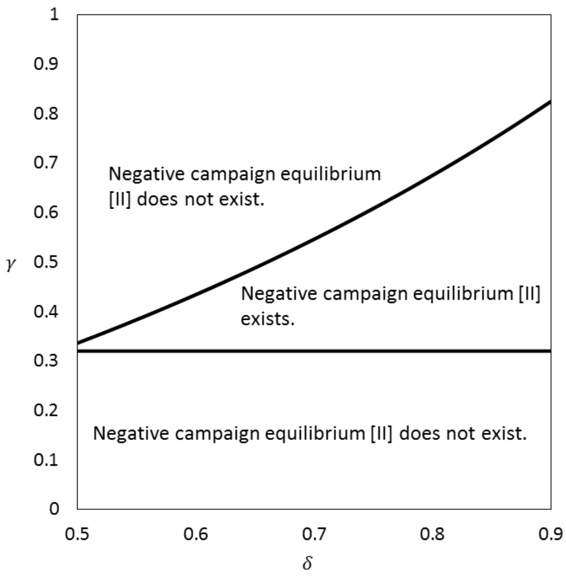
1. *When $p^* < \hat{p}$ and $min\{\gamma_1^-(p^*), \gamma_H, \gamma_H'\} = \gamma_H$, $\gamma_L < \gamma < \gamma_H$ is satisfied.*
2. *When $p^* < \hat{p}$ and $min\{\gamma_1^-(p^*), \gamma_H, \gamma_H'\} \neq \gamma_H$, $\gamma_L < \gamma \leq min\{\gamma_1^-(p^*), \gamma_H'\}$ is satisfied.*
3. *When $p^* \geq \hat{p}$ and $min\{\gamma_1^-(\hat{p}), \gamma_H, \gamma_H'\} = \gamma_H$, $\gamma_L < \gamma < \gamma_H$ is satisfied.*
4. *When $p^* \geq \hat{p}$ and $min\{\gamma_1^-(\hat{p}), \gamma_H, \gamma_H'\} \neq \gamma_H$, $\gamma_L < \gamma \leq min\{\gamma_1^-(\hat{p}), \gamma_H'\}$ is satisfied.*

In the above, for the ease of expositions, we focus on the cases where the condition for the existence of separating equilibria is characterized by a single interval (i.e., 1 and 3 in Theorem 1) and $I(\delta) > 0$. Though the condition in Theorem 2 is stricter than that for the existence of separating equilibria, we again obtain a single interval of γ.

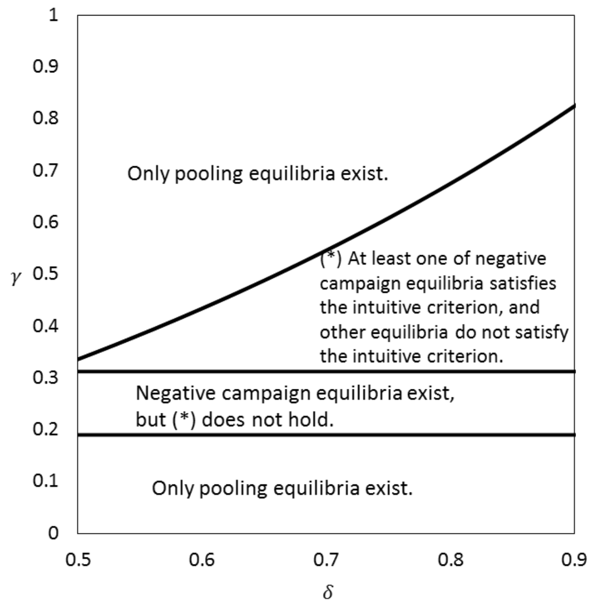
Figure 1 provides a numerical example that summarizes the results. In (a) and (b), we can see the upper and lower bounds for the existence of negative campaign equilibrium [I] and [II]. In (c) we can see that the condition for the elimination of pooling equilibria is characterized by a single interval of γ. Note that there is a region in which negative campaign equilibria exist, but the condition in Theorem 2 is not satisfied.



(a) Negative Campaign Equilibrium [I]



(b) Negative Campaign Equilibrium [II]



(c) Equilibrium Refinements

Figure 1: Numerical Example

$\alpha d = 0.8, \beta g = 0.9, \Phi = N(0,1), \rho = 0.7, \frac{a}{m} = 0.4662,\ p(x,y) = n(x,y) = \frac{x}{x+y}, C_H = 0.8, C_L = 0.2.$

5. Extension

So far, we have assumed that only sophisticated voters receive news. As an extension, we examine the case where naïve voters as well as sophisticated voters receive the news. In particular, we prove the proposition which corresponds to Proposition 1 (the condition for the existence of negative campaign equilibrium [I]). The qualitative result remains the same. Let $G(C_H, C_L) \equiv p(C_H, C_L)\Phi_{HL} + (1 - p(C_H, C_L))\Phi_{LL};\ H(C_H, C_L) \equiv p(C_H, C_L)\Phi_{HH} + (1 - p(C_H, C_L))\Phi_{LH}$.

PROPOSITION 4 *There exists a separating equilibrium in which (i)* $C^B = C_L$ *if and only if* $\theta_A = 0$, *and (ii)* C^A *is independent of the value of* θ_A, *if and only if* $\underline{\gamma}_n \le \gamma \le \overline{\gamma}_n$, *where*

$$\underline{\gamma}_n \equiv \frac{(1-\delta)F(C_H, C_L) + \delta G(C_H, C_L) - F(C_H, C_H)}{(1-\delta)F(C_H, C_L) + \delta G(C_H, C_L) - F(C_H, C_H) + [\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]};$$

$$\overline{\gamma}_n \equiv \frac{(1-\delta)F(C_H, C_L) + \delta H(C_H, C_L) - F(C_H, C_H)}{(1-\delta)F(C_H, C_L) + \delta H(C_H, C_L) - F(C_H, C_H) + (1-\delta)[\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]}.$$

In addition, $0 < \underline{\gamma}_n < \underline{\gamma} \le \overline{\gamma} < \overline{\gamma}_n < 1$.

When naïve voters receive news, the challenger's deviation incentive becomes smaller because even naïve voters can observe the truth. As a result, the condition for the existence of negative campaign equilibrium [I] is weaker when all the voters receive news than that when only sophisticated voters receive news.

6. Conclusion

We constructed a model where an incumbent and a challenger decide whether to focus on policy or ability in electoral campaigning, and then a media outlet decides whether to gather news. The incumbent's ability is unobservable to voters. We showed that a candidate's strategy about which issue to focus on can be a signal of the incumbent's ability even though candidates can tell a lie. In addition, we showed that in any separating equilibria, the challenger focuses on the incumbent's ability if and only if the incumbent's ability is low (i.e., negative campaigning against the incumbent arises as a signal of the incumbent's low ability). Here, separating equilibria exist only when sophisticated and naïve voters coexist. This implies that separating equilibria cannot be sustained without naïve voters.

There remain some challenges for the future researches. First, our model assumes that policies and abilities are binary. To examine the case with continuous variables may be promising. Second, candidates do not choose their policies in our model. In reality, policies can be strategic choice variables since they can commit policies to some extent. Such cases should be examined in the future.

Appendix A: Equilibrium Refinements[20]

Consider the following model.[21] There exist two senders $s = 1, 2$ and one receiver r. Each player takes action $a_i \in A_i$ $(i = 1, 2, r)$. Define $A \equiv \times_i A_i$. The state space is Θ with a generic element θ. Player i's payoff is $u_i : \Theta \times A \to \mathbb{R}$. The timing of the game is as follows. Only players 1 and 2 observe θ. Then, players 1 and 2 simultaneously choose their actions. After observing their actions, player r chooses a_r. We focus on pure strategies.

Our notation is as follows.[22] Denote the expected equilibrium payoff of player s given θ by $u_s^*(\theta)$. Let player s's pure strategy given θ be $m_s^*(\theta)$. Let the belief of player r given a_1, a_2 be π. Using this, define the set of best response actions of player r given π and a_1, a_2, by $BR_r(\pi, a_{-r})$. Then, for any set T of states, define

$$BR_r(T, a_{-r}) \equiv \bigcup_{\{\pi:\pi(T)=1\}} BR_r(\pi, a_{-r}).$$

For $s = 1, 2$, let

$$\Theta^s(a_1, a_2) \equiv \left\{\theta \in \Theta \middle| m_{-s}^*(\theta) = a_{-s}, u_s^*(\theta) \leq \max_{a_r \in BR_r(\pi, a_{-r})} u_1(a_1, a_2, a_r, \theta)\right\}$$

[20] Our refinement is similar to those employed by Bagwell and Ramey (1991), Schultz (1996), Zhang (2016), and so on. See these studies to verify this refinement.

[21] To be precise, the following model does not include the present model, since the media outlet and sophisticated voters exist as player r. The criterion can be extended to our model.

[22] $-s$ represents a sender who is not s i.e., $-s = 2$ if $s = 1$, and $-r$ represents the two senders.

if $\max_{a_r \in BR_r(\pi, a_{-r})} u_1(a_1, a_2, a_r, \theta)$ exists, and

$$\Theta^s(a_1, a_2) \equiv \left\{ \theta \in \Theta \middle| m_{-s}^*(\theta) = a_{-s}, u_s^*(\theta) < \sup_{a_r \in BR_r(\pi, a_{-r})} u_1(a_1, a_2, a_r, \theta) \right\}$$

otherwise. Lastly, define the off-path of the pair of actions taken by the two senders and the off-path of the action taken by a sender, respectively. "(a_1, a_2) is off-path" if there is no $\theta \in \Theta$ such that $(a_1, a_2) = \left(m_1^*(\theta), m_2^*(\theta)\right)$, and "$a_s$ is off-path" if there is no $\theta \in \Theta$ such that $a_s = m_s^*(\theta)$.

Definition *A sequential equilibrium with the belief system* π^* *satisfies the intuitive criterion if the following conditions are satisfied for each off-equilibrium path* (a_1, a_2)*:*

1. *If* a_s *is off-path, but* a_{-s} *is on-path,* $\pi^*(a_1, a_2) \in \Delta(\Theta^s(a_1, a_2))$ *so long as* $\Theta^s(a_1, a_2)$ *is non-empty.*
2. *If* a_1 *and* a_2 *are on-path,* $\pi^*(a_1, a_2) \in \Delta(\Theta^1(a_1, a_2) \cup \Theta^2(a_1, a_2))$ *so long as* $\Theta^1(a_1, a_2) \cup \Theta^2(a_1, a_2)$ *is non-empty.*

Appendix B: Omitted Proofs

PROOF OF LEMMA 2:

$$\begin{aligned} F(C_H, C_L) - F(C_H, C_H) &= \left(p(C_H, C_L)n(1 - C_H, 1 - C_L) - p(C_H, C_H)n(1 - C_H, 1 - C_H)\right)(\Phi_{HH} - \Phi_{LH} - \Phi_{HL} \\ &+ \Phi_{LL}) + \left(p(C_H, C_L) - p(C_H, C_H)\right)(\Phi_{HL} - \Phi_{LL}) \\ &+ \left(n(1 - C_H, 1 - C_L) - n(1 - C_H, 1 - C_H)\right)(\Phi_{LH} - \Phi_{LL}), \end{aligned}$$

$$\begin{aligned} F(C_L, C_L) - F(C_L, C_H) &= \left(p(C_L, C_L)n(1 - C_L, 1 - C_L) - p(C_L, C_H)n(1 - C_L, 1 - C_H)\right)(\Phi_{HH} - \Phi_{LH} - \Phi_{HL} \\ &+ \Phi_{LL}) + \left(p(C_L, C_L) - p(C_L, C_H)\right)(\Phi_{HL} - \Phi_{LL}) \\ &+ \left(n(1 - C_L, 1 - C_L) - n(1 - C_L, 1 - C_H)\right)(\Phi_{LH} - \Phi_{LL}). \end{aligned}$$

$$\begin{aligned} F(C_H, C_H) - F(C_L, C_H) &= \left(p(C_H, C_H)n(1 - C_H, 1 - C_H) - p(C_L, C_H)n(1 - C_L, 1 - C_H)\right)(\Phi_{HH} - \Phi_{LH} - \Phi_{HL} \\ &+ \Phi_{LL}) + \left(p(C_H, C_H) - p(C_L, C_H)\right)(\Phi_{HL} - \Phi_{LL}) \\ &+ \left(n(1 - C_H, 1 - C_H) - n(1 - C_L, 1 - C_H)\right)(\Phi_{LH} - \Phi_{LL}), \end{aligned}$$

$$\begin{aligned} F(C_H, C_L) - F(C_L, C_L) &= \left(p(C_H, C_L)n(1 - C_H, 1 - C_L) - p(C_L, C_L)n(1 - C_L, 1 - C_H)\right)(\Phi_{HH} - \Phi_{LH} - \Phi_{HL} \\ &+ \Phi_{LL}) + \left(p(C_H, C_L) - p(C_L, C_L)\right)(\Phi_{HL} - \Phi_{LL}) \\ &+ \left(n(1 - C_H, 1 - C_L) - n(1 - C_L, 1 - C_L)\right)(\Phi_{LH} - \Phi_{LL}). \end{aligned}$$

Note that by the symmetry of the density function ϕ, the following equality holds:

$$\Phi_{HH} - \Phi_{LH} - \Phi_{HL} + \Phi_{LL} = \int_{\alpha d - 0.5\beta g}^{\alpha d + 0.5\beta g} \phi(x)dx - \int_{-(\alpha d + 0.5\beta g)}^{-(\alpha d - 0.5\beta g)} \phi(x)dx = 0.$$

Therefore,

$$
\begin{aligned}
&F(C_H, C_L) - F(C_H, C_H) \\
&\qquad = \big(p(C_H, C_L) - p(C_H, C_H)\big)(\Phi_{HL} - \Phi_{LL}) \\
&\qquad + \big(n(1 - C_H, 1 - C_L) - n(1 - C_H, 1 - C_H)\big)(\Phi_{LH} - \Phi_{LL}), \\
&F(C_L, C_L) - F(C_L, C_H) \\
&\qquad = \big(p(C_L, C_L) - p(C_L, C_H)\big)(\Phi_{HL} - \Phi_{LL}) \\
&\qquad + \big(n(1 - C_L, 1 - C_L) - n(1 - C_L, 1 - C_H)\big)(\Phi_{LH} - \Phi_{LL}). \\
&F(C_H, C_H) - F(C_L, C_H) \\
&\qquad = \big(p(C_H, C_H) - p(C_L, C_H)\big)(\Phi_{HL} - \Phi_{LL}) \\
&\qquad + \big(n(1 - C_H, 1 - C_H) - n(1 - C_L, 1 - C_H)\big)(\Phi_{LH} - \Phi_{LL}), \\
&F(C_H, C_L) - F(C_L, C_L) \\
&\qquad = \big(p(C_H, C_L) - p(C_L, C_L)\big)(\Phi_{HL} - \Phi_{LL}) \\
&\qquad + \big(n(1 - C_H, 1 - C_L) - n(1 - C_L, 1 - C_L)\big)(\Phi_{LH} - \Phi_{LL}).
\end{aligned}
$$

Here, for any $x \in \{C_H, C_L\}$, $p(x, x) = n(x, x) = 0.5$ and for any $x, y \in \{C_H, C_L\}$, $p(x, y) = 1 - p(y, x)$ and $n(x, y) = 1 - n(y, x)$ because of Assumption 1. Thus, $F(C_H, C_L) - F(C_H, C_H) = F(C_L, C_L) - F(C_L, C_H) = F(C_H, C_H) - F(C_L, C_H) = F(C_H, C_L) - F(C_L, C_L)$.

Finally, $F(C_H, C_L) - F(C_H, C_H) > 0$ can be rewritten as:

$$\left(\frac{\Phi_{HL} - \Phi_{LH}}{\Phi_{LH} - \Phi_{LL}} + 1\right)\big(p(C_H, C_L) - p(C_H, C_H)\big) > n(1 - C_H, 1 - C_H) - n(1 - C_H, 1 - C_L).$$

Therefore, if and only if

$$\left(\frac{\Phi_{HL} - \Phi_{LH}}{\Phi_{LH} - \Phi_{LL}} + 1\right)\big(p(C_H, C_L) - p(C_H, C_H)\big) > n(1 - C_H, 1 - C_H) - n(1 - C_H, 1 - C_L)$$

holds, $F(C_H, C_L) - F(C_H, C_H) > 0$ holds. ■

PROOF OF PROPOSITION 1:

(1) "Only if" part

Consider the incentive compatibility condition of challenger B.

(i) When $\boldsymbol{\theta_A = g}$: If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_H)$ is less than or equal to that when $(C^A, C^B) = (C_H, C_L)$, the challenger chooses C_H when $\theta_A = g$. Derive this condition.

$\pi = 1$ when $(C^A, C^B) = (C_H, C_H)$. As a result, in the election, sophisticated voters believe that $\theta_A = g$ when $(C^A, C^B) = (C_H, C_H)$.

On the contrary, $\pi = 0$ when $(C^A, C^B) = (C_H, C_L)$. Thus, when $(C^A, C^B) = (C_H, C_L)$, the media outlet gathers news and reports the news such that the incumbent's ability is high with probability δ. In summary, in the election, with probability δ, sophisticated voters believe that $\theta_A = g$, while with probability $1 - \delta$, they believe that $\theta_A = 0$ when $(C^A, C^B) = (C_H, C_L)$.

From this discussion, the condition is given by

$$[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C_H)$$
$$\leq \gamma\{(1-\delta)[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + \delta[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}]\}$$
$$+ (1-\gamma)F(C_H, C_L).$$

By rewriting this condition, we have $\gamma \leq \bar{\gamma}$.

(ii) When $\boldsymbol{\theta_A = 0}$: If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_L)$ is less than or equal to that when $(C^A, C^B) = (C_H, C_H)$, the challenger chooses C_L when $\theta_A = 0$. Derive this condition.

$\pi = 1$ when $(C^A, C^B) = (C_H, C_H)$. Thus, the media outlet does not gather news. As a result, in the election, sophisticated voters believe that $\theta_A = g$ when $(C^A, C^B) = (C_H, C_H)$.

On the contrary, $\pi = 0$ when $(C^A, C^B) = (C_H, C_L)$. As a result, in the election, sophisticated voters believe that $\theta_A = 0$ when $(C^A, C^B) = (C_H, C_L)$.

From this discussion, the condition is given by

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L) \leq \gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C_H).$$

By rewriting this condition, we have $\gamma \geq \underline{\gamma}$.

From (i) and (ii), $\underline{\gamma} \leq \gamma \leq \bar{\gamma}$ is the necessary condition for the existence of the equilibrium.

(2) "If" part

We show that if $\underline{\gamma} \leq \gamma \leq \bar{\gamma}$ holds, at least one such equilibrium exists. For this purpose, we show that the following specific equilibrium always exists so long as $\underline{\gamma} \leq \gamma \leq \bar{\gamma}$ holds.

(1) *The media outlet and sophisticated voters' belief after observing* (C^A, C^B)*:*

$$\pi(C^A, C^B) = \begin{cases} 1 \text{ if } C^B = C_H \\ 0 \text{ if } C^B = C_L \end{cases}$$

(2) *Sophisticated voter* i *votes for the incumbent (the challenger) if*

$$\alpha[v(x_A, \hat{x}_i) - v(x_B, \hat{x}_i)] + \beta[\pi(C^A, C^B) - 0.5]g$$

is positive (negative). S/he votes for the incumbent with probability 0.5 *if this is zero.*

(3) $C^A = C_H$ *for any* θ_A.

(4) *If* $\theta_A = g$, $C^B = C_H$. *If* $\theta_A = 0$, $C^B = C_L$.

(5) *When* $C^B = C_L$ *the media outlet gathers news. Otherwise, it does not gather news.*

The belief of sophisticated voters and the media outlet just after observing (C_A, C_B) is obvious consistent with the strategies. After that, the media outlet's (sophisticated voters') belief is updated based on the outcome of gathering news. In addition, the specified strategies of both the sophisticated and naïve voters are optimal for themselves given their beliefs. From now on, we examine the incentive compatibility conditions of each candidate and the media outlet.

(i) The incentive compatibility of incumbent $\boldsymbol{A}$:

(i-1) When $\theta_A = g$: In this case, the challenger chooses C_H.

If and only if the expected number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_H)$ is larger than or equal to that when $(C^A, C^B) = (C_L, C_H)$, the incumbent chooses C_H. This condition is given by

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C_H) \geq \gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H).$$

By rewriting this inequality, $(1-\gamma)[F(C_H, C_H) - F(C_L, C_H)] \geq 0$. This holds from Lemma 2.

(i-2) When $\theta_A = 0$: In this case, the challenger chooses C_L.

If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_L)$ is larger than or equal to that when $(C^A, C^B) = (C_L, C_H)$, the incumbent chooses C_H. This condition is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L) \geq \gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_L, C_L).$$

By rewriting this inequality, $(1-\gamma)[F(C_H, C_L) - F(C_L, C_L)] \geq 0$. This holds from Lemma 2.

(ii) The incentive compatibility of challenger B:

This is straightforwardly satisfied from the discussion in "only if" part.

(iii) The incentive compatibility of the media outlet:

This obviously holds from the discussion of footnote 15.

From (i)-(iii), if $\underline{\gamma} \leq \gamma \leq \bar{\gamma}$ holds, this specified equilibrium exists.

Finally, we obtain Proposition 1. Note that it is easily verified that $0 < \underline{\gamma} < \bar{\gamma} < 1$. ■

PROOF OF LEMMA 3:

Consider the incentive compatibility conditions of incumbent A and challenger B.

(i) The incentive compatibility of incumbent A:

(i-1) When $\theta_A = g$ and $p_{HH} > p^*$: In this case, the challenger chooses C_H. If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_L, C_H)$ is larger than or equal to that when $(C^A, C^B) = (C_H, C_H)$, the incumbent chooses C_H. Derive this condition.

When $(C^A, C^B) = (C_L, C_H)$, $\pi = 1$. As a result, in the election, sophisticated voters believe that $\theta_A = g$ when $(C^A, C^B) = (C_L, C_H)$.

On the contrary, when $(C^A, C^B) = (C_H, C_H)$, $\pi = p_{HH}$. Since $p_{HH} > p^*$, the media outlet does not gather news. As a result, in the election, sophisticated voters believe that $\theta_A = g$ with probability p_{HH} when $(C^A, C^B) = (C_L, C_H)$.

From this discussion, the condition is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H)$$
$$\geq \gamma[\rho\Phi(\alpha d + (p_{HH} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{HH} - 0.5)\beta g)]$$
$$+ (1-\gamma)F(C_H, C_H).$$

By rewriting this inequality, we have $\gamma \geq \gamma_1^+(p_{HH})$.

(i-2) When $\boldsymbol{\theta_A = g}$ and $\boldsymbol{p_{HH} \leq p^*}$: Only one difference from (i-1) is the belief formation when $(C^A, C^B) = (C_L, C_H)$. In this case, $\pi = p_{HH}$. Since $p_{HH} \leq p^*$, the media outlet gathers news and finds the value of θ_A with probability δ. As a result, in the election, with probability $1-\delta$, sophisticated voters believe that $\theta_A = g$ with probability p_{HH}. On the contrary, with probability δ, they believe that $\theta_A = g$.

Therefore, the incentive compatibility condition is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H)$$
$$\geq \gamma[(1-\delta)\{\rho\Phi(\alpha d + (p_{HH} - 0.5)\beta g)$$
$$+ (1-\rho)\Phi(-\alpha d + (p_{HH} - 0.5)\beta g)\} + \delta\{\rho\Phi_{HH} + (1-\rho)\Phi_{LH}\}]$$
$$+ (1-\gamma)F(C_H, C_H).$$

By rewriting this inequality, we have $\gamma \geq \gamma_1^-(p_{HH})$.

(i-3) When $\boldsymbol{\theta_A = 0}$ and $\boldsymbol{p_{LL} > p^*}$: In this case, the challenger chooses C_L. If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_L)$ is larger than or equal to that when $(C^A, C^B) = (C_L, C_L)$, the incumbent chooses C_H. Similarly in (i-1), this condition is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L)$$
$$\geq \gamma[\rho\Phi(\alpha d + (p_{LL} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{LL} - 0.5)\beta g)]$$
$$+ (1-\gamma)F(C_L, C_L).$$

By rewriting this inequality and using Lemma 2, we have $\gamma \leq \gamma_2^+(p_{LL})$.

(i-4) When $\boldsymbol{\theta_A = 0}$ and $\boldsymbol{p_{LL} \leq p^*}$: Similarly in (i-2), the incumbent's incentive compatibility condition is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L)$$
$$\geq \gamma\{(1-\delta)[\rho\Phi(\alpha d + (p_{LL} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{LL} - 0.5)\beta g)]$$
$$+ \delta[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}]\} + (1-\gamma)F(C_L, C_L).$$

By rewriting this inequality and using Lemma 2, we have $\gamma \leq \gamma_2^-(p_{LL})$.

(ii) The incentive compatibility of challenger $\boldsymbol{B}$:

(ii-1) When $\boldsymbol{\theta_A = g}$ and $\boldsymbol{p_{LL} > p^*}$: In this case, the incumbent chooses C_L. If and only if the expected number of voters who vote for the incumbent when $(C^A, C^B) = (C_L, C_H)$ is less than or equal to that when $(C^A, C^B) = (C_L, C_L)$, the challenger chooses C_H. Similarly in (i-1), this condition is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H)$$
$$\leq \gamma[\rho\Phi(\alpha d + (p_{LL} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{LL} - 0.5)\beta g)]$$
$$+ (1-\gamma)F(C_L, C_L).$$

By rewriting this inequality and using Lemma 2, we have $\gamma \leq \gamma_1^+(p_{LL})$.

(ii-2) When $\boldsymbol{\theta_A = g}$ and $\boldsymbol{p_{LL} \leq p^*}$: Similarly in (i-2), the incumbent's incentive compatibility condition is given by

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H)$$
$$\leq \gamma\{(1-\delta)[\rho\Phi(\alpha d + (p_{LL} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{LL} - 0.5)\beta g)]$$
$$+ \delta[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}]\} + (1-\gamma)F(C_L, C_L).$$

By rewriting this inequality and using Lemma 2, we have $\gamma \leq \gamma_1^-(p_{LL})$.

(ii-3) When $\boldsymbol{\theta_A = 0}$ and $\boldsymbol{p_{HH} > p^*}$: In this case, the incumbent chooses C_H. If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_L)$ is less than or equal to that when $(C^A, C^B) = (C_H, C_H)$, the challenger chooses C_L.

Similarly in (i-1), this condition is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L)$$
$$\leq \gamma[\rho\Phi(\alpha d + (p_{HH} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{HH} - 0.5)\beta g)]$$
$$+ (1-\gamma)F(C_H, C_H).$$

By rewriting this inequality, we have $\gamma \geq \gamma_2^+(p_{HH})$.

(ii-4) When $\boldsymbol{\theta_A = 0}$ and $\boldsymbol{p_{HH} \leq p^*}$: Similarly in (i-2), the incumbent's incentive compatibility condition is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L)$$
$$\leq \gamma\{(1-\delta)[\rho\Phi(\alpha d + (p_{HH} - 0.5)\beta g)$$
$$+ (1-\rho)\Phi(-\alpha d + (p_{HH} - 0.5)\beta g)] + \delta[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}]\}$$
$$+ (1-\gamma)F(C_H, C_H)$$

By rewriting this inequality, we have $\gamma \geq \gamma_2^-(p_{HH})$.

Lastly, the belief is consistent and the mass media's strategy is optimal by construction. By combining each condition derived in (i) and (ii), we complete the proof. ■

PROOF OF LEMMA 4:

For the first part, by the definition of the functions $\gamma_1^+(p)$ and $\gamma_1^-(p)$ ($\gamma_2^+(p)$ and $\gamma_2^-(p)$), the denominator of the $\gamma_1^+(p)$ and $\gamma_1^-(p)$ ($\gamma_2^+(p)$ and $\gamma_2^-(p)$) are decreasing (increasing) in p. Therefore, we obtain the first part.

For the second part, by the definition of the functions γ_M and γ_m and monotonicity of the functions $\gamma_1^+(p)$ and $\gamma_1^-(p)$ ($\gamma_2^+(p)$ and $\gamma_2^-(p)$), this is straightforwardly obtained. ■

PROOF OF PROPOSITION 2:

From Lemma 3, there exists a separating equilibrium, in which (i) when the incumbent's ability is low, $(C^A, C^B) = (C_H, C_L)$, and (ii) when the incumbent's ability is high, if and only if there exist p_{HH} and p_{LL} such that $\gamma_M(p_{HH}) \leq \gamma \leq \gamma_m(p_{LL})$ holds.

From now on, we examine the condition under which there exist p_{HH} and p_{LL} for which this inequality holds.

(a) When $\hat{p} > p^*$.

a-1. When $\hat{p} > p^*$ and $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$: The lower bound of γ_M is $\min_{p_{HH}} \gamma_M(p_{HH}) = \gamma_1^+(\hat{p})$, and the upper bound of γ_m is $\max_{p_{LL}} \gamma_m(p_{LL}) = \gamma_1^-(p^*)$. Because of $\gamma_1^+(\hat{p}) < \gamma_1^-(p^*)$, if and only if $\gamma_1^+(\hat{p}) \leq \gamma \leq \gamma_1^-(p^*)$, the equilibrium exists.

a-2. When $\hat{p} > p^*$ and $\gamma_1^+(\hat{p}) \geq \gamma_1^-(p^*)$: The lower bound of γ_M is $\min_{p_{HH}} \gamma_M(p_{HH}) = \gamma_1^+(\hat{p})$, and the upper bound of γ_m is $\max_{p_{LL}} \gamma_m(p_{LL}) = \gamma_1^+(\hat{p})$. Therefore if and only if $\gamma = \gamma_1^+(\hat{p})$, the equilibrium exists.

(b) When $\hat{p} \leq p^*$.

b-1. When $\hat{p} \leq p^*$ and $\gamma_1^-(\hat{p}) > \gamma_1^+(p^*)$: The lower bound of γ_M is $\inf_{p_{HH}} \gamma_M(p_{HH}) = \gamma_1^+(p^*)$, and the upper bound of γ_m is $\max_{p_{LL}} \gamma_m(p_{LL}) = \gamma_1^-(\hat{p})$. Because $\gamma_1^-(\hat{p}) > \gamma_1^+(p^*)$ holds, if and only if $\gamma_1^-(\hat{p}) \geq \gamma > \gamma_1^+(p^*)$, the equilibrium exists.

b-2. When $\hat{p} \leq p^*$ and $\gamma_1^-(\hat{p}) \leq \gamma_1^+(p^*)$: The lower bound of γ_M is $\min_{p_{HH}} \gamma_M(p_{HH}) = \gamma_1^-(\hat{p})$, and the upper bound of γ_m is $\max_{p_{LL}} \gamma_m(p_{LL}) = \gamma_1^-(\hat{p})$. Therefore if and only if $\gamma = \gamma_1^-(\hat{p})$, the equilibrium exists.

From (a) and (b), we obtain the proposition. ■

PROOF OF LEMMA 6:

Consider the incumbent's deviation incentive when $\theta_A = 0$. When $C^A = C_L$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_L, C_L).$$

When $C^A = C_H$, the lowest bound of the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L).$$

Here, $F(C_H, C_L) > F(C_H, C_L)$. Thus, the incumbent has a strict incentive to deviate from $C^A = C_L$ to $C^A = C_L$. Therefore, such equilibrium does not exist. ■

PROOF OF LEMMA 7:

Consider the challenger's deviation incentive when $\theta_A = g$. When $C^B = C_L$, the number of voters who vote for the incumbent is[23]

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C^A, C_L).$$

When $C^B = C_H$, the highest bound of the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C^A, C_H).$$

Here, $F(C^A, C_L) > F(C^A, C_H)$. Thus, the challenger has a strict incentive to deviate from $C^B = C_L$ to $C^B = C_H$. Therefore, such equilibrium does not exist. ■

PROOF OF LEMMA 8:

Consider the incumbent's deviation incentive when $\theta_A = 0$. When $C^A = C_H$, $\pi = 1$. Then, the media outlet does not gather news. As a result, sophisticated voters believe that $\theta_A = g$ in the election. Thus, when $C^A = C_H$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C^B).$$

When $C^A = C_L$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}(-\alpha d - 0.5\beta g)] + (1-\gamma)F(C_L, C^B).$$

Since $\Phi_{HH} > \Phi_{HL}, \Phi_{LH} > \Phi_{LL}, F(C_H, C^B) > F(C_L, C^B)$ hold, the incumbent has a strict incentive to deviate from $C^A = C_L$ to $C^A = C_H$. Therefore, such equilibrium does not exist. ■

PROOF OF LEMMA 9:

First, consider the incumbent's incentive when $\theta_A = g$. When $C^A = C_L$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C^B).$$

When $C^A = C_H$, the number of voters who vote for the incumbent is

$$\gamma\{(1-\delta)[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + \delta[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}\} + (1-\gamma)F(C_H, C^B).$$

Thus, the incumbent chooses C_L when $\theta_A = g$ if and only if

$$(1-\delta)\gamma\{[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] - [\rho\Phi_{HL} + (1-\rho)\Phi_{LL}]\} \geq (1-\gamma)[F(C_H, C^B) - F(C_L, C^B)]. \quad (1)$$

Second, consider the incumbent's incentive when $\theta_A = 0$. When $C^A = C_L$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C^B).$$

(The reason is the same as in the proof of Lemma 8). When $C^A = C_H$, the number of voters

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[23] Since this is on equilibrium path, sophisticated voters believe that $\theta_A = g$ with probability one, provided that $C^B = C_L$. Thus, we obtain this number of voters.

who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C^B).$$

Thus, the incumbent chooses C_H when $\theta_A = 0$ if and only if

$$\gamma\{\rho\Phi_{HH} + (1-\rho)\Phi_{LH} - [\rho\Phi_{HL} + (1-\rho)\Phi_{LL}]\} \qquad (2)$$
$$\leq (1-\gamma)[F(C_H, C^B) - F(C_L, C^B)].$$

However, inequalities (1) and (2) never hold at the same because the left-hand side of (2) is strictly larger than that of (1). Hence, there is no such equilibrium. ■

PROOF OF LEMMA 10:

Consider the incumbent's deviation incentive when $\theta_A = 0$. When $C^A = C_H$, the lowest number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L).$$

When $C^A = C_L$, the number of voters who vote for the incumbent is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_L, C_L).$$

Since $F(C_H, C_L) > F(C_L, C_L)$ holds, the incumbent has a strict incentive to deviate from $C^A = C_L$ to $C^A = C_H$. Therefore, such equilibrium does not exist. ■

PROOF OF LEMMA 11:

Because of Lemma 4, $\gamma_1^+(p)$ and $\gamma_1^-(p)$ are increasing functions of p. Therefore for any $p \in (0,1)$, $\gamma_1^+(p) > \gamma_1^+(0) = \underline{\gamma}$ and $\gamma_1^-(p) > \gamma_1^-(0) = \overline{\gamma}$.

Conversely, because of Lemma 4, $\gamma_2^+(p)$ and $\gamma_2^-(p)$ are decreasing functions of p. Therefore for any $p \in (0,1)$, $\gamma_2^+(p) > \gamma_2^+(1) = \underline{\gamma}$ and $\gamma_2^-(p) > \gamma_2^-(1) = \overline{\gamma}$.■

PROOF OF LEMMA 12:

To begin with, prove the first part. $\gamma_1^+(\hat{p}) \leq \overline{\gamma}$ if and only if

$$(1-\delta)[\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})]$$
$$\leq \rho[\Phi_{HH} - \Phi(\alpha d + (\hat{p} - 0.5)\beta g)] + (1-\rho)[\Phi_{LH} - \Phi(-\alpha d + (\hat{p} - 0.5)\beta g)].$$

The left-hand side decreases with δ while the right-hand side is independent of δ. In addition, from Lemma 5, when $\delta = 0.5$, the inequality holds with equality. Thus, we obtain the first part.

For the second part, $\gamma_1^+(p^*) \leq \overline{\gamma}$ if and only if

$$\rho\big(\Phi_{HH} - \Phi(\alpha d + (p^* - 0.5)\beta g)\big) + (1-\rho)\big(\Phi_{LH} - \Phi(-\alpha d + (p^* - 0.5)\beta g)\big)$$
$$\geq (1-\delta)[\rho(\Phi_{HH} - \Phi_{HL}) + (1-\rho)(\Phi_{LH} - \Phi_{LL})].$$

The right-hand side decreases with δ, and the left-hand side is independent of δ.Further, the left-hand side is always more than zero, and when $\delta = 1$, the right-hand side is zero. Thus, the inequality above holds with a strict inequality when $\delta = 1$. Hence, the second part is obtained. ■

PROOF OF LEMMA 13:

Suppose that such equilibrium exists. Consider the belief consistent with the equilibrium:

$$\pi(C^A, C^B) = \begin{cases} 0.5 \text{ if } (C^A, C^B) = (C_H, C_H) \\ 1 \text{ if } (C^A, C^B) = (C_H, C_L) \\ p_{LH} \text{ if } (C^A, C^B) = (C_L, C_H) \\ 1 \text{ if } (C^A, C^B) = (C_L, C_L) \end{cases},$$

where $p_{LH} \in (p^*, 0.5)$. Then, the media outlet never gathers news. Thus, sophisticated voters use belief $\pi(C^A, C^B)$ in the election.

Incumbent A has no incentive to deviate from the equilibrium if and only if

$$\gamma[\rho\Phi(\alpha d) + (1-\rho)\Phi(-\alpha d)] + (1-\gamma)F(C_H, C_H)$$
$$\geq \gamma[\rho\Phi(\alpha d + (p_{LH} - 0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p_{LH} - 0.5)\beta g)]$$
$$+ (1-\gamma)F(C_L, C_H).$$

This holds from $p_{LH} < 0.5$ and Lemma 2. Thus, the incumbent has no deviation incentive.

Next, challenger B has no incentive to deviate from the equilibrium if and only if

$$\gamma[\rho\Phi(\alpha d) + (1-\rho)\Phi(-\alpha d)] + (1-\gamma)F(C_H, C_H)$$
$$\leq \gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C_L).$$

This holds from Lemma 2. Thus, the challenger has no deviation incentive.

Therefore, there is an equilibrium in which $(C^A, C^B) = (C_H, C_H)$. ■

PROOF OF LEMMA 14:

Step 1: $\boldsymbol{\Theta^A(C_L, C_H) = \{g, 0\}}$ or $\boldsymbol{\emptyset}$.

To begin with, we prove that $\Theta^A(C_L, C_H) = \{g, 0\}$ or $\emptyset$. The equilibrium payoff of incumbent A is independent of θ^A. Thus, if the maximum payoff of incumbent A when $C^A = C_L$ is also independent of θ^A, $\Theta^A(C_L, C_H) = \{g, 0\}$ or $\emptyset$. Therefore, it suffices to prove that the maximum payoff of incumbent A when $C^A = C_L$ is independent of θ^A.

Consider the case where $\theta^A = g$. The maximum payoff is the payoff when $\pi = 1$. Thus, the maximum payoff is given by

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H).$$

Consider the case where $\theta^A = 0$. When sophisticated voters and the media outlet believe that $\theta^A = g$, the media outlet does not gather news. As a result, sophisticated voters believe that $\theta^A = g$ in the election. Thus, the maximum payoff is the payoff when $\pi = 1$. Hence, the maximum payoff is given by

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H).$$

Therefore, the maximum payoff of incumbent A when $C^A = C_L$ is independent of θ^A.

Step 2: $\boldsymbol{\Theta^B(C_H, C_L) = \{0\}}$ if and only if either 1 or 2 in the lemma holds.

Step 2-1 $\boldsymbol{0 \in \Theta^B(C_H, C_L)}$ if and only if $\boldsymbol{\gamma \geq \gamma_L}$.

Challenger B's maximum payoff is equivalent to incumbent A's minimum payoff/ number of obtained votes. From now on, we consider the latter instead of the former. Suppose that $\theta^A = 0$. The smallest number of incumbent A's obtained votes when $C^B = C_L$ is that when $\pi = 0$. That is given by

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L). \tag{3}$$

On the other hand, the equilibrium number of incumbent A's votes is

$$\gamma[\rho\Phi(\alpha d) + (1-\rho)\Phi(-\alpha d)] + (1-\gamma)F(C_H, C_H). \tag{4}$$

Therefore, if and only if (3)≤(4), $0 \in \Theta^B(C_H, C_L)$. By rewriting this inequality, we have $\gamma \geq \gamma_L$.

Step 2-2 $g \notin \Theta^B(C_H, C_L)$ if and only if (i) $I(\delta) > 0, \gamma < \gamma_H$, and $\gamma \leq \gamma_H{}'$, or (ii) $I(\delta) \leq 0$ and $\gamma \leq \gamma_H{}'$.

Suppose that $\theta_A = g$. The number of voters who vote for incumbent A when $\pi = 0$ is given by

$$(1-\delta)\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + \delta\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_H, C_L). \tag{5}$$

The number of voters who vote for incumbent A when $\pi = p > p^*$ is given by

$$\gamma[\rho\Phi(\alpha d + (p-0.5)\beta g) + (1-\rho)\Phi(-\alpha d + (p-0.5)\beta g)] + (1-\gamma)F(C_H, C_L). \tag{6}$$

Here, (6) is increasing with p. Thus, there is no minimum of (6).

Therefore, if and only if (5)>(4) and $\inf_{p\in(p^*,1]}$(6)≥(4), $g \notin \Theta^B(C_H, C_L)$.

Case 1: $I(\delta) > 0$. (5)>(4) is written as $\gamma < \gamma_H$, and $\inf_{p\in(p^*,1]}$(6)≥(4) is written as $\gamma \leq \gamma_H{}'$.

Case 2: $I(\delta) \leq 0$. (5)>(4) always holds. In addition, $\inf_{p\in(p^*,1]}$(6)≥(4) is written as $\gamma \leq \gamma_H{}'$.

From cases 1 and 2, we complete the proof of step 2-2.

From steps 2-1 and 2-2-, we complete the proof of step 2.

Step 3: Suppose that $\gamma \neq \gamma_L$. Then, the sequential equilibrium in which $(C^A, C^B) = (C_H, C_H)$ independently of θ^A does not satisfy the intuitive criterion if and only if $\Theta^B(C_H, C_L) = \{0\}$.

Step 3-1: "Only if" part

Prove the contrapositive. Suppose that $\Theta^B(C_H, C_L) \neq \{0\}$.

Case 1: $\Theta^B(C_H, C_L) = \{0, g\}$ or $\emptyset$. In this case, any belief π is allowed for $(C^A, C^B) = (C_H, C_L)$. In addition, from step 1, any belief π is allowed for $(C^A, C^B) = (C_L, C_H)$. Therefore, the equilibrium constructed in the proof of Lemma 13 satisfies the intuitive criterion.

Case 2: $\Theta^B(C_H, C_L) = \{g\}$. In this case, only $\pi = 1$ is allowed for $(C^A, C^B) = (C_H, C_L)$. In addition, from step 1, any belief π is allowed for $(C^A, C^B) = (C_L, C_H)$. Therefore, the equilibrium constructed in the proof of Lemma 13 satisfies the intuitive criterion.

From cases 1 and 2, we complete the proof of contrapositive.

Step 3-2: "If" part

Suppose that $\Theta^B(C_H, C_L) = \{0\}$. Prove by contradiction. Suppose that a sequential equilibrium in which $(C^A, C^B) = (C_H, C_H)$ independently of θ^A satisfies the intuitive criterion. Only $\pi = 0$ is allowed for $(C^A, C^B) = (C_H, C_L)$. Thus, the number of voters who vote for incumbent A when $(C^A, C^B) = (C_H, C_L)$ is (3). Therefore, (3)≥(4) must hold to prevent challenger B's deviation.

However, $\Theta^B(C_H, C_L) = \{0\}$ and $\gamma \neq \gamma_L$ imply that $\gamma > \gamma_L$ from step 2-1. Thus, (3)<(4) holds. This is contradiction.

Step 4: When $\boldsymbol{\gamma = \gamma_L}$, a sequential equilibrium in which $\boldsymbol{(C^A, C^B) = (C_H, C_H)}$ independently of $\boldsymbol{\theta^A}$ satisfies the intuitive criterion .

$\gamma = \gamma_L$ implies that $\gamma < \gamma_H$ if $I(\delta) > 0$, and $\gamma < \gamma_H{}'$. Thus, $\Theta^B(C_H, C_L) = \{0\}$ i.e., only $\pi = 0$ is allowed for $(C^A, C^B) = (C_H, C_L)$. Thus, the number of voters who vote for incumbent A when $(C^A, C^B) = (C_H, C_L)$ is (3). Since (3)=(4) holds, challenger B has no deviation incentive.

In addition, from step 1, any belief π is allowed for $(C^A, C^B) = (C_L, C_H)$. Therefore, by setting π as in the proof of Lemma 13, incumbent A has no deviation incentive.

Therefore, there is a sequential equilibrium in which $(C^A, C^B) = (C_H, C_H)$ independently of θ^A, and which satisfies the intuitive criterion.

We complete the proof. Note that γ_L, $\gamma_H{}' \in (0, 1)$, and $\gamma_L{}' > 0$ are straightforward. ■

PROOF OF LEMMA 15:

Suppose that there is a sequential equilibrium in which $(C^A, C^B) = (C_L, C_L)$ independently of θ^A. Consider incumbent A's deviation incentive.

The equilibrium number of voters who vote for incumbent A is

$$\gamma[\rho\Phi(\alpha d) + (1-\rho)\Phi(-\alpha d)] + (1-\gamma)F(C_L, C_L). \tag{7}$$

If (7) is less than the smallest number of voters who vote for incumbent A when $C^A = C_H$, incumbent A has a strict deviation incentive.

Here, the number of voters who vote for incumbent A when $\pi = 0$ is given by (5). Also, the number of voters who vote for incumbent A when $\pi = p > p^*$ is given by (6).

Thus, (7) is less than the smallest number of voters who vote for incumbent A when $C^A = C_H$ if and only if (5)>(7) and $\inf_{p \in [0, p^*)}$(6)≥(7). Since $F(C_H, C_H) = F(C_L, C_L)$, (7)=(4). Therefore, these conditions are equivalent to (5)>(4) and $\inf_{p \in [0, p^*)}$(6)≥(4). From the proof of Lemma 13, these condition hold when the condition in Lemma 14 is satisfied. Hence, incumbent A has a strict deviation incentive. ■

PROOF OF THEOREM 2:

Step 1: There are no pooling equilibria satisfying the intuitive criterion if and only if the condition in Lemma 14 is satisfied.

This is straightforwardly obtained from Lemmas 14 and 15.

Step 2: Negative campaign equilibrium [I] satisfies the intuitive criterion when the equilibrium exists.

Given unilateral deviation, only $(C^A, C^B) = (C_L, C_H)$ is observed as an off-equilibrium path when sophisticated voters and the media outlet observe each candidate's campaign strategy. Thus, the restriction on the belief formation due to the intuitive criterion is only that for the case where $(C^A, C^B) = (C_L, C_H)$. Here, using the same logic in step 1 in the proof of Lemma 14, $\Theta^A(C_L, C_H) = \{g, 0\}$ or $\emptyset$. Thus, any π is allowed for $(C^A, C^B) = (C_L, C_H)$. Therefore, negative campaign equilibrium [I] satisfies the intuitive criterion if it exists.

Step 3: Negative campaign equilibrium [II] satisfies the intuitive criterion when the equilibrium exists, the condition in Lemma 14 is satisfied, and $\boldsymbol{\gamma > \bar{\gamma}}$.

Only $(C^A, C^B) = (C_L, C_L)$ and $(C^A, C^B) = (C_H, C_H)$ are observed as off-equilibrium paths when sophisticated voters and the media outlet observe each candidate's campaign strategy. Thus, it is enough to consider these two cases.

Step 3-1: $\boldsymbol{\Theta^A(C_L, C_L) \cup \Theta^B(C_L, C_L) = \{0, g\}}$. To begin with, consider $\Theta^A(C_L, C_L)$. Challenger B chooses C_L only when $\theta_A = 0$. Thus, $\Theta^A(C_L, C_L) = \{0\}$ or $\emptyset$. Examine the condition under which $\Theta^A(C_L, C_L) = \{0\}$.

The equilibrium number of voters who vote for incumbent A is

$$\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + (1-\gamma)F(C_H, C_L). \tag{8}$$

On the contrary, the maximum number of voters who vote for incumbent A when $C^A = C_L$ is that when $\pi = 1$ i.e.,

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_L). \tag{9}$$

Therefore, if and only if (9)≥(8), $\Theta^A(C_L, C_L) = \{0\}$. Here, this condition is rewritten as $\gamma \geq \gamma_L$. Since $\underline{\gamma} < \gamma_L$ holds, $\gamma \geq \underline{\gamma}$ is satisfied. Therefore, $\Theta^A(C_L, C_L) = \{0\}$.

Next, consider $\Theta^B(C_L, C_L)$. Incumbent A chooses C_L only when $\theta_A = g$. Thus, $\Theta^A(C_L, C_L) = \{g\}$ or $\emptyset$. Examine the condition under which $\Theta^B(C_L, C_L) = \{g\}$.

The equilibrium number of voters who vote for incumbent A is

$$\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_H). \tag{10}$$

The number of voters who vote for incumbent A when $C^B = C_L$, and $\pi = 0$ is

$$(1-\delta)\gamma[\rho\Phi_{HL} + (1-\rho)\Phi_{LL}] + \delta\gamma[\rho\Phi_{HH} + (1-\rho)\Phi_{LH}] + (1-\gamma)F(C_L, C_L). \tag{11}$$

Therefore, if (10)≥(11), $\Theta^B(C_L, C_L) = \{g\}$. Here, (10)≥(11) holds because $\gamma \geq \bar{\gamma}$. Therefore, $\Theta^B(C_L, C_L) = \{g\}$.

In summary, $\Theta^A(C_L, C_L) \cup \Theta^B(C_L, C_L) = \{0, g\}$.

Step 3-2: $\boldsymbol{\Theta^A(C_H,C_H)\cup\Theta^B(C_H,C_H)=\{0,g\}}$. To begin with, consider $\Theta^A(C_H,C_H)$. Challenger B chooses C_H only when $\theta_A=g$. Thus, $\Theta^A(C_H,C_H)=\{g\}$ or $\emptyset$. Examine the condition under which $\Theta^A(C_H,C_H)=\{g\}$.

The equilibrium number of voters who vote for incumbent A is (10). On the contrary, the maximum number of voters who vote for incumbent A when $C^A=C_H$ is that when $\pi=1$ i.e.,

$$\gamma[\rho\Phi_{HH}+(1-\rho)\Phi_{LH}]+(1-\gamma)F(C_H,C_H). \tag{12}$$

Since (12)>(10) holds, $\Theta^A(C_H,C_H)=\{g\}$.

Next, consider $\Theta^B(C_H,C_H)$. Incumbent A chooses C_H only when $\theta_A=0$. Thus, $\Theta^B(C_H,C_H)=\{0\}$ or $\emptyset$. Examine the condition under which $\Theta^B(C_H,C_H)=\{0\}$.

The equilibrium number of voters who vote for incumbent A is (8). On the contrary, the smallest number of voters who vote for incumbent A when $C^B=C_H$ is that when $\pi=0$ i.e,

$$\gamma[\rho\Phi_{HL}+(1-\rho)\Phi_{LL}]+(1-\gamma)F(C_H,C_H). \tag{13}$$

Since (13)<(8) holds, $\Theta^B(C_H,C_H)=\{0\}$.

In summary, $\Theta^A(C_H,C_H)\cup\Theta^B(C_H,C_H)=\{0,g\}$.

From steps 3-1 and 3-2, any π is allowed for $(C^A,C^B)=(C_L,C_L)$ and $(C^A,C^B)=(C_H,C_H)$. Therefore, negative campaign equilibrium [II] satisfies the intuitive criterion.

From steps 1-3, if and only if the conditions in Theorem 1 and the condition in Lemma 14 are satisfied, (i) at least one separating equilibrium in which the challenger chooses C_L if and only if $\theta_A=0$, satisfy the intuitive criterion, and (ii) all the other equilibria (pooling equilibria) do not satisfy the intuitive criterion. Moreover, $\gamma_L<\gamma_1^-(p^*)$ if $p^*<\hat{p}$, and $\gamma_L<\gamma_1^-(\hat{p})$ if $p^*\geq\hat{p}$ from Lemma 16. As a result, we have the condition in the theorem. ■

PROOF OF PROPOSITION 4:

As in the proof of Proposition 1, it suffices to derive the incentive compatibility conditions of the challenger.

(i) When $\boldsymbol{\theta_A=g}$: If and only if the number of voters who vote for the incumbent when $(C^A,C^B)=(C_H,C_H)$ is less than or equal to that when $(C^A,C^B)=(C_H,C_L)$, the challenger chooses C_H when $\theta_A=g$. This condition is given by

$$\begin{aligned}\gamma(\rho\Phi_{HH}+(1-\rho)\Phi_{LH})+(1-\gamma)F(C_H,C_H)\\ \leq \gamma[(1-\delta)(\rho\Phi_{HL}+(1-\rho)\Phi_{LL})+\delta(\rho\Phi_{HH}+(1-\rho)\Phi_{LH})]\\ +(1-\gamma)[(1-\delta)F(C_H,C_L)+\delta H(C_H,C_L)].\end{aligned}$$

By rewriting this condition, we have $\gamma\leq\bar{\gamma}_n$.

(ii) When $\boldsymbol{\theta_A = 0}$: If and only if the number of voters who vote for the incumbent when $(C^A, C^B) = (C_H, C_L)$ is less than or equal to that when $(C^A, C^B) = (C_H, C_H)$, the challenger chooses C_L when $\theta_A = 0$. This condition is given by

$$\gamma(\rho\Phi_{HL} + (1-\rho)\Phi_{LL}) + (1-\gamma)[(1-\delta)F(C_H, C_L) + \delta G(C_H, C_L)]$$
$$\leq \gamma(\rho\Phi_{HH} + (1-\rho)\Phi_{LH}) + (1-\gamma)F(C_H, C_H).$$

By rewriting this condition, we have $\gamma \geq \underline{\gamma}_n$.

Lastly, $\overline{\gamma}, \overline{\gamma}_n, \underline{\gamma}$ and $\underline{\gamma}_n$ have the same functional form such that $f(x) = x/(a+x)$ where $a > 0$. Here, f is increasing in x. Since $G(C_H, C_L) < F(C_H, C_L) < H(C_H, C_L)$ holds from Lemma 1, $\underline{\gamma}_n < \underline{\gamma} \leq \overline{\gamma} < \overline{\gamma}_n$. In addition, it is obvious that $0 < \underline{\gamma}_n$, $\overline{\gamma}_n < 1$. ■

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Chapter 3. Game Theoretic Analysis of Positive and Negative Campaign for Policy

1. Introduction

Recently, negative campaigns and extreme political manifestos are observed simultaneously. For example, on June 2016, United Kingdom decided to exit European Union by United Kingdom European Union membership referendum and under the referendum campaign activity, the supporters of exiting EU and opponents criticized each other violently. These negative campaigns became very severe. As a result, Jo Cox, who was a British Labour Party politician and opponents of exiting EU, was killed by one of the supporters.[1] After the tragic affair, they refrained criticizing each other between fixed intervals. On 26 June 2016, the referendum outcome is supporters of exiting EU won 52% - 48% which was a close battle.[2] We consider this referendum outcome, in other words, the policy of exiting European Union is a very extreme policy. After this referendum, how do British consider this outcome? An answer about the above question was provided by the Google trends.[3] The following figure 1 which is the top questions on the European Union in the United Kingdom since the Brexit result officially announced by Google Trends shows that British awareness of the Brexit problem is very low. Thus, from the above problem, I predict decrease in voters' awareness for policy induces the extreme policy and violent negative campaigns. Therefore, to verify our prediction, in this paper, we represent and analyze a competitive election model which two candidates choose the

(Figure 1) Top questions on the European Union in the United Kingdom since Brexit result officially announced by Google Trends.

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1 Booth, Robert; Dodd, Vikram; Parveen, Nazia (17 June 2016). "Jo Cox killing: suspect's far-right links a 'priority line of inquiry'". The Guardian. Retrieved 22 June 2016. https://www.theguardian.com/uk-news/2016/jun/17/jo-cox-killing-suspect-far-right-links-a-priority-line-of-inquiry

2 EU referendum: full results and analysis The Guardian, 24 Jun 2016. http://www.theguardian.com/politics/ng-interactive/2016/jun/23/eu-referendum-live-results-and-analysis

3 https://twitter.com/GoogleTrends/status/746303118820937728/photo/1?ref_src=twsrc%5Etfw

degree of policy, positive and negative campaigning for policy in order to maximize their own probability of winning an election.

Past literatures focus on the relationship between the candidates' ability and the degree of campaign resources. However, these literatures neglect voters' behavior. We consider that the relationship between candidates and voters is important for the same or more than relationship between candidates in order to verify our prediction of the Brexit problem and for voters, usefulness of the negative campaign. Therefore, we analyze the relationship between voter's awareness of the policy effect and voter's welfare and we consider whether we should regulate negative campaigning by using voter's welfare.

Candidates and companies use advertisements or campaigns in order to differentiate from a competitor. In order to give theirselves an advantage there are two campaign and advertisement types, which are positive and negative. Positive campaign is defined as expression of their own good aspect. Negative campaign is defined as expression of competitor's bad aspect. Negative campaign is often used by political campaigns rather than companies' advertisements. In particular, in American president election, negative campaigns are often used. For example, Young (1987) discussed amount to use negative campaign in the 1980s was greater than in twenty years ago. So, after the 1990s, empirical and experimental researches for negative campaign in American election increase. In Japan, even though the regime of Liberal Democratic Party continued in 50 years, there exist negative campaigns. It is obvious by Curini (2011)'s empirical research which shows if parties' ideology is close, then amount of negative campaign for candidates' valence increases by using Japan and Italia data. Recent example is Japanese general election in 2009. In this election, Democratic Party of Japan used negative campaign for Liberal Democratic Party and then Democratic Party of Japan won. In Politics field, negative campaign infiltrates. So, we consider it is worth to studying negative campaign.

As described above, in previous literatures of negative campaigns, empirical researches are a lot, however theoretical research is rare.[4] Particularly, first theoretical studies of negative campaigns are Skaperdas and Grofman (1995) and Harrington and Hess (1996). Skaperdas and Grofman (1995) defines positive campaigning as increasing independent voters who vote for theirselves and negative campaigning as decreasing competitor's supporters, and then show if candidate's supporters are much more than competitor's, he does not have incentive to use negative campaigns. In other word, a candidate who is much advantageous to the competitor uses positive campaign only under Nash equilibrium. Harrington and Hess (1996) defines positive campaign as advertising

[4] Lau and Rovner (2009) is great survey about negative campaign's theory and empirical research.

their own ideology is moderate and negative campaigns as advertising that the opponent's ideology is extreme, and then shows if a candidate's personality is advantageous to the competitor's, the candidate uses positive campaigns more than the competitor. So, Skaperdas and Grofman (1995)'s outcome is similar to Harrington and Hess (1996)'s. In other word, these models show the candidate who is advantageous to the competitor uses positive campaigns more than the opponent. These outcomes are consistent with Druckman, Kifer and Perkin (2009) which shows the challenger uses negative campaigns more than incumbent by an empirically method. However, these analyses are limited, because these two theoretic studies assume an effect of positive and negative campaign. In other word, a campaign effect is not limited, for example, in Chakrabarti (2007) negative campaigning is defined as advertising competitor's personality is bad. So, we consider positive campaign is defined as representing their own good aspect and negative campaign is defined as representing competitor's bad aspect. For example, theoretic studies of campaign by using the above definition of positive and negative campaign are Mattes and Redlawsk (2015) and Schipper and Woo (2014). Mattes and Redlawsk (2015) constructs and analyzes a competitive election model which voter has belief of candidates' type (which is high or low ability for political issue) and voter updates his belief by candidates' campaigning. However, in this model there exist multi equilibria, so this model cannot show proper use of positive and negative campaign. Schipper and Woo (2014) analyzes a microtargeting election. Schipper and Woo (2014) shows an election's outcome where voters know all issues of election is equal to where voters do not know even though voters' rationality is bounded in candidates using negative campaign. So, Schipper and Woo (2014) shows affirmative effect of negative campaigning. However, this model cannot show proper use of positive and negative campaign.

Past theoretical literatures of negative campaign are not sufficient for the following two reasons. First, past theoretical models of negative campaign assume effect of campaign, for example negative campaign affects competitor's ideology. However, campaign does not only affect ideology of policy or candidates but also candidates' policy effect which is announced by their manifesto. Therefore, this paper does not assume campaign effects, but defines positive campaign as representing good aspect of candidates' own policy and negative campaign as representing bad aspect of competitor's policy. And this paper constructs and analyzes competitive election model which two candidates choose the degree of policy, positive and negative campaigning for policy in order to maximize their own probability of winning an election. Second, past theoretical models only analyze the relationship between candidates' ability and the degree of campaign resources, in other word they neglect the aspect of votes' behavior. Indeed in real elections, there is a difference between candidates' ability. However, we consider a voters' behavior, aspect and relationship between voters and candidates is as important as or more than relationship between candidates' ability in elections. Thus, in this paper we analyze the relationship between voters' behavior and candidates' behavior.

In this paper we show the following three outcomes. First, symmetric equilibrium policy is more extreme than voters' welfare maximization policy. In this paper, voters' awareness for policy effect is imperfect. Therefore, voters' welfare maximization policy is not realized under symmetric equilibrium. Second, if voters' awareness of policy effects is high, then voters' welfare which is obtained by policy is high. Reversely, this proposition affirms our prediction of Brexit problem. Finally, regulation of negative campaign is not necessarily because voters' welfare in no regulating negative campaign for policy is more than in regulating. Previous empirical literatures of negative campaign show bad effect of negative campaigns. For example, Ansolabehere, Iyengar and Simon (1999) shows that negative campaign decreases voter turnout by using empirical method. Geer and Vavreck (2014) show that if a candidate uses negative campaign, then voters recognize his ideology is extreme by using experimental method. Therefore, we can guess negative campaign should be regulated because negative campaign causes bad influence. However, our outcome is the opposite of our guess that negative campaign should be regulated. Thus, we show negative campaign do not only have bad effect.

The remainder of the paper is organized as follows. In the next section, we construct two-stage game which two candidates maximize their probability of winning election. In Section 3, We analyze candidates' behavior and the relationship between voters' awareness and the degree of policy under symmetric equilibrium. In Section 4, we analyze whether we should regulate negative campaigning by using voters' welfare. This paper closes in Section 5 with brief remarks on further studies concerning negative campaign.

2. The Model

In this section, we construct a two-stage game which two candidates who have the same ability maximize their probability of winning an election. In the first stage, candidates simultaneously choose their policy $x_i \in [0, \infty)$, which is their manifesto and represents degree of innovation from the status quo. Innovation of politics has both good and bad aspect. Good aspect represents how much it brings a positive effect on economy or for voters. Bad aspect represents how much it brings a negative effect on economy or for voters, or how extreme ideology of policy is. For example of this policy, we present Policy of free trade. (More specifically say TPP.) Policy of free trade eliminates the tariff. Therefore, cheap products (whose quality is almost the same as domestic products) are imported from foreign. Thus, consumers' welfare improves. This character is good aspect of Policy of free trade. However, if consumers buy cheap products made by foreign, then domestic products is not consumed. Therefore, domestic industry may decline. This character is bad aspect of Policy of free trade. In summary of the above, political policy includes positive and negative aspect. In this model, to characterize this political policy's property, we define the positive aspect of policy x_i as $f(x_i)$ and the negative aspect of policy as $g(x_i)$. Now, we assume function f and g satisfy the following condition.

Assumption 1

i. Function $f: [0, \infty) \to (0, \infty)$ and $g: [0, \infty) \to (0, \infty)$ are C^2 -function and satisfy $f' > 0, f'' \leq 0, g' > 0, g'' \geq 0$.
ii. $f(0) = g(0)$.
iii. $\lim_{x \to 0} f'(x) > \lim_{x \to 0} g'(x)$, $\lim_{x \to \infty} f'(x) < \lim_{x \to \infty} g'(x)$.

Assumption 1's i represents the more innovation of policy x_i increases, the more good and bad aspect increase and marginal effect of good (bad) aspect decreases (increases). In other word, extreme policy gives a bad influence for voter. Assumption 1's ii represents if candidate chooses status quo, then good aspect of the status quo is equal to bad aspect. In other word, if candidate chooses the status quo, then voter cannot receive welfare by policy. Assumption 1's iii means a little innovation is better than no innovation, however extreme innovation causes more bad aspect of policy than good aspect of policy.

In the second stage, candidates have one resource (or time). They distribute one resource to positive campaigning p_i and negative campaigning n_i . In other word, they divide one resource which satisfies $p_i + n_i = 1$. In this model, positive (negative) campaigning is defined as that candidates convey $P(p_i)$ ($N(n_i)$) about the good (bad) aspect of his own (opponent's) policy to median voter. Now, we assume function P and N satisfy the following condition.

Assumption 2

i. Function $P: [0,1] \to [0,1]$ and $N: [0,1] \to [0,1]$ are C^2 -function and satisfy $P' > 0, P'' \leq 0, N' > 0, N'' \leq 0$.
ii. $P(0) = N(0) = 0, P(1) = N(1) = 1$.

Assumption 2's i means that if a candidate increases the resource of campaigning, then the effect of campaigning increases but the marginal effect of campaigning decreases. Assumption 2's ii means if candidates choose no resources for campaigning, then the effect of campaigning does not exist and if candidates allocate positive (negative) campaigning to all resources, then voter recognizes perfectly his good (bad) aspect of policy.

Next, we consider the probability of winning an election. Alesina and Spear (1988) and Harrington (1991) construct the probability of winning election by using median voter's utility. However, their researches consider campaigning affects only ideology of policy. In this paper, we consider a good and bad aspect which concludes ideology of policy. Therefore, we construct the probability of winning an election by using voters' utility which voters get when a candidate i carry an election. In this paper, we assume that set of voters is $[0, 1]$ and each voter knows a part of good and bad aspect of policy from the first and understands a unknown part of a good and bad aspect by using candidates' campaigning. In other word, each voter knows $\alpha \in (0,1)$ about good aspect and $\beta \in (0,1)$ about bad aspect from the first. Therefore, in this model, each voter does not understand perfectly that their welfare is $f(x) - g(x)$. Then, to summarize the above, we define voters' utility when he chooses candidate i as the following equation (1).

$$u(i) = \left(\alpha + (1-\alpha)P(p_i)\right) f(x_i) - \left(\beta + (1-\beta)N(n_{-i})\right) g(x_i) \qquad (1)$$

Next, we construct voters' strategy and probability of winning an election by using equation (1). Each voter k has $z_{k,ij}$ which is the degree of aversion of a candidate i compared to a candidate j. In this model, for each $k = 1,2, z_{k,ij}$ follows identically and independently distribution whose median is θ_{ij}, and satisfies $z_{k,ij} = -z_{k,ji}$. We assume that each candidate does not know aversion distribution's median θ_{ij}, however each candidate knows the distribution which aversion distribution's median follows. In this model, aversion distribution's median θ_{ij} follows the symmetric distribution whose mean is 0. In other word, each candidate does not know true aversion's value of median voter, who is defined as the voter whose aversion is median value, but each candidate knows the distribution of aversion's median. Next, we introduce voters' strategies. We assume that each voter k votes for candidate i if $u(i) - u(j) > z_{k,ij}$ and votes for candidate j if $u(i) - u(j) < z_{k,ij}$. (If $u(i) - u(j) = z_{k,ij}$, then each voter votes for i with probability 0.5.) If we assume the above voters' strategy, candidate wins an election when he gets vote of median voter. Therefore, we consider the probability of candidate i winning an election is equal to the probability of the median voter voting for candidate i. Thus, we construct the probability of candidate i winning an election for the following equation (2) by using the difference of voters' utility when he votes for each candidate and median voter's aversion.

$$\begin{aligned} EP_i &= EP\left(u(i) - u(-i)\right) \\ &= EP\left(\left\{\left(\alpha + (1-\alpha)P(p_i)\right) f(x_i) - \left(\beta + (1-\beta)N(n_{-i})\right) g(x_i)\right\}\right. \qquad (2) \\ &\quad \left. - \left\{\left(\alpha + (1-\alpha)P(p_{-i})\right) f(x_{-i}) - \left(\beta + (1-\beta)N(n_i)\right) g(x_{-i})\right\}\right) \end{aligned}$$

Now, we assume function EP satisfies the following conditions since the above discussion. (For the following assumption, we write y as $u(i) - u(j)$.)

Assumption 3

i. $\forall\, y \in (-\infty, \infty)\,, EP(y) \in (0,1)$.

ii. EP is C^1 –function and $\forall\, y \in (-\infty, \infty)\,, EP'(y) > 0$.

iii. $EP(y) = 1 - EP(-y)$.

iv. $\lim_{y \to -\infty} EP(y) = 0\ , \lim_{y \to \infty} EP(y) = 1$.

Assumption 3's ii means if voters' utility in his voting for a candidate i increases or voters' utility in his voting for opponent decreases, then probability of a candidate i's winning an election increases. Assumption 3's iii means the sum of candidate i's probability and opponent's probability must be equal to one.

In this paper, each candidate chooses policy x_i and resource for positive campaigning p_i in order to maximize his probability which is defined by equation (2). In following Section 3, we show symmetric equilibrium of this game by using backward induction and examine property of candidate's behavior under symmetric equilibrium.

3. Equilibrium

In this section, we consider the situation which satisfies following Assumption 4.

Assumption 4

i. $\alpha = \beta$.

ii. $P(p_i) = p_i^t\,, N(n_i) = n_i^t\ \big(t \in (0,1)\big)$.

iii. $f(x)^{t/1-t} f'(x)$ is non-increasing function.

Assumption 4's i means that voters know the good and bad aspect of policy by the same. This is because in this model, we construct the probability function of candidate's winning an election by using median voter. Therefore, we focus on median voter, and actually, it is rare that medium voter knows one of aspects well like independent voters. Thus, we consider this case. Assumption 4's ii means we assume specific campaigning function P and N satisfying Assumption 2. Assumption 4's iii means marginal effect of policy's good aspect is always stronger than or equal to policy effect of good aspect. In other word, extreme innovation does not really provide good effect. Then, each candidate maximizes the following probability function of winning an election.

$$\max_{x_i, p_i} EP(\{(\alpha + (1-\alpha)p_i^t) f(x_i) - (\alpha + (1-\alpha)(1-p_{-i})^t) g(x_i)\}$$
$$- \{(\alpha + (1-\alpha)p_{-i}^t) f(x_{-i}) - (\alpha + (1-\alpha)(1-p_i)^t) g(x_{-i})\})$$

Next, we analyze this game by using backward induction. In the second stage, each candidate simultaneously chooses resource of positive campaigning p_i . So, we differentiate the above probability function in p_i. Then we get the following condition

(3).[5]

$$p_i = \frac{f(x_i)^{1/1-t}}{f(x_i)^{1/1-t} + g(x_{-i})^{1/1-t}} \tag{3}$$

Next, we input (3) for the probability function and we analyze first stage game. In the first stage, each candidate simultaneously chooses policy x_i . So, we differentiate probability function in x_i for which we input equation (3). Then, we get the following condition (4).[6]

$$EP' \times \left\{ \alpha[f'(x_i) - g'(x_i)] + (1-\alpha) \left[\frac{f(x_i)^{\frac{t}{1-t}} f'(x_i)}{\left(f(x_i)^{\frac{1}{1-t}} + g(x_{-i})^{\frac{1}{1-t}}\right)^t} - \frac{g(x_i)^{\frac{t}{1-t}} g'(x_i)}{\left(f(x_{-i})^{\frac{1}{1-t}} + g(x_i)^{\frac{1}{1-t}}\right)^t} \right] \right\} = 0 \tag{4}$$

Policy x_i which satisfies the equation (4) is optimal policy for candidate i, and resource of positive campaigning p_i which satisfies equation (3) and (4) is optimal resource of positive campaigning for candidate i. Because of Assumption 3 which is that EP' is always positive, therefore we neglect EP' in equation (4) for the following discussion. Next, we consider symmetric case where we input $x_i = x_{-i} = x$ for equation (4). Then we get the following condition of symmetric equilibrium $x_1 = x_2 = x^*$.

$$\alpha\{f'(x^*) - g'(x^*)\} + \frac{(1-\alpha)\left\{f(x^*)^{\frac{t}{1-t}} f'(x^*) - g(x^*)^{\frac{t}{1-t}} g'(x^*)\right\}}{\left(f(x^*)^{\frac{1}{1-t}} + g(x^*)^{\frac{1}{1-t}}\right)^t} = 0 \tag{5}$$

Now, we analyze symmetric equilibrium. If Assumption 1~3 hold, we can prove existence of interior solution. Before this proposition shows, we show lemma in order to prove existence of interior solution.

Lemma 1

Suppose x^1, x^2 *and* x^3 *satisfy* $f'(x^1) = g'(x^1), f(x^2)^{t/1-t} f'(x^2) = g(x^2)^{t/1-t} g'(x^2)$, $f(x^3) = g(x^3)$. *If Assumption1 holds, then* $x^1 < x^2 < x^3$.

Proof

Because of Assumption 1 and 4's iii, $f(x)^{t/1-t} f'(x) - g(x)^{t/1-t} g'(x)$ is non-increasing function. And Because of Assumption 1, $f(x)^{t/1-t} f'(x) - g(x)^{t/1-t} g'(x)$ is positive if $0 < x \leq x^1$, and $f(x)^{t/1-t} f'(x) - g(x)^{t/1-t} g'(x)$ is negative if $x \geq x^3$. Therefore, because of Mean Value Theorem there exists x^2 which satisfies $x^1 < x^2 < x^3$.■

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[5] Probability function EP is increasing function (in other word, EP' is always positive) because of Assumption 3. Therefore, we neglect EP' in first order condition.

[6] Because of Assumption 1, 2 and 4, the section 2 of equation (4) is decreasing in x_i . Therefore, there exists a reaction function.

Next, we show existence of the symmetric equilibrium by using Lemma1.

Proposition 1

If Assumption 1, 3 and 4 hold, there exists the symmetric equilibrium policy $x_1 = x_2 = x^*$ *and symmetric equilibrium policy* x^* *is greater than voters' welfare maximization policy* x^1 *.*

Proof

In order to get symmetric equilibrium policy x^*, we differentiate left hand side of equation (5) (which we calls $B(x)$) in x. Then, we get the following equation.

$$B'(x) = \alpha(f'' - g'') + (1-\alpha)\frac{K'(x)L(x) - K(x)L'(x)}{L(x)^2}$$

$$where\ K(x) = f(x)^{t/1-t}f'(x) - g(x)^{t/1-t}g'(x)\ , L(x) = \left(f(x)^{\frac{1}{1-t}} + g(x)^{\frac{1}{1-t}}\right)^t$$

Because of Assumption 1, 3's iii and Lemma 1, $K'(x) < 0, L(x) > 0, L'(x) > 0$ for all x and because of Lemma 1, $K(x) > 0$ if $0 \leq x < x^2$. Therefore, $B'(x) < 0$ when $0 \leq x \leq x^2$. Thus, $B(x)$ is decreasing function when $0 \leq x \leq x^2$. Equation $B(x)$ satisfies $B(x) > 0$ if $0 \leq x \leq x^1$ and $B(x) < 0$ if $x \geq x^2$. Therefore, there exists x^* which satisfies $x^1 < x^* < x^2$.■

By using Proposition 1, we can show upper bound of symmetric equilibrium policy.

Lemma 2

If Assumption 1, 3 and 4 hold, then symmetric equilibrium policy x^* *is smaller than policy* x^2 *which is realized when voters do not recognize all of policy effect.*

Because of Proposition 1 and Lemma 2, we discovered where symmetric equilibrium policy exists. And we turn out symmetric equilibrium policy x^* is more extreme than the policy x^1 which maximizes voters' welfare. In other word, candidates have no incentive to realize voters' welfare maximizing policy x^1 when voters' awareness is imperfect. In our model, voters' awareness for policy effects is not completely. So, each candidate wants to choose a little extreme policy and increase resource of positive campaigning. For example, we consider the case where candidates choose policy x^1 which is voters' welfare maximization policy. Then, amount of positive campaign resource is more than amount of negative campaign resource because of equation (3) and Assumption 1. Thus, candidate's marginal benefit which is represented by equation (5) is positive because marginal benefit from campaign which is represented by section 2 of equation (5) is positive. Therefore, each candidate have incentive to choose more extreme policy than voters' welfare maximization policy x^1 .

Next, we consider relationship between voter's awareness α and symmetric equilibrium policy x^*. By equation (5), if voters do not understand the effect of policy (in other word, α is close to 0) , then symmetric equilibrium policy x^* is close to extreme policy x^2, and if voters understand the effect of policy (in other word, α is close to 1) , then symmetric equilibrium policy x^* is close to the policy of the maximizing voters' welfare x^1. So, we can guess if voters know the effect of policy more, then voters' welfare increases. So, we show this guess by the following proposition.

Proposition 2

Under Assumption 1, 3 and 4, if voters' awareness α increases, then symmetric equilibrium policy x^* decreases and symmetric equilibrium resource of positive (negative) campaigning increases (decreases).

Proof

Firstly, we show relationship between α and x^*. In order to prove this relationship, we apply implicit function theorem with respect to α for equation (5). Then, we get the following outcome.

$$\frac{dx^*}{d\alpha} = \left\{ -f'(x^*) + g'(x^*) + \frac{\left\{ f(x^*)^{\frac{t}{1-t}} f'(x^*) - g(x^*)^{\frac{t}{1-t}} g'(x^*) \right\}}{\left(f(x^*)^{\frac{1}{1-t}} + g(x^*)^{\frac{1}{1-t}} \right)^t} \right\} \Big/ B'(x^*) \quad (6)$$

Equation (6)'s numerator of right hand side is positive and denominator is negative because of Proposition 1 and Lemma 2. Therefore, equation (6) is negative.

Next, we show relationship between α and symmetric equilibrium resource of positive and negative campaigning. In order to prove this relationship, we differentiate equation (3) in α for which we input symmetric equilibrium policy x^* (which we call $p(x^*)$). Then, we get the following equation (8).

$$\frac{dp(x^*)}{d\alpha} = \frac{(1-t)^{-1}\{f(x^*)g(x^*)\}^{\frac{1}{1-t}}}{\left(f(x^*)^{\frac{1}{1-t}} + g(x^*)^{\frac{1}{1-t}} \right)^2} \left(\frac{f'(x^*)}{f(x^*)} - \frac{g'(x^*)}{g(x^*)} \right) \times \frac{dx^*}{d\alpha} \quad (7)$$

Section 1 of equation (7)'s right hand side is positive and section 3 is negative because of equation (6). Thus, we consider section 2 of equation (7)'s right hand side. By using Lemma1, 2 and Proposition 1, $x^1 < x^* < x^2 < x^3$ holds. And because of Assumption 1, $f(x^*) > g(x^*)$ and $f'(x^*) < g'(x^*)$ hold. Thus, section 2 is negative. Therefore equation (7) is positive. And in this model, symmetric equilibrium resource of negative campaigning $n(x^*)$ satisfies $n(x^*) = 1 - p(x^*)$. So, $dn(x^*)/d\alpha = -dp(x^*)/d\alpha <$

0 .■

By using Proposition 2, we show value of symmetric equilibrium policy when voters' awareness is asymptotically close to 1, in other word voters know almost all of policy effect.

Corollary 1

Under Assumption 1, 3 and 4, if voters' awareness α *is asymptotically close to 1, then symmetric equilibrium policy* x^* *is asymptotically equal to voters' welfare maximization policy* x^1 *.*

Proof

In order to show this Collorary, we input $\alpha = 1$ for equation (5). Then, we get symmetric equilibrium policy x^* is equal to voters' welfare maximization policy x^1 .■

Because of Proposition 2, if voters' awareness increases, then resource of positive campaigning and voters' welfare increase and symmetric equilibrium policy decreases. Therefore, if voters know the effect of policy more, then the policy which voters like more realizes. In this model, if voters' awareness α increases, then voters can understand policy effect by not very using candidates' campaign. Thus, candidates chooses close of voters' welfare maximization policy. Next we consider intuition of relationship between voters' awareness and campaign resource. In this model, because of equation (3), amount of campaign resource is determined by comparative assessment between positive and negative effect of policy. Thus, if degree of policy innovation decreases, in other word policy is not extreme, then bad effect of policy decreases rapidly and good effect of policy decreases gently. Therefore, candidates' incentive to use negative campaign decreases.

In following Section 4, we consider whether we regulate negative campaigning by using voters' welfare.

4. Regulation versus No Regulation of Negative Campaign

In Section 3, we discussed candidates' behavior when they can use negative campaigning. However, negative campaign does not only express opponent's bad aspect of policy. For example, Ansolabehere, Iyengar and Simon (1999) show that negative campaign decreases voter turnout by using empirical method. Geer and Vavreck (2014) show that if a candidate uses negative campaign, then voters recognize his ideology is extreme by using experimental method. Therefore, we can guess negative campaign should be regulated because negative campaign causes bad influence. So, in this section, in order to verify this guess we compare voters' welfare in regulating negative campaigning with welfare in no regulating.

Next, we analyze candidates' behavior when they cannot use negative campaigning. In this case, each candidate chooses the resource of positive campaigning only. Therefore, we present next Proposition 3 which means that how much each candidate chooses resource of positive campaigning and symmetric equilibrium policy in regulating negative campaigning.

Proposition 3

Under Assumption 1, 3 and 4, if candidates cannot use negative campaigning, then each candidate chooses symmetric equilibrium resource of positive campaigning in regulating negative campaigning $p_i = 1$.

Proof

Fixed any policy $x_i', x_{-i}' \in (0. \infty)$ which each candidate chooses in first stage. Then we check that candidate i has incentive to deviate $p_i' \in [0,1)$ when other candidate chooses $p_{-i}' \in [0,1]$. Therefore, in order to check this we differentiate equation (2) in p_i for which we input $n_i = n_{-i} = 0$. Then we get the following equation (9).

$$\frac{dEP_i}{dp_i} = EP' \times (1-\alpha)P'(p_i')f(x_i') \quad (8)$$

Because of Assumption 3, EP' is always positive. Because of Assumption 5, $(1-\alpha)P'(p_i)f(x_i')$ is always positive. Therefore, equation (9) is always positive. Therefore, candidate i has incentive to deviate from $p_i' \in [0,1)$. Thus, next we check if each candidate chooses $p_i' = 1$, then he does not have incentive to deviate. In order to check this, we input $p_i' = 1$ for equation (9). Then, because this equation (9) is always positive, candidate i wants to deviate. But, he cannot choose $p_i > 1$. Thus, under subgame perfect equilibrium each candidate chooses $p_i = 1$. ■

Proposition 3 means if candidates' negative campaign is regulated, then they use full of resources for positive campaign in order to increase their own probability of winning an election. And because of Proposition 3, we showed symmetric equilibrium policy in regulating negative campaign x'. Next, we compare voters' welfare in regulating negative campaigning with welfare in no regulating.

Proposition 4

If Assumption 1, 3 and 4 hold, then voters' welfare in no regulating negative campaigning is greater than in regulating negative campaigning.

Proof

To prove this proposition, we compare first order condition in regulating and no regulating negative campaign. In regulating negative campaign, first order condition under symmetric is the following equation (where we call left hand equation $C(x)$).

$$(C(x) =)\alpha\{f'(x) - g'(x)\} + (1-\alpha)f'(x) = 0$$

For any x, $C(x)$ is non increasing function in x. And then, we compare first order condition in no regulating negative campaign $B(x)$ as $C(x)$. Then, for any x, $B(x)$ is less than $C(x)$. Therefore, if x^* satisfies $B(x^*) = 0$, $C(x^*) > 0$. Thus x^{**} is greater than x^*. Giving attention to x^{**} is greater than x^1, voters' welfare in x^* (where negative campaign is not regulated) is greater than in x^{**}.■

By Proposition 4, voters' welfare in no regulating negative campaigning is better than in regulating. Thus, we consider negative campaign for policy should not be regulated. Next, we consider intuition of Proposition 4. If candidates cannot use negative campaigning, because of Proposition 3, candidates allocate all resource for positive campaigning. Then, candidates advertise strongly their good aspect of policy on campaigning. Therefore, they choose more extreme policy. However, if negative campaigning is not regulated, each candidate monitors each other's bad aspect of policy. Thus, it is difficult for candidate to use extreme policy. So, voters' welfare in no regulating negative campaigning is better than in regulating.

For example Ansolabehere, Iyngar & Simon (1999), bad effect of negative campaign is focused. In Japan, candidates can not use negative campaign on Internet advertisement and election broadcast because of Japanese Public Offices Election Act paragraph 7, Article 142 and paragraph 2, Article 150. However, we consider negative campaign for policy should not be regulated.

5. Concluding Remark

Most of previous literature analyzed the case where campaign affects ideology of policy or effect of campaign is specialized. So, we construct and analyze the model which candidates use campaign for policy effect. First outcome of this paper is that the more voters' awareness increases, the more voters' welfare increases. This proposition affirms our prediction of Brexit problem. Actually, in Japanese election young voters have little interest in politics and policy effect. However, we show little interest in politics leads to extreme policy and then voters' welfare decreases. So, we consider voters should increase their awareness of politics and policy effect in order to improve their welfare. Second outcome of this paper is that if voters' awareness of policy effect is half, negative campaign should be regulated because voters' welfare in no regulating negative campaigning is greater than in regulating negative campaigning. Most of past literature focuses on bad aspect of negative campaign. However, we showed negative campaigning for policy improves voters' welfare, so negative campaign does not only cause bad influence.

In this paper, we analyzed symmetric equilibrium only. In other word, we focused on candidates who have the same ability. However in real election, there exists the case where a candidate's ability is much greater than other's ability. So, in future literature we expect that the general case of this election model will be analyzed.

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Chapter 4. When Populism Meets Globalization:

Analysis of Tax Competition

1. Introduction

An important feature of populism, which is on the rise in many countries, is the preference for extreme economic policies. This study examines extremely low taxation as a populist economic policy. In particular, by using the framework of capital tax competition, we investigate the consequences of populism by focusing on its connection with globalization.

Populists often favor extreme policies even though such actions seem to be harmful to the majority of voters. Nonetheless, populists are supported by a large number of voters. This paradoxical phenomenon---extremism with strong support by citizens---is an important feature of populism. A typical policy dimension in which this interesting phenomenon arises is fiscal policies. For instance, in the 1990s, right-wing populism strongly connected with neoliberal economic policies emerged in Western Europe (Betz 1993) and Latin America (Roberts 1995)[1] Such right-wing populists typically argue for anti-taxation.[2] The objective of this study is to investigate the consequences of the right-wing populist taxation policy.

To explore this objective, we pay special attention to the effect of globalization since it drastically changes the nature of taxation policies. Recent globalization has enabled production factors to move across countries at low cost, implying that tax bases such as capital are now mobile. This increased mobility results in severe international tax competition (Devereux, Lockwood, and Redoano 2008). Indeed, corporate tax rates have tended to decline (Keen and Konrad 2013: Figure 1) and policymakers have thus paid considerable attention to tax competition concerns. As such, globalization affects taxation policies. To take this into account, we adopt the framework of capital tax competition. Here, we consider taxation on capital simply because it is a typical mobile tax base and the literature on tax competition has been developing in this direction.

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[1] Other cases include the Tea Party in the United States (Formisano 2012), market populism in Canada such as argued by the Harper government (Sawer and Laycock 2009), and neoliberal populism in Japan that emerged in the 2000s and 2010s (Weathers 2014; Lindgren 2015). Note that our scope is broader than expected from the aforementioned examples. Extremely low taxation includes a situation in which the status quo tax rate, which is lower than the socially optimal level, is maintained. Hence, even traditional politicians' behaviors to hesitate to argue for the necessary tax increase could be included in our focus.

[2] Current right-wing populists in Europe often mix left- and right-wing economic policies (Rovny 2013). However, the analysis of anti-taxation populism is still important to understand current right-wing populism in Europe for the following reasons. First, the origins of right-wing populist parties are based on neoliberalism and many of them such as the Progress Party in Norway still favor anti-taxation. Furthermore, one of the largest features of populism is anti-elitism (Mudde 2004). Even if their economic policies are not based on neoliberalism, they argue that the current welfare state is a self-serving tool in the hands of bureaucrats (De Koster, Achterberg, and Van der Waal 2013).

To this end, we construct a two-country capital tax competition model in which capital can move freely across countries. There are two types of politicians: the benevolent type whose objective is to maximize residents' utility and the leviathan type whose objective is to maximize tax revenue.[3] In addition, politicians have reputation (i.e. reelection) concerns; namely, they want to maintain their reputation as the benevolent type (i.e., a good politician). In the presented model, the residents of country 1 do not know the policymaker's type, while country 2's policymaker is known to be benevolent. We also consider a closed economy model in which capital is immobile. By comparing country 1 in the tax competition model with that in the closed economy model, we can therefore investigate the effect of globalization.[4]

We start by showing that extremely low taxation arises when high reputation concerns are present.[5] As the residents in country 1 do not know their policymaker's type, they update their beliefs based on the chosen tax rate. Here, the tax rate maximizing the budget is higher than that maximizing welfare, meaning that a low tax rate can be a signal that the policymaker is of the benevolent type (i.e., s/he is not corrupt). In other words, extremely low taxation works as a symbolic policy to appeal that the politician is a civic servant rather than the leviathan. Hence, to acquire a good reputation, the benevolent type chooses an extremely low tax rate that the leviathan type never chooses. Furthermore, a politician who implements such an extreme policy is supported by voters in the sense that s/he acquires a good reputation. In this regard, extremely low taxation with strong support by citizens (a feature of right-wing populism) arises in country 1.[6]

Globalization alters the properties of this populism.[7] The most drastic change concerns the welfare consequences. Reputation concerns induce extremely low taxation on capital. Hence, the existence of reputation concerns inducing populism seems to be harmful to welfare. Indeed, this is the case in a closed economy. By contrast, perhaps surprisingly, we show that in the tax competition model, such reputation concerns can improve welfare

[3] The leviathan-type government was first proposed by Brennan and Buchanan (1977, 1980) in the literature on public choice and this has been followed by many studies in the tax competition literature.
[4] In reality, the degree of capital mobility has been gradually decreasing. However, imperfect mobility is not analytically tractable so that the literature has mainly compared two extreme cases (perfectly mobility and perfectly immobility) to obtain insights about the effect of globalization.
[5] In reality, reputation concerns affect policymaking. See Kartik and Van Weelden (2018: footnote 2).
[6] In Japan, neoliberal populism emerged in 2010s in the local politics level. Takashi Kawamura, the mayor of Nagoya (the third largest city in Japan), drastically cut the municipal tax including the tax for corporations. He explained that one of the objectives was to credibly commit to administrative reform (Kawamura 2010). This is consistent with our idea such that reduction of tax rates can be a signal that the government will never act for bureaucrats.
[7] The following welfare implications do not depend on the mechanism behind the emergence of populism. Hence, even if the actual mechanism is different from that of our study, the same welfare implications hold to some extent.

in terms of either the whole world or the populist country (i.e., country 1), depending on country 1's productivity. This indicates that globalization changes the welfare implications of populism.

The first positive result is that reputation concerns inducing populism improve world welfare when country 1's productivity is sufficiently higher than that of country 2. Under tax competition, there is a fiscal externality such that a lower tax rate in a country negatively affects the other country's tax revenue. Hence, anti-taxation populism seems to hurt world welfare more severely in the tax competition model than that does in a closed economy. Nonetheless, the opposite can be the case.

The key is the inefficiency coming from the misallocation of capital. Capital is efficiently allocated across countries when its marginal productivity is equal across countries. Hence, the tax rates must be the same between countries. However, decentralization yields different tax rates, which reduces the aggregate level of production in the whole world.[8] Therefore, whether populism leads to a larger difference in tax rates determines its effect on world welfare. Suppose that country 1's productivity is fairly high. Then, without populism, country 1's tax rate is high compared with that of country 2, creating the welfare loss. On the contrary, populism drastically lowers country 1's tax rate chosen by the benevolent type. Hence, the difference in tax rates across countries is reduced. As such, populism improves world welfare when country 1 is rich.

Another positive result is about country 1's welfare. Extremism in a country by definition implies that policies are extreme for the country. Nonetheless, reputation concerns inducing populism improve country 1's welfare when the country's productivity is sufficiently low. The driving force is the fact that a change in a country's tax rate affects the price of capital, generating the terms-of-trade effect (DePeter and Myers 1994), which has been widely recognized in the tax competition literature.

To illustrate, suppose that two countries are symmetric. First, consider the effect when country 1's policymaker is the benevolent type. Populism makes the benevolent type choose an extremely low tax rate, which increases the interest rate. Hence, populism improves country 1's welfare only when it is a capital-exporter. However, country 1 is a capita-importer. Since country 2 does not know country 1's policymaker's type, country 2 chooses a tax rate taking into account the possibility that country 1's policymaker is the leviathan type. Hence, country 2's tax rate is higher than country 1's tax rate implemented by the benevolent type, meaning that country 1 attracts a large amount of capital.

[8] This has been regarded as one of the largest evils of tax competition. Indeed, many studies analyze how tax coordination to prevent such production inefficiency is achievable (e.g., Peralta and van Ypersele 2006; Itaya, Okamura, and Yamaguchi 2008).

Therefore, populism hurts country 1 (i.e., the terms of trade are worse off).

However, we see the opposite effect when country 1's policymaker is the leviathan type. In this case, country 1's tax rate is considerably higher than country 2's tax rate. Hence, country 1 attracts only a small amount of capital, meaning that it is a capital-exporter. Therefore, an increase in the interest rate is beneficial for country 1. The possibility of populism indeed increases the interest rate.[9] Therefore, populism has a positive effect.

In summary, two opposite effects on country 1's welfare exist. Furthermore, the positive effect sometimes dominates the negative effect. In particular, country 1 enjoys the benefits of populism when its productivity is sufficiently lower than that of country 2. The lower country 1's productivity is, the lower the amount of capital it imports, implying that the negative effect falls, while the positive effect rises. Hence, reputation concerns improve country 1's welfare when its productivity is sufficiently low.

These results together argue that under tax competition, populism can improve welfare in contrast to in a closed economy.[10] Interestingly, this welfare-enhancing effect crucially depends on whether the populist country is rich. The populist country itself enjoys the benefits from the possibility of populism only when the country is quite poor, while it improves world welfare only when the populist country is quite rich.[11] That is, the relative economic condition of the populist country matters.[12] Lastly, it should be cautioned that such welfare-enhancing effects are not always obtained. Even under tax competition, populism is harmful when countries have similar characteristics.

The remainder of the paper proceeds as follows. Section 2 reviews the related literature. Section 3 describes the model. Section 4 derives the equilibrium in a closed economy. Section 5 derives the equilibrium under tax competition. Section 6 investigates the welfare implications of populism, which is our main focus. Section 7 discusses some extensions. Section 8 concludes.

2. Related Literature

[9] Remember that country 2 chooses its tax rate taking into account the possibility that country 1's policymaker is the benevolent type. Thus, the possibility of populism in country 1 decreases country 2's tax rate. Furthermore, this decreases country 1's tax rate implemented by the leviathan type. Hence, the interest rate when country 1's policymaker is the leviathan type increases due to populism.

[10] In Section 7, we analyze a small open economy in which each country is a price-taker. In this situation, the welfare-enhancing effect of populism is still preserved to some extent.

[11] This implies that when one country enjoys the benefit from populism, the other country's welfare is always undermined.

[12] The key for the positive effect on world welfare is that country 1's tax rate is sufficiently high without populism, whereas the key for the positive effect on country 1's welfare is that country 1 is a capital-exporter. Hence, although we focus on the asymmetry in production technologies, we expect that the similar implications hold whatever asymmetry countries face, so long as they lead to those key properties.

Our study is related to two strands of the literature: populism and tax competition.

Populism. A growing number of studies provide formal models of populism.[13] Since populism has a multifaceted nature, each study focuses on a specific aspect such as extremism (e.g., Acemoglu, Egorov, and Sonin 2013), herding (e.g., Frisell 2009), and anti-elitism (e.g., Kishishita 2017). In this study, we consider populism such that a politician chooses an extreme policy to signal that s/he is a good politician. Acemoglu, Egorov, and Sonin (2013) explore this type of explanation as signaling. By adopting a similar mechanism,[14] we analyze how globalization changes the properties of populism as extremism.

One contribution to the literature on populism as extremism is showing that populism can improve welfare. By definition, extremism implies that politicians choose policies that are extreme compared with the socially optimal policy.[15] Nonetheless, we show that extremism can have a positive effect when countries face tax competition.[16]

In addition, our study contributes to the literature by investigating the connection between populism and globalization. Several studies both theoretically and empirically find that globalization can be a cause of populism in various ways (e.g., Dippel, Gold, and Heblich 2015; Autor et al. 2017; Karakas and Mitra 2017; Colantone and Stanig 2018). Although this is certainly interesting and important, globalization could influence populism in other ways. As overlooked effects, we show that globalization creates the welfare-enhancing effect of populism. Ours is thus the first study to show that globalization alters the welfare consequences of populism, shedding new light on the

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[13] Studies of populist fiscal policies include Acemoglu, Robinson, and Torvik (2013), Matsen, Natvik, and Torvik (2016), Aggeborn and Persson (2017), and Karakas and Mitra (2017). None of these works concerns tax competition.

[14] In contrast to our model, they adopt an abstract model describing policy preferences as the quadratic loss function and focus on left-wing populism. See Matsen, Natvik, and Torvik (2016) for the application to petro populism.

[15] To be precise, extremism enables voters to select a good politician in the future elections, and thus taking the future payoff into account, it can improve welfare (Acemoglu, Egorov, and Sonin 2013). Furthermore, even the static payoff can be improved when voters face uncertainty about how desirable the implemented policy was (Kartik and Van Weelden 2018). In that setting, the bad type politician is disciplined to some extent by extremism, implying that extremism can benefit the country. However, we show that even without them, extremism can improve welfare. Moreover, even in the presence of uncertainty on policymaking, the welfare under the good type politician is always worse-off. However, even this welfare can be improved under globalization in our model.

[16] Eguia and Giovannoni (2017) study extremism such that the opposition party commits to an unorthodox policy and invests in the ability to implement such a policy. They show that this can be welfare-improving because the opposition party's high ability to implement the unorthodox policy is beneficial for voters when the mainstream policy becomes invalid in the future. The key factor is that the extreme policy can be a desirable policy in the future. By contrast, we show that even extremism inducing an extreme policy, which is never good for voters, may still benefit them.

connection between populism and globalization.

Tax competition. Drawing on the seminal works of Zodrow and Mieszkowski (1986) and Wilson (1986), numerous studies have analyzed capital tax competition to clarify the effects of interregional competition for mobile tax bases (see Keen and Konrad (2013) for a literature review). We contribute to this literature in the following three aspects.

Although some studies analyze the political process in an indirect democracy, they fail to explain the paradoxical phenomenon that some politicians argue for extremely low taxation and yet are still supported by a large number of voters. The first contribution is to explain this paradox. The indirect democracy with heterogeneous politicians has been modeled in two directions. In one strand, politicians are either the benevolent or the leviathan type similarly with ours. This strand considers a model in which voters choose which one to delegate the choice of tax rates (Pal and Sharma 2013; Kawachi, Ogawa, and Susa 2018). By construction of the model, tax rates are not extremely low. The other strand focuses on the difference in a candidate's capital share (Persson and Tabellini 1992; Ihori and Yang 2009; Ogawa and Susa 2017; Nishimura and Terai 2017). Voters choose the policymaker among candidates with different capital shares. In this model, voters tend to delegate to the politician whose capital share is lower than the median voter's share.[17] The lower the capital share the policymaker has, the higher the tax rate is, and therefore tax rates tend not to be extremely low. Hence, neither strand can explain the reality on which we focus in this study.[18] By contrast, we show that the paradoxical phenomena can be explained by the information asymmetries between politicians and voters.

Furthermore, our model dealing with these information asymmetries provides a new way to analyze tax competition. Despite its importance, few studies have analyzed information asymmetries between voters and politicians under tax competition. The exception is the study of Besley and Smart (2002). However, their environments differ from ours in the following two aspects. First, taxation in their model is not on capital. Second, the benevolent type in their setting has no reputation concerns and thus does not behave strategically. As a result, populism never arises in contrast to in our model. This distinction is another novelty of our study.

Lastly, our study contributes to the literature on asymmetric tax competition. Since

[17] When there is a large asymmetry, the opposite can be the case. Otherwise, this holds.

[18] This cannot be explained by special interests politics in which interest groups formed by capitalists try to affect policymaking. First, lobbying by capitalists does not necessarily try to lower capital tax rates under tax competition (e.g., Lai 2010; Lai 2014). Furthermore, even if tax rates are reduced as a result of lobbying, the majority of rational/informed voters would not support the corrupt politician who chooses low taxation.

Bucovetsky (1991), tax competition between asymmetric countries has been extensively analyzed. In particular, some of them analyze the asymmetry in productivity in the context of fiscal coordination, endogenous timing, strategic delegation, and so on (e.g., Hindriks, Peralta, and Weber 2008; Itaya, Okamura, and Yamaguchi 2008; Kempf and Rota-Graziosi 2010; Ogawa 2013; Pal and Sharma 2013; Eichner 2014; Hindriks and Nishimura 2015; Ogawa and Susa 2017). Following this literature, we introduce the asymmetry in productivity and show that the welfare implications of populism crucially hinges on whether the populist country is rich or poor. This finding gives us new insights about the role of asymmetric production technologies in tax competition.

3. The Model

3.1 Basic Settings

There are two countries $i \in \{1,2\}$, and in each of these there is a continuum of homogeneous residents with measure one. Each resident owns one unit of labor and provides it inelastically. Labor is immobile across countries. The production of private goods requires labor and capital under a constant-returns-to-scale technology. Our focus throughout the analysis is on country 1.

Capital endowment. The initial endowment of capital per capita in country i is $\bar{k}$, meaning that each country has the same amount of capital endowment $\bar{k}$. There are no absentee capital owners (i.e., total capital in this economy is $2\bar{k}$).

Firms. In each country, there is a continuum of firms with measure one whose production technology is the same. Since we assume constant-returns-to-scale technology, this yields perfect competition in each country. In particular, the production function per capita in country i is given by $f_i(k_i) = (A_i - k_i)k_i$, where k_i represents the amount of capital per capita in country i and $A_i > 0$ represents the productivity of country i.[19] Let $\Delta \equiv A_1 - A_2$. Assume that $|\Delta| \leq 16\bar{k}$ and $A_i \leq 4\bar{k}$.[20] Then, the profit of a firm in country i is given by $\Pi_i = (A - k_i)k_i - w_i - r_i k_i - t_i k_i$, where w_i is the wage rate, r_i is the interest rate, and t_i is the capital tax rate in country i.

In the closed economy model analyzed in Section 4, capital is immobile across countries, and thus $k_i = \bar{k}$. Hence, the interest rate in country 1 is given by

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19 This production technology, which is homogeneous of degree one, is standard in the literature on strategic tax competition. Studies using similar settings include Bucovetsky (1991), Hindriks, Peralta, and Weber (2008), Itaya, Okamura, and Yamaguchi (2008), Kempf and Rota-Graziosi (2010), Ogawa (2013), Pal and Sharma (2013), Eichner (2014), Hindriks and Nishimura (2015), Nishimura and Terai (2017), and Kawachi, Ogawa, and Susa (2018).

20 The level of productivity must be sufficiently large to ensure k_i to be less than the capital level at which the production function has its maximum.

$$r_1 = A - \bar{k} - t_1. \tag{1}$$

In the open economy model analyzed in Section 5, capital is mobile across countries, and hence $r_1 = r_2 = r$. Thus, $r = A - 2k_i - t_i$ and $2\bar{k} = k_1 + k_2$. Combining these two yields the amount of capital and the interest rate in an open economy:

$$k_1 = \bar{k} + \frac{\Delta - (t_1 - t_2)}{4};\ k_2 = \bar{k} - \frac{\Delta - (t_1 - t_2)}{4}. \tag{2}$$

$$r = \frac{A_1 + A_2}{2} - \frac{t_1 + t_2}{2} - 2\bar{k}. \tag{3}$$

We assume that r must be non-negative.

Residents. The preference of residents in country i is defined by $U(c_i, g_i) = c_i + (1+\alpha)g_i$, where c_i is the consumption of a private numeraire good and g_i is the public good.[21] Here, $\alpha \in [0, 1)$ represents the strength of preferences for public goods.[22]

The total income of a resident in country i consists of labor income and rent from capital. Labor income is $f_i(k_i) - f_i'(k_i)k_i$. Thus, $c_i = f_i(k_i) - f_i'(k_i)k_i + r_i\,\bar{k}$.

Government. In each country, a policymaker chooses a unit tax rate on the capital used within the country, t_i, and produces the public good. t_i is allowed to be negative (negative t_i represents a subsidy). The production technology of the public good is linear. In particular, one unit of the public good is produced by one unit of the private good. We assume that the budget of country i is given by $T + t_i k_i$, where T is sufficiently large so that the budget is positive. T represents the initial endowment of the government including the other sources of tax revenue such as the revenue from natural resources and capital tax in past periods.[23] Thus, $g_i = T + k_i t_i$.

3.2 Politicians

Politicians are divided into two types: the *benevolent* type and the *leviathan* type.

The objective function of the benevolent politician in country i is the weighted sum

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[21] This preference has been adopted by various studies including some of papers cited in footnote 19.
[22] This interpretation as the preference for public goods is adopted by several studies (e.g., Kawachi, Ogawa, and Susa 2018). Another interpretation is that $1 + \alpha$ is the marginal costs of public funds in country i. See, for instance, Keen and Konrad (2013) and Eichner (2014).
[23] The equilibrium tax (subsidy) rate t_i can be negative under populism. Peralta and van Ypersele (2006) (and the subsequent studies) also allow t_i to be negative. However, in such a case, it is difficult to interpret g_i without T. Thus, we introduce T. Indeed, Peralta and van Ypersele (2006) introduced additional tax revenues, which do not affect the choice of taxation on capital. The alternative way is to introduce the non-negativity of t_i instead of T. In this setting, a similar result holds.

of country i's welfare and her/his own reputation:

$$\max_{t_i} U(c_i, g_i) + \lambda\, p\big(\pi_i(t_i)\big),$$

where $\lambda \geq 0$, p is a non-decreasing function such that $p(0) = 0$ and $p(1) = 1$, and $\pi_i(t_i)$ is residents' subjective probability of the policymaker in country i being the benevolent type given t_i. Hence, politicians have an incentive to maintain the reputation that they are the benevolent. One interpretation is reelection concerns. In reality, residents would vote for the politician likely to be the benevolent type.[24] Thus, the reelection probability of the incumbent should be weakly increasing in $\pi(t_i)$. In this regard, $p\big(\pi_i(t_i)\big)$ represents the reelection probability and λ represents the benefit of reelection. That said, politicians have reputation concerns as reelection concerns in addition to policy preferences.

We assume that λ is not too large (i.e., $\rho\sqrt{\lambda} \leq 16\bar{k} + \Delta$), where $\rho \in (0, 1)$ is defined later. The beliefs the residents hold are updated based on t_i endogenously as in usual incomplete information games.

On the contrary, the objective function of the leviathan type in country i is the weighted sum of country i's (net) tax revenue[25] and her/his own reputation:

$$\max_{t_i} T + t_i k_i + \lambda p\big(\pi_i(t_i)\big).$$[26]

Since both types of politicians have reputation concerns, they take into account the possibility that the chosen tax rate undermines their own reputations. This is the key of our model.

Remark 1. Kartik and Van Weelden (2018) also assume that p is exogenously given. Provided that p is regarded as the reelection probability, we might want to endogenously derive p based on residents' equilibrium voting strategies. We provide such a dynamic election model in Section 7.3. In the analysis of populism, Acemoglu, Egorov, and Sonin (2013) also derive similar reelection concerns by using a dynamic election model.

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24 It can be optimal to vote for the leviathan type because of the benefit of strategic delegation (Kawachi, Ogawa, and Susa 2018). However, even in such a case, it is natural that residents vote for the benevolent type for the following two reasons. First, the leviathan type would extract some tax revenue (see Section 7.4). Second, the leviathan type is self-interested and may not follow voters' policy preferences for other policy issues (see Section 7.3).

25 The assumption that the leviathan type simply maximizes the tax revenue has been widely adopted (e.g., Keen and Kotsogiannis 2003; Pal and Sharma 2013; Kawachi, Ogawa, and Susa 2018), although previous studies have not incorporated the reputation term.

26 For the discussion about the case where λ takes different values between the two types, see footnote 54.

Remark 2. It might not be straightforward that the benevolent type has reelection concerns. The first interpretation is that this politician is not purely benevolent. This politician is self-interested but her/his policy preferences are congruent with those of residents. The second interpretation is that s/he is purely benevolent. Even so, s/he can have reelection concerns in a dynamic setting (see Section 7.3). In addition to the studies of populism (e.g., Acemoglu, Egorov, and Sonin 2013), many studies of political agency problems have analyzed politicians who have congruent policy preferences but have reelection concerns (e.g., Maskin and Tirole 2004).

To focus on the effect of such politicians on one country, we suppose that country 2's policymaker is the benevolent type[27] and that country 1's policymaker as well as the residents in the economy know this. Since country 2's policymaker is known to be benevolent, $\pi_2(t_2) = 1$ for all t_2. Thus, country 2's policymaker only maximizes residents' welfare. On the contrary, the type of country 1's policymaker is unobservable to country 2's policymaker as well as to the residents in this economy. The prior probability that country 1's policymaker is the benevolent type is denoted by $\rho \in (0, 1)$.

Note that country 2's policymaker has no private information. Hence, country 2's tax rate never signals the type of country 1's policymaker. This fact allows us to exclude the possibility of yardstick competition, which arises because of information externalities (Besley and Case 1995).[28]

3.3 Timing of the Game and Equilibrium Concept

The timing of the game is as follow:

1. Nature draws the type of country 1's policymaker. Only country 1's policymaker observes this.
2. Each country simultaneously determines the tax rate. Each country's tax rate is observable to all the players.

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[27] The situation in which country 2's policymaker is known to be benevolent could be verified by the following reasons. For instance, country 2's policymaker serves a second term (i.e., her/his type is already well known). Alternatively, the selection of politicians works well in country 2 because of monitoring by mass media and thus only the benevolent type is elected. One might have concerns about how robust our results are when country 2's policymaker is known to be the leviathan type. Even in such a case, populism still arises in the presence of high reputation concerns. As for the welfare implications, given the identified mechanism, it is expected that the positive consequences are less likely to hold because the tax rate chosen by country 2 becomes pretty high. However, we expect that the qualitatively same result still holds so long as the asymmetry in production technologies is sufficiently large since the same mechanism works.

[28] While yardstick competition has been widely observed in local government, Devereux, Lockwood, and Redoano (2008) empirically show that competition over corporate tax across countries is tax competition rather than yardstick competition.

3. Given the tax rate, residents in country 1 update the belief about their policymaker's type $\pi_1(t_1)$.
4. Capital moves, and both production and consumption are done.
5. The payoff is realized.[29]

Since t_1 can signal the type of country 1's policymaker, there could be several equilibria depending on the belief formation as in standard signaling games. To deal with this issue, we employ the intuitive criterion proposed by Cho and Kreps (1987) and eliminate equilibria that are sustained by implausible belief formations. In short, the equilibrium concept is the perfect Bayesian equilibrium satisfying the intuitive criterion. In particular, we focus on pure strategies.[30] Hence, an equilibrium consists of $(t_1^{B*}, t_1^{L*}, t_2^*, \pi_1^*)$ in which $t_1^{B*}(t_1^{L*})$ represents the equilibrium tax rate chosen by the benevolent (leviathan) policymaker in country 1. See Appendix A for the definition of the intuitive criterion.

4. Benchmark: Closed Economy

We start by investigating the benchmark case where capital is totally immobile. In this situation, $k_i = \bar{k}$. We examine country 1's equilibrium tax rates in this closed economy. Here, the utility of the residents in country 1 can be rewritten as

$$U(c_1, g_1) = \left(A_1 - \bar{k}\right)\bar{k} - t_1\bar{k} + (1+\alpha)\left(T + t_1\bar{k}\right).$$

Let the equilibrium tax rate implemented by country 1's benevolent (leviathan) policymaker given λ be $t_{1C}^{B*}(\lambda)$ $\left(t_{1C}^{L*}(\lambda)\right)$. We sometimes omit λ in the expression of the equilibrium tax rates to simplify the notations. Throughout this section, we assume that $\alpha \in (0, 1)$.[31]

4.1 Equilibrium without Reputation Concerns

Consider the case where $\lambda = 0$ (i.e., no reputation concerns). $\lambda = 0$ represents the situation that the incumbent policymaker is removed from office with certainty because of term limits. Alternatively, perfect information (i.e., the incumbent's type is directly revealed to residents before the election) is equivalent to $\lambda = 0$ since the reelection

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[29] 3 and 4 are interchangeable. In addition, one alternative timing is that residents' payoff is realized and then residents update the belief based on the received utility and the tax rates. Since the tax rates are sufficient statistics for the received utility in our model, the exactly same result holds.

[30] Most studies of tax competition have focused on pure strategy equilibria. Following this convention, we restrict our attention to pure strategies, implying that we do not analyze hybrid equilibria or completely mixed equilibria.

[31] Since the provision of capital is totally inelastic in this simple closed economy model, when $\alpha = 0$, any tax rate is optimal for residents in the constant marginal utility setting. To exclude such an implausible case, we assume that $\alpha > 0$. See also Section 7.5.

probability is independent of the tax rate in this setting.

The equilibrium tax rates are the solutions to the following maximization problems:

$$t_{1C}^{B*}(0) = \underset{t_1}{\operatorname{argmax}}\left(A_1 - \bar{k}\right)\bar{k} - t_1\,\bar{k} + (1+\alpha)\left(T + t_1\,\bar{k}\right).$$

$$t_{1C}^{L*}(0) = \underset{t_1}{\operatorname{argmax}}\, T + t_1\,\bar{k}.$$

Since $\alpha > 0$, both the benevolent and the leviathan types prefer as high a capital tax rate as possible (i.e., their objective functions are increasing in t_1).[32] Here, we have the non-negativity constraint of the interest rate, meaning that $r_1 = A_1 - 2\bar{k} - t_1 \geq 0$. Thus, $\left(t_{1C}^{B*}(0), t_{1C}^{L*}(0)\right) = \left(A_1 - 2\bar{k}, A_1 - 2\,\bar{k}\right)$.

4.2 Definition of Populism

Before analyzing the equilibrium with reputation concerns, we define populism formally. Populism herein is characterized by extremism supported by a large number of voters. In other words, under populism, a politician who chooses an extreme policy acquires a good reputation. The following definition reflects this verbal definition.

Definition 1. *An equilibrium* $(t_{1C}^{B*}, t_{1C}^{L*}, \pi_1^*)$ *is a populism equilibrium if (i) there exists* $t_1 \in \{t_{1C}^{B*}, t_{1C}^{L*}\}$ *such that* $t_1 \notin argmax\ U_1(c_1, g_1)$, *and (ii) for* $t_1 \in \{t_{1C}^{B*}, t_{1C}^{L*}\}$ *such that* $t_1 \notin argmax\ U_1(c_1, g_1)$, $\pi_1^*(t_1) > \rho$ *holds.*

(i) requires that at least one politician implements an extreme policy and (ii) requires that such a politician obtains a reputation higher than that held previously. Here, if $t_1 \in argmax\ U_1(c_1, g_1)$, (ii) does not hold. Therefore, the above definition is equivalent to the following definition.

Definition 1. *An equilibrium* $(t_{1C}^{B*}, t_{1C}^{L*}, \pi_1^*)$ *is a populism equilibrium if (i)* $t_{1C}^{B*} \notin argmax\ U_1(c_1, g_1)$ *and (ii)* $\pi_1^*(t_{1C}^{B*}) = 1$.

We note two remarks. First, from (ii), pooling equilibria are not populism equilibria. Thus, it suffices to focus on separating equilibria. Second, we can define right-wing (left-wing) populism by using the above definition. If $t_{1C}^{B*} < (>) argmax\ U_1(c_1, g_1)$ the equilibrium is a right-wing (left-wing) populism equilibrium.

4.3 Equilibrium with Reputation Concern

Consider the case where $\lambda > 0$. In this case, the benevolent type has an incentive to choose a tax rate below $A_1 - 2\bar{k}$ to signal that s/he is the benevolent type to residents.

32 Since the preferences are linear, the higher tax rate is better for residents. See also Section 7.5.

We examine how such an incentive affects the possibility of populism. To this end, without loss of generality, we focus on separating equilibria such that $t_{1C}^{B*} \neq t_{1C}^{L*}$ since populism equilibria are always separating equilibria as seen in the previous subsection.

First, $t_{1C}^{L*} = A_1 - 2\,\bar{k}$. Suppose that this does not hold. Since $\pi_1(t_{1C}^{L*}) = 0$ from the Bayes rule, the leviathan type's payoff from reputation is the lowest when choosing t_{1C}^{L*}. Thus, if t_{1C}^{L*} does not maximize $T + t_1\,\bar{k}$, s/he can obtain a higher payoff by deviating from the equilibrium tax rate. Hence, $t_{1C}^{L*} = A_1 - 2\,\bar{k}$ must hold.

Next, pin down the value of t_{1C}^{B*}. Here, as in the usual signaling game, the leviathan type must be indifferent between t_{1C}^{B*} and t_{1C}^{L*} in separating equilibria satisfying the intuitive criterion (see the proof of Theorem 1). Since $\pi_1(t_{1C}^{B*}) = 1$ and $\pi_1(t_{1C}^{L*}) = 0$, this condition is given by

$$t_{1C}^{L*}\,\bar{k} = t_{1C}^{B*}\,\bar{k} + \lambda. \tag{4}$$

Here, the left-hand side is the payoff of the leviathan type when choosing its equilibrium tax rate, while the right-hand side is her/his payoff when implementing the tax rate chosen by the benevolent type and pretending to be the benevolent type. By using (4), we can pin down the value of t_{1C}^{B*}:

$$t_{1C}^{B*} = A_1 - 2\bar{k} - \frac{\lambda}{\bar{k}}.$$

The remaining task is to show that only the derived tax rates constitute separating equilibria. We obtain the following result (Appendix B presents the omitted proofs).

Theorem 1. *When $\lambda > 0$ and $\alpha > 0$, there exist unique separating equilibrium tax rates such that*

$$t_{1C}^{B*}(\lambda) = A_1 - 2\bar{k} - \frac{\lambda}{\bar{k}};\ t_{1C}^{L*}(\lambda) = A_1 - 2\bar{k}.$$

Here, the benevolent type chooses extremely low taxation, which is not optimal for residents' welfare. Furthermore, such an extreme policy signals to residents that the politician is good. In other words, this equilibrium is a populism equilibrium according to Definition 2. In this regard, the extreme reduction of tax rates supported by residents (a feature of right-wing populism) arises when reputation concerns exist.

4.4 Comparison

Compare the equilibrium with and without reputation concerns. First, observe that the equilibrium tax rate chosen by the leviathan type is the same independently of the value of λ. This fact implies that the populist taxation policy by the benevolent type does not affect the policy chosen by the leviathan type in a closed economy--at least in this simple setting.

Next, examine welfare. Without reputation concerns, the benevolent type chooses the socially optimal tax rate. However, with reputation concerns, s/he chooses a tax rate below the socially optimal tax rate. As a result, the welfare of country 1 with reputation concerns is lower than that without reputation concerns (i.e., populism is harmful).[33] In addition, since country 1 is completely isolated from country 2, there is no externality of populism. It only affects country 1's welfare. These welfare implications drastically change in the following tax competition model.

5. Equilibrium: Tax Competition

In Sections 5 and 6, for simplicity, we assume that $\alpha = 0$, namely tax revenues are returned to residents as a lump-sum transfer. This assumption is standard in the literature on tax competition. Furthermore, this is a useful approach to examine the terms-of-trade effect. Since there is no discontinuity between $\alpha = 0$ and $\alpha > 0$ in the tax competition model,[34] the equilibrium under tax competition with $\alpha = 0$ can be regarded as the approximation of the equilibrium under tax competition with sufficiently small $\alpha > 0$. The case where $\alpha > 0$ is examined in Section 7.3. When $\alpha = 0$,

$$U(c_i, g_i) = (A_i - k_i)k_i + r(\bar{k} - k_i) + T. \tag{5}$$

Let the equilibrium tax rate implemented by country 1's benevolent (leviathan) policymaker be $t_{1O}^{B*}(\lambda)$ ($t_{1O}^{L*}(\lambda)$) and the equilibrium tax rate implemented by country 2's policymaker be $t_{2O}^{*}(\lambda)$. Although we allow the countries to be asymmetric (i.e., $\Delta \neq 0$), our results qualitatively do not depend on the asymmetry except for the welfare implications.

5.1 Equilibrium without Reputation Concerns

We first derive the equilibrium without reputation concerns (i.e., $\lambda = 0$). In this model, country 1's policymaker is unconcerned about her/his reputation when choosing t_1. Hence, the benevolent type maximizes welfare, while the leviathan type maximizes the budget.

The equilibrium tax rates are the solutions to the following maximization problems:

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33 This welfare implication does not depend on our specific settings about the utility function. Since the definition of populism is that the tax rate chosen by the benevolent type and the policy chosen by the benevolent type are independent of whether populism arises, reputation concerns inducing populism are always harmful. See Section 7.4.

34 In the closed economy model, $\alpha = 0$ is problematic because the provision of capital is totally inelastic. This is not the case in the tax competition model. Under tax competition, the optimal tax rate for residents is uniquely determined even if $\alpha = 0$.

$$t_{1O}^{B*}(0) = \underset{t_1}{\text{argmax}}(A_1 - k_1)k_1 + r(\bar{k} - k_1)\ \ s.t. (2), (3), and\ t_2 = t_{2O}^{*}(0)$$

$$t_{1O}^{L*}(0) = \underset{t_1}{\text{argmax}}\, t_1 k_1\ s.t. (2), (3), and\ t_2 = t_{2O}^{*}(0).$$

$$t_{2O}^{*}(0) = \underset{t_2}{\text{argmax}}\, E\left[(A_2 - k_2)k_2 + r(\bar{k} - k_2)\right] s.t. (2), (3), and\ t_1 = t_{1O}^{B*}(0)\left(t_{1O}^{L*}(0)\right) \text{ with prob. } \rho.$$

By solving each maximization problem, we have the following best-response functions:

$$t_{1O}^{B*}(0) = \frac{\Delta + t_{2O}^{*}(0)}{3}. \tag{6}$$

$$t_{1O}^{L*}(0) = \frac{\Delta + t_{2O}^{*}(0)}{2} + 2\bar{k}. \tag{7}$$

$$t_{2O}^{*}(0) = \frac{-\Delta + \rho t_{1O}^{B*}(0) + (1-\rho)t_{1O}^{L*}(0)}{3}. \tag{8}$$

These equations yield the equilibrium capital tax rates.

Theorem 2. *When* $\lambda = 0$*, there exist unique equilibrium tax rates such that*

$$t_{1O}^{B*}(0) = \frac{4}{15+\rho}\left[\Delta + (1-\rho)\bar{k}\right];\ t_{1O}^{L*}(0) = \frac{6}{15+\rho}\left[\Delta + (1-\rho)\bar{k}\right] + 2\bar{k};$$

$$t_{2O}^{*}(0) = \frac{1}{15+\rho}\left[-(3+\rho)\Delta + 12(1-\rho)\bar{k}\right].$$ [35]

5.2 Equilibrium with Reputation Concerns

We next derive the equilibrium with reputation concerns (i.e., $\lambda > 0$). Again, we focus on separating equilibria since populism equilibria must be separating equilibria. Then, the equilibrium belief must satisfy $\pi_1(t_{1O}^{B*}) = 1$ and $\pi_1(t_{1O}^{L*}) = 0$ from the Bayes rule. For now, we examine the separating equilibria other than those in the previous subsection (i.e., $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$).

First, in any separating equilibria, country 1's leviathan policymaker maximizes $T + k_1 t_1$ as in the closed economy model. Thus, we have the following fact from (7) and (8).

Fact 1. *The following must hold:*

$$t_{1O}^{L*} = \frac{\Delta + t_{2O}^{*}}{2} + 2\bar{k}. \tag{9}$$

[35] We implicitly assume that A_1 and A_2 are so large that r under these tax rates is non-negative. In addition, we implicitly assume that k_i is non-negative under these tax rates. The same is also assumed in Theorem 3. Indeed, the numerical examples presented later satisfy them.

$$t_{2O}^{*} = \frac{-\Delta + \rho t_{1O}^{B*} + (1-\rho)t_{1O}^{L*}}{3}. \tag{10}$$

By substituting (10) into (9), we can rewrite t_{1O}^{L*} *as the function of* t_{1O}^{B*}*:*

$$t_{1O}^{L*} = \frac{\Omega + \rho t_{1O}^{B*}}{5+\rho}, \tag{11}$$

where $\Omega \equiv 12\bar{k} + 2\Delta$*. Substituting this into (9) yields*

$$t_{2O}^{*} = \frac{1}{3}\left[\frac{(1-\rho)\Omega + 6\rho t_{1O}^{B*}}{5+\rho} - \Delta\right]. \tag{12}$$

We have succeeded in rewriting the equilibrium tax rates of country 1's leviathan policymaker and country 2's policymaker as the function of country 1's benevolent policymaker's equilibrium tax rate.

The remaining task is to pin down the value of t_{1O}^{B*}. If $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$, the leviathan type must be indifferent between t_{1O}^{B*} and t_{1O}^{L*} in separating equilibria satisfying the intuitive criterion. By using this property, we can pin down the value of t_{1O}^{B*}.

Lemma 1. *At separating equilibria where* $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$*, the following must hold:*

$$t_{1O}^{B*} = \frac{\Omega \pm (5+\rho)2\sqrt{\lambda}}{5}. \tag{13}$$

First, country 1's leviathan policymaker prefers t_{1O}^{L*} to a highly low tax rate even if s/he can acquire a good reputation (i.e., $\pi_1 = 1$) under such a low tax rate. Thus, there exists a low tax rate such that country 1's leviathan policymaker is indifferent between t_{1O}^{L*} and that tax rate with $\pi_1 = 1$. That is $\frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$. In addition, an extremely high tax rate is also not beneficial for the leviathan type because the country can attract only a small amount of capital and thus tax revenue remains small. Hence, there also exists an excessively high tax rate such that country 1's leviathan policymaker is indifferent between t_{1O}^{L*} and that tax rate with $\pi_1 = 1$. That is $\frac{\Omega+(5+\rho)2\sqrt{\lambda}}{5}$.

So far, we have shown that if separating equilibria other than those in the previous subsection exist, (13) holds. However, this does not mean that (13), (11), and (12) always constitute an equilibrium. To prove that this is an equilibrium, we must examine the incentive compatibility condition of country 1's policymaker. We find the following result.

Lemma 2.

1. *When* $\sqrt{\lambda} < \bar{R} \equiv \left(16\bar{k} + \Delta\right)/(15+\rho)$*, country 1's benevolent policymaker has a*

strict incentive to deviate from $\frac{\Omega \pm (5+\rho)2\sqrt{\lambda}}{5}$ *for any belief* π *satisfying the intuitive criterion.*

2. *When* $\sqrt{\lambda} \geq \bar{R}$,
   i. *Country 1's benevolent policymaker has no incentive to deviate from* $\frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$ *for some belief* π *satisfying the intuitive criterion, and*
   ii. *Country 1's leviathan policymaker has no incentive to deviate from* t_{1O}^{L*} *under* $t_{1O}^{B*} = \frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$ *for some belief* π *satisfying the intuitive criterion, but*
   iii. *Country 1's benevolent policymaker has a strict incentive to deviate from* $t_{1O}^{B*} = \frac{\Omega+(5+\rho)2\sqrt{\lambda}}{5}$ *for any belief* π *satisfying the intuitive criterion.*

The remaining task is to examine the condition for the existence of an equilibrium discussed in the previous section. We obtain the following result.

Lemma 3. *The tax rates* $\left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$ *constitute an equilibrium if and only if* $\sqrt{\lambda} \leq \bar{R}$.

By combining Lemmas 2 and 3, we finally obtain the characterization of separating equilibria.

Theorem 2. *Suppose that* $\lambda > 0$.

1. *When* $\sqrt{\lambda} \leq \bar{R}$, *there exist unique separating equilibrium tax rates:* $(t_{1O}^{B*}, t_{1O}^{L*}, t_{2O}^{*}) = \left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$.
2. *When* $\sqrt{\lambda} \geq \bar{R}$, *there exist unique separating equilibrium tax rates:* $t_{1O}^{B*} = \frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$, $t_{1O}^{L*}(\lambda)$ *is characterized by (11), and* $t_{2O}^{*}(\lambda)$ *is characterized by (12).*[36]

5.3 Emergence of Populism

Examine whether and under which conditions the extremely low tax rate arises. In the tax competition model, country 1's optimal tax rate for its residents depends on country 2's

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[36] When $\sqrt{\lambda} = \bar{R}$, $\frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5} = t_{1O}^{B*}(0)$.

tax rate. Thus, we define populism as the equilibrium in which (i) the equilibrium tax rate chosen by country 1's benevolent policymaker is different from the best response to country 2's equilibrium tax rate when country 1's objective function is its residents' welfare, and (ii) such an extreme policy signals that the policymaker is the benevolent type (i.e., $\pi_1(t_{1B}^*) = 1$). This is an extension of Definition 2. In particular, when country 1's tax rate implemented by the benevolent type is lower than the best response to maximize residents' welfare, we call the equilibrium right-wing populism.

Proposition 1. *Suppose that* $\lambda > 0$.

1. *When* $\sqrt{\lambda} \leq \bar{R}$,
$$t_{1O}^{B*}(\lambda) = t_{1O}^{B*}(0) = \mathrm{argmax}_{t_1}(A_1 - k_1)k_1 + r(\bar{k} - k_1) \text{ s.t. } (2), (3), \text{and } t_2 = t_{2O}^*(\lambda)$$
2. *When* $\sqrt{\lambda} > \bar{R}$,
$$t_{1O}^{B*}(\lambda) = \frac{\Omega - (5+\rho)2\sqrt{\lambda}}{5} < argmax_{t_1}(A_1 - k_1)k_1 + r(\bar{k} - k_1)\ s.t.\ (2), (3), and\ t_2 = t_{2O}^*(\lambda)$$

The benevolent type can separate her/himself from the leviathan type by implementing a tax rate that the leviathan type never chooses. To this end, in the presence of high reputation concerns, the benevolent type chooses extremely low taxation as a signal of being the benevolent type.[37] Hence, right-wing populism arises. Notice that this does not mean that the welfare of country 1 is lower under the benevolent type than the leviathan type. Even if populism arises, the benevolent type's policy still gives the voter a higher payoff than the leviathan type does so long as the degree of reputation concerns are not too high (see footnote 44).[38]

We have two key underlying assumptions that induce populism. We believe that those assumptions reflect the real aspects of populism. The first key assumption is the existence of the leviathan type (i.e., corrupt politicians), which makes voters think that the incumbent might be the leviathan type. Without such politicians, the benevolent type has no incentive to distort policies. In the literature of populism, it has been pointed out that populism has the aspect of anti-elitism.[39] Since voters' belief that the incumbent might be the leviathan type can be regarded as the distrust towards politicians, our model reflects

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[37] Though extremely high taxation can also serve as the signal, it is too costly to send a signal for the benevolent type. The benevolent type prefers a lower tax rate than the leviathan type does (See 2. (iii) in Lemma 2). Thus, the high taxation that the leviathan type never chooses is also that the benevolent type never chooses.

[38] In this sense, the reputation formation is based on retrospective evaluations.

[39] For instance, Mudde (2004: 543) defines populism as ``an ideology that considers society to be ultimately separated into two homogeneous and antagonistic groups, `the pure people' versus `the corrupt elite', and which argues that politics should be an expression of the volonté générale (general will) of the people."

the fact that anti-elitism induces populism.

The second key assumption is that even the benevolent type has reputation concerns. Without high reputation concerns, the benevolent type never distorts policies, meaning that populism does not arise. This implies that populists in our model choose extreme policies not because of ideological reasons but because of opportunistic reasons. While at first glance, populists' motivations seem to be ideological one, this is not necessarily the case. Indeed, some scholars argue that populists are opportunistic. For instance, Weyland (2017: 62) points out ``populism tailors its appeals in opportunistic ways to maximize the leader's chances of capturing the government." That is, populists' policies are chosen in terms of how to attract voters. In these aspects, the underlying mechanism of populism in our model reflects the reality.

Lastly, we note the comparative statics about the threshold value of λ (i.e., $\bar{R}$), although this result could be dependent upon our specifications. In our model, $\bar{R}$ is increasing in Δ, meaning that the poorer country 1 is (in terms of the production technology), the more likely populism is to arise in country 1.

5.4 Comparison

Before examining the welfare implications of populism in the next section, we investigate how populism changes the outcome variables such as the tax rates, interest rate, and capital each country attracts. Let $r_O^{B*}(\lambda)\left(r_O^{L*}(\lambda)\right)$ be the interest rate given $\left(t_{1O}^{B*}(\lambda), t_{2O}^{*}(\lambda)\right)\left(\left(t_{1O}^{L*}(\lambda), t_{2O}^{*}(\lambda)\right)\right)$, and $k_{1O}^{B*}(\lambda)\left(k_{1O}^{L*}(\lambda)\right)$ be k_1 given $\left(t_{1O}^{B*}(\lambda), t_{2O}^{*}(\lambda)\right)\left(\left(t_{1O}^{L*}(\lambda), t_{2O}^{*}(\lambda)\right)\right)$.

In this section, we focus on the case where $\sqrt{\lambda} > \bar{R}$ since otherwise, the equilibrium with reputation concerns is reduced to the equilibrium without reputation concerns.

Proposition 2. *Fix λ so as to satisfy $\sqrt{\lambda} > \bar{R}$.*

A) $t_{1O}^{B*}(\lambda) < t_{1O}^{B*}(0), t_{1O}^{L*}(\lambda) < t_{1O}^{L*}(0), t_{2O}^{*}(\lambda) < t_{2O}^{*}(0)$.

B) $r_O^{B}(\lambda) - r_O^{B}(0) = \frac{5+3\rho}{5}\left(\sqrt{\lambda} - \bar{R}\right) > 0 \ and \ r_O^{L}(\lambda) - r_O^{L}(0) = \frac{3\rho}{5}\left(\sqrt{\lambda} - \bar{R}\right) > 0$.

C) $k_{1O}^{B*}(\lambda) - k_{1O}^{B*}(0) = \frac{5-\rho}{10}\left(\sqrt{\lambda} - \bar{R}\right) > 0 \ and \ k_{1O}^{L*}(\lambda) - k_{1O}^{L*}(0) = -\frac{\rho}{10}\left(\sqrt{\lambda} - \bar{R}\right) < 0$

First, examine the equilibrium tax rates. The most interesting property is the effect of populism on the leviathan type's equilibrium tax rate. In a closed economy, the populist taxation policy of the benevolent type does not affect the taxation policy of the leviathan type because the latter has no incentive to choose the extremely low taxation chosen by the former and simply chooses the tax rate that maximizes the budget, which is independent of the benevolent type's taxation policy. However, this is not the case under tax competition because of strategic interactions. As a result of populism, the benevolent type in country 1 implements a lower tax rate than s/he implements without reputation concerns. Then, country 2's policymaker chooses the tax rate by taking this fact into account. Since there is strategic complementarity, country 2's policymaker also chooses a lower tax rate than s/he does without reputation concerns. Hence, the tax rate that maximizes country 1's budget becomes lower as a result of populism. Therefore, even the leviathan type chooses a lower tax rate than s/he does without reputation concerns. As such, the low taxation induced by reputation concerns spreads from country 1's benevolent policymaker to country 2's policymaker and country 1's leviathan policymaker through the strategic interactions between the countries.

Since all the tax rates decrease as a result of reputation concerns, both the interest rate when country 1's policymaker is the benevolent type and that when country 1's policymaker is the leviathan type increase. This effect of populism on the interest rates plays a key role in determining the effect on country 1's welfare.

Lastly, examine the effect on the amount of capital country 1 attracts. Consider the case where country 1's policymaker is the benevolent type. In this case, country 1's policymaker chooses an extremely low tax rate when s/he faces reputation concerns. On the contrary, country 2's policymaker behaves less aggressively because s/he takes into account the possibility that country 1's policymaker is the leviathan type. Thus, country 1 can attract a larger amount of capital as a result of populism. However, the opposite is true when country 1's policymaker is the leviathan type. The tax rate implemented by country 1's leviathan policymaker also decreases due to populism. However, country 2's tax rate decreases more aggressively because country 2's policymaker takes into account the possibility that country 1's policymaker is the benevolent type. Hence, the amount of capital country 1 attracts decreases as a result of populism.

6. Welfare Consequences of Populism

Based on equilibria derived in Section 5, we investigate welfare implications of populism under tax competition.

6.1 Country 1’s Welfare

We start by exploring country 1's welfare. Let $W_{1O}^{B*}(\lambda)$ $\left(W_{1O}^{L*}(\lambda)\right)$ be $U(c_1, g_1)$ given

$\left(t_{1O}^{B*}(\lambda), t_{2O}^{*}(\lambda)\right)$ $\left(\left(t_{1O}^{L*}(\lambda), t_{2O}^{*}(\lambda)\right)\right)$. In addition, let us fix λ so as to satisfy $16\bar{k}/15 + \rho < \sqrt{\lambda} < 16\bar{k}/\rho$.[40] We compare the welfare under such λ with the case without reputation concerns. This is also applied to Propositions 4 and 5.

Proposition 3. *Suppose that* $\rho\sqrt{\lambda} \leq \Delta < (15 + \rho)\sqrt{\lambda} - 16\bar{k}$.[41]

A) *Suppose that* $\Delta = 0$. $W_{1O}^{B*}(\lambda) < W_{1O}^{B*}(0)$ *while* $W_{1O}^{L*}(\lambda) > W_{1O}^{L*}(0)$.

B) *When* $W_{1O}^{B*}(\lambda) < W_{1O}^{B*}(0)$ *holds for some* Δ, *there exists* $\underline{\Delta} < 0$ *such that* $W_{1O}^{B*}(\lambda) < W_{1O}^{B*}(0)$ *if and only if* $\Delta > \underline{\Delta}$.

C) *When* $W_{1O}^{L*}(\lambda) \leq W_{1O}^{L*}(0)$ *holds for some* Δ, *there exists* $\overline{\Delta} > 0$ *such that if and only if* $\Delta < \overline{\Delta}$, $W_{1O}^{L*}(\lambda) > W_{1O}^{L*}(0)$.

D) *When* $\rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda) > \rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$ *for some* Δ, *there exists* $\overline{\Delta}' < 0$ *such that if and only if* $\Delta < \overline{\Delta}'$, $\rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda) > \rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$. *In addition, there exist* (k, λ, ρ) *under which* $\rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda) > \rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$ *for some* Δ.

As the benchmark case, suppose that $\Delta = 0$. Then, $W_{1O}^{B*}(\lambda) < W_{1O}^{B*}(0)$, while $W_{1O}^{L*}(\lambda) > W_{1O}^{L*}(0)$. This fact indicates that country 1's welfare when the policymaker is the benevolent type is worse off due to populism, while that when the policymaker is the leviathan type is better off. The driving force is the terms-of-trade effect. To see this, first observe that $t_{1O}^{B*}(0) < t_{2O}^{*}(0) < t_{1O}^{L*}(0)$ holds when $\Delta = 0$, meaning that country 1 is a capital-importer (capital-exporter) when the policymaker is the benevolent (leviathan) type. Thus, an increase in the interest rate improves (hurts) country 1's terms of trade when its policymaker is the leviathan (benevolent) type. Here, as seen in Proposition 2, populism increases the interest rate. Therefore, country 1's welfare is undermined when its policymaker is the benevolent type, whereas country 1 enjoys the benefits when its policymaker is the leviathan type.[42] This result can be extended to the asymmetric

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[40] This condition guarantees that the inequality imposed at the beginning of Proposition 3 holds at least when $\Delta = 0$. That said, we consider λ such that populism arises when$\Delta = 0$. This condition is not essential at all to derive the welfare implications. We impose this just because we want to include $\Delta = 0$ case as benchmark in the comprative statics with respect toΔ.

[41] This is the condition for the emergence of populism. In more detail, this is equivalent that $\sqrt{\lambda} > \bar{R}$ and $\rho\sqrt{\lambda} \leq 16\bar{k} + \Delta$ hold. Note that the latter one is imposed in Section 3

[42] The positive effect on welfare under the leviathan policymaker is obtained because of the strategic interactions between countries. To see this, suppose that country 2's policymaker does not change the tax rate independently of the value of λ (i.e., the tax rate in country 1). Given this, t_{2O}^{*} and t_{1O}^{L*} are independent of λ, implying that the interest rate also does not change. Hence, the terms of trade are constant regardless of whether reputation concerns inducing populism exist or not. In short, country 1's welfare under the leviathan policymaker is the same between the cases where $\lambda = 0$ and λ is

technology case as long as the difference in production technology is not large (see B) and C) in the above proposition).

In a closed economy, reputation concerns inducing extremely low taxation are always harmful. However, such a clear negative effect is no longer obtained in an open economy. The negative effect on welfare when the policymaker is benevolent is offset to some extent by the positive effect on welfare when the policymaker is leviathan. In particular, for some parameter values, the positive effect dominates the negative effect. Table 1 shows a numerical example of welfare, highlighting that $\rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda) > \rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$ holds. In other words, country 1's expected welfare is improved by reputation concerns inducing populism.

This welfare-enhancing effect is obtained when country 1's productivity is sufficiently low (see Proposition 3 D)). The lower country 1's productivity is, the larger the amount of capital the country exports under a leviathan policymaker. Thus, the positive effect on welfare under the leviathan type is strengthened when Δ is small. In addition, the lower country 1's productivity is, the smaller the amount of capital the country imports under a benevolent policymaker. Thus, the negative effect on welfare under the benevolent type falls as country 1's productivity is lower. Hence, only when country 1's productivity is lower than that of country 2, populism benefits country 1. This result indicates that a country that has poor production technology can enjoy the benefit of populism.[43]

Notice that this does not mean that the more severe populism is, the better country 1 is.

W_{1O}^{B*}	27.46025	W_{1O}^{L*}	21.76246	$\rho W_{1O}^{B*} + (1-\rho) W_{1O}^{L*}$	24.04157
$W_{1O}^{B*}(0)$	27.51813	$W_{1O}^{L*}(0)$	21.67081	$\rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$	24.00974

Table 1: **Numerical Example: Country 1's Welfare (1).** *Notes:* $A_1 = 12$, $A_2 = 17$, $\bar{k} = 3$, $\rho = 0.4$, and $\lambda = 10$. Each welfare includes a constant term T as in (5). As the normalization, we subtract T from each welfare in the above numerical values. This is also applied to Table 2. The values are rounded off to the fifth decimal place.

W_{1O}^{B*}	35.61989	W_{1O}^{L*}	32.36434	$\rho W_{1O}^{B*} + (1-\rho) W_{1O}^{L*}$	34.64322
$W_{1O}^{B*}(0)$	35.35458	$W_{1O}^{L*}(0)$	31.83719	$\rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$	34.29936

Table 2: **Numerical Example: Country 1's Welfare (2).** *Notes:* $A_1 = 12$, $A_2 = 26$, $\bar{k} = 3$, $\rho = 0.7$, and $\lambda = 7$. The values are rounded off to the fifth decimal place.

Fact 2. *Fix* Δ. *For any* Δ, *there always exists* $\bar{\lambda} > 0$ *such that for any* $\lambda \geq$

sufficiently large.

43 This finding is clear when country 1's productivity is excessively smaller than that of country 2. In such a case, country 1 is a capital-importer even if the policymaker is the benevolent type. Thus, an increase in the interest rate is beneficial even when the policymaker is the benevolent type. Hence, welfare under the benevolent policymaker can be improved by populism. In such a case, welfare under both the benevolent and the leviathan policymakers improves. As a result, expected welfare rises. Table 2 illustrates this case.

$\bar{\lambda}, \rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda) < \rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$.

Proof. This is straightforward given equation (44) in Appendix B. Thus, we omit the proof.

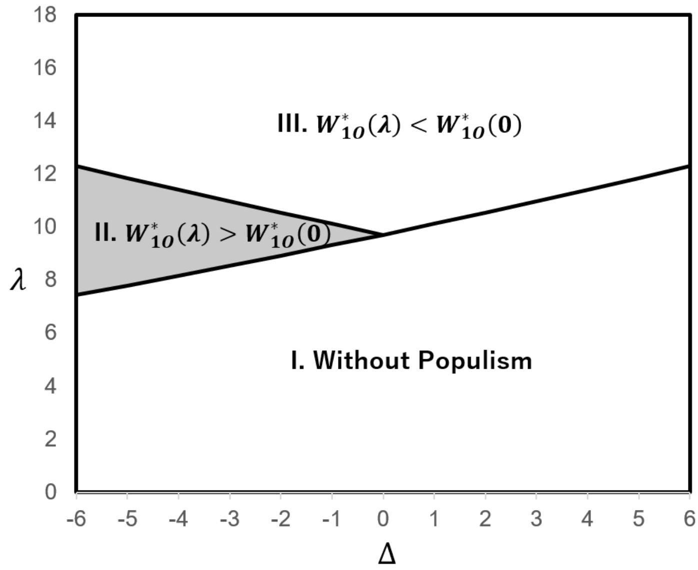

Figure 1: **Numerical Example: Country 1's Welfare (3)**. *Notes:* $A_1 = 20, \bar{k} = 3, \rho = 0.4$. In region I, populism never arises because $\sqrt{\lambda} \leq \bar{R}$. $W^*_{1O} \equiv \rho W_{1O}^{B*}(\lambda) + (1-\rho) W_{1O}^{L*}(\lambda)$.

The higher λ is, the lower the tax rate chosen by the benevolent type in country 1 is. In this regard, the value of λ corresponds to how severe populism in country 1 is. This fact argues that when λ is too high, populism is always harmful even if country 1 is sufficiently poor, meaning that only moderate populism can improve country 1's welfare. This is unsurprising. Even if country 1 is the capital-exporter, too much low tax rates are undesirable. Hence, severe populism is harmful.

These results together can be seen in Figure 1, in which the welfare-enhancing effect is obtained in region II. Populism improves the populist country's welfare when its productivity is low and the degree of populism is not too high.[44]

6.2 Country 2's Welfare

In addition, populism in country1 has an externality to country 2's welfare under tax competition. Hence, the effect on country 2 must be taken into account for the evaluation

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44 We can also compare $W_{1O}^{B*}(\lambda)$ and $W_{1O}^{L*}(\lambda)$:

$$W_{1O}^{B*}(\lambda) > W_{1O}^{L*}(\lambda) \Leftrightarrow \sqrt{\lambda} < \frac{16\bar{k} + \Delta}{7.5 + \rho}$$

Hence, so long as the degree of populism is not too high, the benevolent type gives the higher payoff to the voter than the leviathan type does. Indeed, in all the regions of Figure 1, this condition is satisfied.

of world welfare. To this end, we obtain the following result.

Proposition 4. *Suppose that* $\rho\sqrt{\lambda} - 16\bar{k} \leq \Delta < (15+\rho)\sqrt{\lambda} - 16\bar{k}$. *When* $\rho W_{2O}^{B*}(\lambda) + (1-\rho)W_{2O}^{L*}(\lambda) < \rho W_{2O}^{B*}(0) + (1-\rho)W_{2O}^{L*}(0)$ *holds for some* Δ, *there exists* $\underline{\Delta''}$ *such that if and only if* $\Delta \geq \underline{\Delta''}$, $\rho W_{2O}^{B*}(\lambda) + (1-\rho)W_{2O}^{L*}(\lambda) < \rho W_{2O}^{B*}(0) + (1-\rho)W_{2O}^{L*}(0)$.

Hence, whether high reputation concerns in country 1 are harmful for country 2 depends on country 2's relative productivity. In particular, when country 2's productivity is sufficiently high, country 2 might suffer the negative effect of country 1's populism. On the contrary, the opposite is true when country 2's productivity is sufficiently low.

The mechanism behind this result is the same as that for country 1's welfare. Reputation concerns inducing populism increase the interest rate. Country 2 suffers (enjoys) this high interest rate when country 2 is likely to be the capital exporter (importer).

6.3 World Welfare

We have investigated the effect on each country's welfare. Based on them, we explore the effect on world welfare. Let the sum of country 1's welfare and country 2's welfare when country 1's policymaker is the benevolent type (the leviathan type) be $W_O^{B*}(\lambda)$ ($W_O^{L*}(\lambda)$).

Proposition 5. *Suppose that* $\rho\sqrt{\lambda} - 16\bar{k} \leq \Delta < (15+\rho)\sqrt{\lambda} - 16\bar{k}$. *When* $\rho W_O^{B*}(\lambda) + (1-\rho)W_O^{L*}(\lambda) > \rho W_O^{B*}(0) + (1-\rho)W_O^{L*}(0)$ *holds for some* Δ, *there exists* $\underline{\Delta'''} > 0$ *such that if and only if* $\Delta \geq \underline{\Delta'''}$, $\rho W_O^{B*}(\lambda) + (1-\rho)W_O^{L*}(\lambda) > \rho W_O^{B*}(0) + (1-\rho)W_O^{L*}(0)$. *In addition, there exist* (k, λ, ρ) *under which* $\rho W_O^{B*}(\lambda) + (1-\rho)W_O^{L*}(\lambda) > \rho W_O^{B*}(0) + (1-\rho)W_O^{L*}(0)$ *for some* Δ.

The key is the effect on the efficiency of the resource allocation.[45] The aggregate output (i.e., the world welfare under $\alpha = 0$) is maximized when the allocation of capital is efficient across countries. However, the difference in tax rates between countries hinders such efficient allocation because the equalization of the marginal productivity of capital does not hold. Hence, the larger the difference in tax rates is, the more severe the production inefficiency is.

[45] Nishimura and Terai (2017) also find that political process can affect welfare through the efficiency loss due to the misallocation of capital, although their focus is strategic delegation.

W_O^{B*}	70.10637	W_O^{L*}	71.46032	$\rho W_O^{B*}+(1-\rho)W_O^{L*}$	70.91874
$W_O^{B*}(0)$	70.73250	$W_O^{L*}(0)$	71.49401	$\rho W_O^{B*}(0)+(1-\rho)W_O^{L*}(0)$	71.18941

Table 3: **Numerical Example: World Welfare (1).** *Notes:* $A_1 = 12$, $A_2 = 17$, $\bar{k} = 3$, $\rho = 0.4$, and $\lambda = 10$. Each world welfare includes a constant term $2T$ since each country's welfare is given by (5). As the normalization, we subtract $2T$ from each welfare in the above numerical values. The same is applied to Table 4. The values are rounded off to the fifth decimal place.

W_O^{B*}	85.07836	W_O^{L*}	72.99840	$\rho W_O^{B*}+(1-\rho)W_O^{L*}$	77.83039
$W_O^{B*}(0)$	84.94215	$W_O^{L*}(0)$	73.04132	$\rho W_O^{B*}(0)+(1-\rho)W_O^{L*}(0)$	77.80165

Table 4: **Numerical Example: World Welfare (2).** *Notes:* $A_1 = 20$, $A_2 = 12$, $\bar{k} = 3$, $\rho = 0.4$, and $\lambda = 14$. The values are rounded off to the fifth decimal place.

When country 1's productivity is not so high, populism expands the difference between tax rates implemented by country 1 and 2. To see this, suppose that $\Delta = 0$. Then, $t_{1O}^{B*}(0) < t_{2O}^{*}(0)$ holds and populism drastically lowers t_{1O}^{B*}. Hence, $|t_{1O}^{B*}(\lambda) - t_{2O}^{*}(\lambda)| > |t_{1O}^{B*}(0) - t_{2O}^{*}(0)|$. Therefore, populism is harmful in terms of world welfare when country 1's productivity is not so high. This can be seen in Table 3.

In contrast, the opposite is the case when Δ is sufficiently high. That is, populism improves world welfare when country 1 is sufficiently rich compared with country 2. The numerical example presented in Table 4 shows this. Under fairly high Δ, country 1's tax rate is quite high without populism so that $t_{1O}^{B*}(0) > t_{2O}^{*}(0)$ holds. Under this situation, populism that lowers t_{1O}^{B*} reduces the difference between t_{1O}^{B*} and $t_{2O}^{*}(0)$, meaning that inefficiency of capital allocation is mitigated. Consequently, populism improves even world welfare when country 1 is rich. This can be also seen in Figure 2.

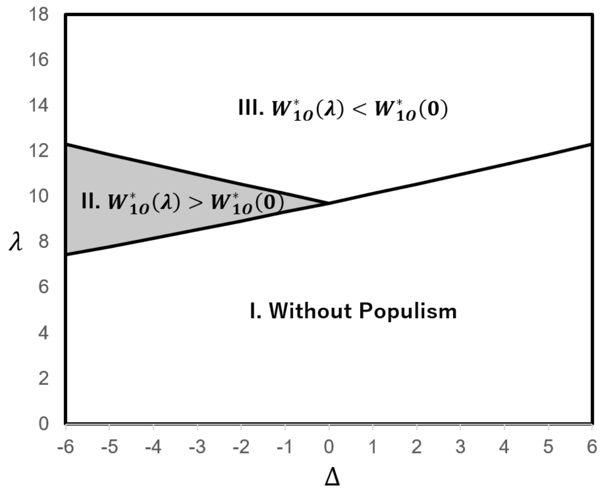

Figure 2: **Numerical Example: World Welfare (3).** Notes: $A_1 = 20, \bar{k} = 3, and\ \rho = 0.4$. In region I, populism never arises because $\sqrt{\lambda} \le \bar{R}$. $W_O^* \equiv \rho W_O^{B*}(\lambda) + (1-\rho)W_O^{L*}(\lambda)$.

Notice that this possibility of the welfare-improvement does not mean that the more severe populism is, the better the world is. Only the moderate populism could be beneficial as in the case of country 1's welfare.

Fact 3. *Fix* Δ*, there always exists* $\bar{\lambda} > 0$ *such that for any* $\lambda \geq \bar{\lambda}, \rho W_O^{B*}(\lambda) + (1-\rho)W_O^{L*}(\lambda) < \rho W_O^{B*}(0) + (1-\rho)W_O^{L*}(0)$.

Proof. This is straightforward given equation (46) in Appendix B. Thus, we omit the proof.

7. Discussions

In this section, we discuss some issues that are left in the former sections.

7.1 Public Goods

So far, we have assumed $\alpha = 0$ in the tax competition model. In this subsection, we investigate the case where $\alpha > 0$, which describes the situation where public goods are provided.

7.1.1 Equilibrium without Reputation Concerns

As in Section 5.1, we have the following best response functions:

$$t_{1O}^{B*}(0) = \frac{8\alpha\bar{k} + (1+2\alpha)\Delta + (1+2\alpha)t_{2O}^{*}(0)}{3+4\alpha}. \tag{14}$$

$$t_{1O}^{L*}(0) = \frac{\Delta + t_{2O}^{*}(0)}{2} + 2\bar{k}. \tag{15}$$

$$t_{2O}^{*}(0) = \frac{8\alpha\bar{k} - (1+2\alpha)\Delta + (1+2\alpha)[\rho t_{1O}^{B*}(0) + (1-\rho)t_{1O}^{L*}(0)]}{3}. \tag{16}$$

These equations yield the equilibrium capital tax rates.

Theorem 4. *When* $\lambda = 0$*, there exist unique equilibrium tax rates such that*

$$t_{1O}^{B*}(0) = \frac{4}{(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho}\left\{(1+2\alpha)(1+\alpha)\Delta + [24\alpha^2 + 18\alpha + 1 - (1+2\alpha)\rho]\bar{k}\right\};$$

$$t_{1O}^{L*}(0) = \frac{2}{(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho}\left\{(3+4\alpha)\Delta + [(3+4\alpha)(1+6\alpha) - 3(1+2\alpha)\rho]\bar{k}\right\} + 2\bar{k};$$

$$t_{2O}^{*}(0) = \frac{1}{(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho}\left\{-(3+4\alpha+\rho)(1+2\alpha)\Delta + 4[(3+4\alpha)(1+6\alpha) - 3(1+2\alpha)\rho]\bar{k}\right\}.$$

7.1.2 Equilibrium with Reputation Concerns

We again focus on separating equilibria. First, we have the following fact that corresponds to Fact 1.

Fact 4. *The following must hold:*

$$t_{1O}^{L*} = \frac{\Delta + t_{2O}^{*}}{2} + 2\bar{k}. \tag{17}$$

$$t_{2O}^{*} = \frac{8\alpha\bar{k} - (1+2\alpha)\Delta + (1+2\alpha)[\rho t_{1O}^{B*} + (1-\rho)t_{1O}^{L*}]}{3+4\alpha}. \tag{18}$$

By substituting (18) into (17), we can rewrite t_{1O}^{L*} *as the function of* t_{1O}^{B*}*:*

$$t_{1O}^{L*} = \frac{\Omega_1 + (1+2\alpha)\rho t_{1O}^{B*}}{5+\rho+2\alpha(3+\rho)}, \tag{19}$$

where $\Omega \equiv 12(1+2\alpha)\bar{k} + 2(1+\alpha)\Delta$. *Substituting this into (17) yields*

$$t_{2O}^{*} = \frac{1}{3+4\alpha}\left[\frac{(1+2\alpha)(1-\rho)\Omega_1 + 2(1+2\alpha)(3+4\alpha)\rho t_{1O}^{B*}}{5+\rho+2\alpha(3+\rho)} + 8\alpha\bar{k} - (1+2\alpha)\Delta\right]. \tag{20}$$

The remaining task is to pin down the value of t_{1O}^{B*}. If $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$, the leviathan type must be indifferent between t_{1O}^{B*} and t_{1O}^{L*} in separating equilibria satisfying the intuitive criterion. Using this property, we obtain the following lemma.

Lemma 4. *At separating equilibria where* $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$, *the following must hold:*

$$t_{1O}^{B*} = \frac{\Omega_1 \pm [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}}{5+6\alpha}, \tag{21}$$

From now on, as the tax rate chosen by the benevolent type other than $t_{1O}^{B*}(0)$, we focus on $\{\Omega_1 - [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}\}/(5+6\alpha)$, which corresponds to the right-wing populism when $\alpha = 0$. Finally, we obtain the characterization of separating equilibria.

Theorem 5. *Suppose that* $\lambda > 0$ and $(A+B\rho)\bar{k} + (C+D\rho)\Delta \geq 0$.

A) When $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right) - \rho(1+2\alpha) \geq 0$ *and* $\sqrt{\lambda} \leq \frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E[(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho]}$, *there exist unique separating equilibrium tax rates:* $\left(t_{1O}^{B*}(\lambda), t_{1O}^{L*}(\lambda), t_{2O}^{*}(\lambda)\right) = \left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$.

B) When $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right) - \rho(1+2\alpha) \geq 0$ *and* $\frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E[(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho]} \leq \sqrt{\lambda} < \frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E(1+2\alpha)\rho}$, $\left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$ *does not constitute any equilibrium. In addition, there exist separating equilibrium tax rates such that* $t_{1O}^{B*}(\lambda) = \{\Omega_1 - [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}\}/(5+6\alpha)$, $t_{1O}^{L*}(\lambda)$ *is characterized by (19), and* $t_{2O}^{*}(\lambda)$ *is characterized by (20).*

C) When $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right)-\rho(1+2\alpha)<0$ *and* $\sqrt{\lambda}\le\frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E[(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho]}$, *there exist unique separating equilibrium tax rates:* $\left(t_{10}^{B*}(\lambda),t_{10}^{L*}(\lambda),t_{20}^{*}(\lambda)\right)=\left(t_{10}^{B*}(0),t_{10}^{L*}(0),t_{20}^{*}(0)\right)$.

D) When $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right)-\rho(1+2\alpha)<0$ *and* $\frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E[(5+6\alpha)(3+4\alpha)+(1+2\alpha)\rho]}\le\sqrt{\lambda}<\bar{L}$, $\left(t_{10}^{B*}(0),t_{10}^{L*}(0),t_{20}^{*}(0)\right)$ *does not constitute any equilibrium. In addition, there exist separating equilibrium tax rates such that* $t_{10}^{B*}(\lambda)=\left\{\Omega_1-[5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}\right\}/(5+6\alpha)$, $t_{10}^{L*}(\lambda)$ *is characterized by (19), and* $t_{20}^{*}(\lambda)$ *is characterized by (20).*

Here,

$$A\equiv 2(5+6\alpha)(12\alpha^3+36\alpha^2+37\alpha+12);B\equiv 2(1+2\alpha)(-36\alpha^2-24\alpha^2+19\alpha+12);$$

$$C\equiv(5+6\alpha)(4\alpha^2+6\alpha+3);D\equiv(1+2\alpha)(-12\alpha^2-6\alpha+3);$$

$$E\equiv(3+4\alpha)[5+6\alpha+\rho(1+2\alpha)];$$

$$\bar{L}\equiv\min\left\{\frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E\left[(1+2\alpha)\rho+(5+6\alpha)(3+4\alpha)-2\sqrt{3+4\alpha}(5+6\alpha)\right]},\frac{2(A+B\rho)\bar{k}+(1+\alpha)(C+D\rho)\Delta}{E(1+2\alpha)\rho}\right\}.$$

In Theorem 6, we assume one additional condition: $(A+B\rho)\bar{k}+(C+D\rho)\Delta\ge 0$. This holds when $\bar{k}$ is sufficiently larger than $|\Delta|$.[46] In particular, when $\alpha=0$, this is reduced to $|\Delta|\le 16\bar{k}|$ which has been assumed in the model. Under this assumption, right-wing populism arises when reputations concerns are sufficiently large (and not too large).[47] Thus, the emergence of right-wing populism due to reputation concerns can be the case even if $\alpha>0$.

Lastly, examine the relationship with the case where $\alpha=0$. Though the notations are quite complicated, we can see that when $\alpha\to 0$, equilibria in Theorem 6 converge to those in Theorem 3. In other words, there is a continuity between the case where $\alpha=0$ and the case where $\alpha>0$. In this regard, the result for the case where $\alpha=0$ is a limit result that approximates the case where α is positive but small.

7.1.3 Welfare

Since the result under $\alpha=0$ is a limit result, for sufficiently small α, the same welfare implications hold. Indeed, the numerical example in Table 5 illustrates that reputation concerns inducing populism improve the expected welfare of country 1 as in the case where $\alpha=0$. Here, the values of parameters except for α are the same as those in Table 2 and the value of α is 0.2.

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[46] For all $\rho\in(0,1)$, $A+B\rho>0$ and $C+D\rho>0$ hold. Therefore, if $\bar{k}$ is sufficiently large, this assumption holds.

[47] In Theorem 3, it seems that there is no upper bound of λ. However, this is not the case. As in the proof of Step 2-3 in Lemma 2, $\sqrt{\lambda}\le\left(16\bar{k}+\Delta\right)/\rho$ must hold. However, since this was already assumed in Section 3, we ignored the upper bound. Indeed, we can easily verify that the upper bound given in Theorem 6 converges to $\left(16\bar{k}+\Delta\right)/\rho$ as α goes to zero.

W_{1O}^{B*}	31.36863	W_{1O}^{L*}	28.84232	$\rho W_{1O}^{B*} + (1-\rho) W_{1O}^{L*}$	30.61074
$W_{1O}^{B*}(0)$	31.36279	$W_{1O}^{L*}(0)$	28.08256	$\rho W_{1O}^{B*}(0) + (1-\rho) W_{1O}^{L*}(0)$	30.37872

Table 5: **Numerical Example: Public Goods.** *Notes:* $A_1 = 12$, $A_2 = 26$, $\bar{k} = 3$, $\rho = 0.7$, $\lambda = 7$, and $\alpha = 0.2$. Each welfare includes a constant term $(1+\alpha)T$. As the normalization, we subtract $(1+\alpha)T$ from each welfare in the above numerical values. The values are rounded off to the fifth decimal place.

However, this does not mean that all the effects of reputation concerns on the welfare are exactly the same. Indeed, when $\alpha > 0$, we have the effect on public goods provision. To see this, observe that $U(c_i, g_i)$ can be rewritten as $[(A_i - k_i)k_i + r(\bar{k} - k_i) + (1+\alpha)T] + \alpha t_i k_i$. For simplicity, consider the case where α is sufficiently close to zero. Examine country 1's welfare under the leviathan type policymaker. For λ under which right-wing populism arises, $W_{1O}^{L*}(\lambda) - W_{1O}^{L*}$ can be decomposed as follows:

$$W_{1O}^{L*}(\lambda) - W_{1O}^{L*} = \left(A_1 - k_{1O}^{L*}(\lambda)\right)k_{1O}^{L*}(\lambda) + r_O^{L*}(\lambda)\left(\bar{k} - k_{1O}^{L*}(\lambda)\right) \tag{22}$$

$$- \left[\left(\left(A_1 - k_{1O}^{L*}(0)\right)k_{1O}^{L*}(0) + r_O^{L*}(0)\left(\bar{k} - k_{1O}^{L*}(0)\right)\right)\right].$$

$$+\alpha[t_{1O}^{L*}(\lambda)k_{1O}^{L*}(\lambda) - t_{1O}^{L*}(0)k_{1O}^{L*}(0)]. \tag{23}$$

Here, the first-term (22) is positive so long as Δ is not too large from Proposition 3 C). This is due to the terms-of-trade effect. In addition, we have the opposite effect that is the second-term (23). Since $t_{1O}^{L*}(\lambda)k_{1O}^{L*}(\lambda) < t_{1O}^{L*}(0)k_{1O}^{L*}(0)$ from Proposition 2, this second-term is negative. This negative effect is the effect due to a decrease in the amount of public goods provision. As the result of populism, the tax rate decreases and thus the tax revenue shrinks, implying a decrease in the amount of public goods. When α is positive, this additional negative effect exists.

7.2 Small Open Economy

So far, we have assumed that there exist only two countries so that there is a strategic interaction. While this is realistic, one may have concerns about how the results depend on such assumptions. To see this, we consider a small open economy model.

7.2.1 The Model

There is a continuum of countries with measure one $(i \in [0, 1])$, meaning that the interest rate is independent of each country's tax rate.

There are two types of countries: *democratic countries* and *non-democratic countries* each of which correspond to countries 1 and 2 in the basic model. The fraction of populist countries is denoted by $\beta \in (0, 1)$. In each democratic country, the probability of the incumbent being the benevolent type is $\rho \in (0,1)$ and this is independent across countries. Each country's productivity A_i is assumed to be the same i.e., $A_i = A$. Instead, we consider another asymmetry that is about the policymaker's objective.[48] In each non-democratic country, the resident who owns $\theta \in (0, 2)$ amount of labor and $\theta\bar{k}$ amount of capital[49] decides the tax rate, meaning that a non-democratic country i's policymaker maximizes

$$\theta\left(r\bar{k} + w_i\right) + (1 + \alpha)t_i k_i.$$

This policymaker has no reputation concerns because there is no election and her/his type is known.

7.2.2 Equilibrium

For simplicity, assume that $\alpha = 0$. We can derive the equilibrium as in the basic model. The only exception is that countries are price-takers. Note that we focus on the equilibrium in which the benevolent policymaker chooses the same tax rate across democratic countries and the same also holds for the leviathan policymakers. Let the equilibrium tax rate chosen by the benevolent (leviathan) policymaker in democratic countries by $t_{1O}^{B*}(\lambda)\left(t_{1O}^{L*}(\lambda)\right)$. In addition, let the tax rate chosen by the policymaker in non-democratic countries be $t_{2O}^{*}(\lambda)$.

First, we have the equilibrium without reputation concerns.

Theorem 6. *When $\lambda = 0$, there exist unique separating equilibrium tax rates such that*

$$t_{1O}^{B*}(0) = 0;$$

$$t_{1O}^{L*}(0) = \frac{A - r}{2}; t_{2O}^{*}(0) = \frac{1 - \theta}{2 - \theta}(A - r), \tag{24}$$

where

$$r = A - 4\bar{k}\beta(1 + \rho) + 2\beta\frac{1 - \theta}{2 - \theta}.$$

Next, we have the separating equilibrium with reputation concerns. As in the basic model, from the indifference condition between t_{1O}^{B*} and t_{1O}^{L*} for the leviathan politician,

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48 We consider not the asymmetry in the production technologies but the asymmetry between the objective function of the benevolent type in democratic countries and that of the policymaker in non-democratic countries for the following two reasons. First, we want to focus on the mechanism presented in the main analysis. To this end, α should be zero. However, in the small open economy model, the tax rate maximizing a country's welfare is always zero when $\alpha = 0$ since there is no incentive to manipulate the terms of trade. Hence, when $\alpha = 0$, we cannot analyze asymmetric tax rates so long as $\theta = 1$. To overcome this difficulty, we allow θ not to be one. Second, the analysis on the asymmetry other than in production technologies enables us to investigate how our results are robust to the types of asymmetries.

49 The total endowment in each country is one and $\bar{k}$ for each production factor.

we have the following lemma.

Lemma 5. *At separating equilibria where* $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$, *the following must hold:*

$$t_{1O}^{B*} = \frac{A-r}{2} \pm \sqrt{2\lambda}.$$

$t_{1O}^{B*} = (A-r)/2 - \sqrt{2\lambda}$ corresponds to the right-wing populism equilibrium. Let us define

$$r_P \equiv A - 4\frac{\bar{k} - \beta\rho\sqrt{\frac{\lambda}{2}}}{\beta + \frac{2(1-\beta)}{2-\theta}}.$$

This is the interest rate in the right-wing populism equilibrium. Given them, we have the characterization of separating equilibria. Since the proof is basically the same as that of Theorem 1, we omit the proof.

Theorem 7. *Suppose that* $0 < \lambda < \frac{\sqrt{2}}{\beta\rho}\bar{k}$.[50]

1. *When* $\sqrt{\lambda} < \sqrt{2}\bar{k}\left[\beta(1+\rho) + \frac{2(1-\beta)}{2-\theta}\right]^{-1}$, *there exist unique separating equilibrium tax rates:* $(t_{1O}^{B*}, t_{1O}^{L*}, t_{2O}^{*}) = \left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$.
2. *When* $\sqrt{\lambda} \geq \sqrt{2}\bar{k}\left[\beta(1+\rho) + \frac{2(1-\beta)}{2-\theta}\right]^{-1}$, *there exist unique separating equilibrium tax rates:* $t_{1O}^{B*} = \frac{A-r}{2} - \sqrt{2\lambda}$, $t_{1O}^{L*}(\lambda)$ *and* $t_{2O}^{*}(\lambda)$ *are characterized by (24), and* $r = r_P$.

As in the basic model, high reputation concerns induce right-wing populism.

7.2.3 Welfare

First, let us explore the effect of populism on the democratic country's welfare. To this end, suppose that one country (denoted by i)'s λ changes from zero to a value larger than that inducing the right-wing populism, keeping all other democratic countries' λ zero. This does not affect the interest rate at all because each country is small. Hence, the welfare under $t_i = t_{1O}^{B*}(\lambda)$ is obviously lower than that under $t_i = t_{1O}^{B*}(0)$, implying

[50] The condition that $\lambda < \frac{\sqrt{2}}{\beta\rho}\bar{k}$ guarantees that the amount of capital each country attracts in the right-wing populism equilibrium is positive.

that high reputation concerns inducing populism hurt country i itself. This is easy to understand by recalling the mechanism behind the positive effect on the populist country's welfare. In the two-country model, populism can improve the populist country's welfare because it changes the terms of trade through the change in the interest rate. However, that never occurs in the small open economy model because the interest rate is constant. Populism in one country always hurts the country's welfare.

The democratic countries' expected welfare when $\lambda = 0$	2.82520
The democratic countries' expected welfare when $\lambda = 1$	2.82725

Table 6: **Numerical Example: Small Open Economy (1).** *Notes:* $A = 4$, $\bar{k} = 1$, $\rho = 0.2$, $\beta = 0.6$ and $\theta = 10/7$. Each welfare includes a constant term T. As the normalization, we subtract T from each welfare in the above numerical values. The values are rounded off to the fifth decimal place.

This does not mean that our positive result for the populist country's welfare no longer holds. Instead, compare two situations: the expected welfare of each democratic country when all democratic countries' $\lambda = 0$ and that when all democratic countries' λ are sufficiently high. In other words, consider the effect of populism in a set of countries on the welfare of those countries. The simultaneous emergence of populism in those countries certainly affect the interest rate. Hence, the terms of trade effect exists so that it can improve the populist countries' welfare. We can see this from the numerical example presented in Table 6. In this example, θ is large so that non-democratic countries' tax rates are pretty low. Hence, without populism, democratic countries tend to be the capital-exporter. Therefore, an increase in the interest rate induced by populism improves their welfare. In this regard, the positive effect for the populist countries still holds to some extent.

World welfare when $\lambda = 0$	2.87883
World welfare when $\lambda = 0.8$	2.89881

Table 7: **Numerical Example: Small Open Economy (2).** *Notes:* $A = 4$, $\bar{k} = 1$, $\rho = 0.4$, $\beta = 0.6$ and $\theta = 10/7$. Each welfare includes a constant term T. As the normalization, we subtract T from each welfare in the above numerical values. The values are rounded off to the fifth decimal place.

In addition, the positive effect for world welfare is still preserved. To see this, compare the case where all the populist countries' λ is zero with the case where their λ are sufficiently large.[51] The positive effect can be seen from the numerical example presented in Table 7.[52] Without populism, the non-democratic countries' tax rate is lower than that of the democratic countries, which creates the misallocation of capital. On the

[51] Here, we do not see the effect of the change of one country's λ because it has no effect on world welfare (each country is measure zero).
[52] World welfare is defined by the sum of production across countries since $\alpha = 0$.

contrary, when populism arises, the democratic countries' tax rates are drastically reduced so that the difference in tax rates across countries becomes smaller. As a result, the misallocation of capital is mitigated, which improves world welfare.

These results together suggest that our main welfare implications holds even in a small open economy.

7.3 Dynamic Model

In this subsection, we construct a two-periods model in which the incumbent's reputation affects the reelection probability. This extension provides one micro-foundation for reputation concerns.

There are two periods ($t = 1, 2$). In period 1, there is an incumbent in each country. In each period, there is one policy issue. In period 1, the policymaker chooses the tax rate on capital that will be applied in both periods 1 and 2. In period 2, there is another policy issue x. The policy about this issue is chosen from a unidimensional policy space $[0, 1]$. Let the policy chosen by country 's policymaker in period 2 be x_i.

The total utility of residents in country i is given by $(1 + \delta)U(c_i, g_i) - \delta(x_i - x_i^*)^2$, where $\delta \in (0, 1]$ is the discount factor and $x_i^* \in [0, 1]$ is the residents' ideal policy about issue x. The policy preference about issue x is represented by a quadratic loss function.[53]

The benevolent type's total utility is given by $(1 + \delta)U(c_i, g_i) - \delta(x_i - x_i^*)^2 + \delta\mathbf{1}_i b$, where $\mathbf{1}_i$ is the indicator function which takes one if this politician is the policymaker in period 2, and $b > 0$ represents the office-seeking motivation. On the other hand, the leviathan type's total utility is given by $(1 + \delta)(T + T_i k_i) - \delta(x_i - x_{iL}^*)^2 + \delta\mathbf{1}_i b$, where $x_{iL}^* \in [0, 1]$ is the leviathan type's ideal policy and $x_{iL} \neq x_i^*$. Since the leviathan type is self-interested, her/his objective is different from residents in terms of not only the taxation policy but also other policy dimensions.

At the beginning of period 2, there are two candidates: the incumbent and a challenger who is benevolent with probability a half.[54] Based on the observed tax rate, each resident

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[53] We assume that this issue is not an economic policy issue (e.g., foreign policies, national security policies and so on) so that the utility from this issue is additively separable from the economic utility.

[54] When the probability that the challenger is the benevolent type is not a half, λ takes different values between the benevolent and leviathan types. We obtain the qualitatively same result even if λ can take different values between two types. To see this, recall that t_{1O}^{B*} in populism equilibria is the tax rate such that the leviathan type is indifferent between t_{1O}^{B*} and t_{1O}^{L*} (Lemma 1). Hence, t_{1O}^{B*} only depends on the leviathan type's λ, denoted by λ_L, implying that

$$t_{1O}^{B*} = \frac{\Omega \pm (5 + \rho)2\sqrt{\lambda_L}}{5}.$$

In short, the characterization of populism equilibria is basically the same though the condition for the existence of populism equilibria could be complicated.

votes for one of the two politicians sincerely.[55] Note that the utilities of residents and politicians are realized at the end of the game.

Since the measure of each voter is zero, the set of perfect Bayesian equilibria involves equilibria in which voters do not vote sincerely. To rule out such implausible equilibria, we focus on perfect Bayesian equilibria with weakly undominated strategies in which sincere voting is guaranteed.

In period 2, the benevolent type chooses the residents' ideal policy x_i^*, while the leviathan type chooses the policy undesirable for the residents x_{iL}^*. Thus, residents in country 1 vote for the incumbent (the new candidate) if $\pi_1(t_1)$ is higher (smaller) than 0.5. In this regard, the reputation is connected to the reelection probability.[56] On the other hand, residents in country 2 vote for the incumbent who is known to be benevolent. Therefore, we obtain the results that correspond to Theorems 1 and 3. Define

$$\lambda \equiv \frac{\delta}{1+\delta}\left[b + \frac{1}{2}(x_i^* - x_{iL}^*)^2\right]. \tag{25}$$

Theorem 8. *Separating equilibria in the closed economy model and the open economy model are characterized by Theorem 1 and 3.*

We give one remark to the interpretation of the benevolent type. In the basic model, the benevolent type has reputation concerns in addition to the concerns about the residents' utility. In this regard, the benevolent type seems not to be purely benevolent. This is true in one sense while not true in the other sense. To see this, observe the decomposition of reputation concerns in (25). On the one hand, when the benevolent type has office-seeking motivation b, λ is high. Since the office-seeking motivation is the self-interesting one, the benevolent type with reputation concerns is not necessarily purely benevolent. On the other hand, λ also depends on the difference between the residents' ideal policy and the leviathan type's ideal policy for the second issue $(x_i^* - x_{iL}^*)^2$. When the leviathan type wins the election, the policy different from the residents' ideal policy is implemented for the second issue. To avoid such loss, the benevolent type has an incentive to be reelected. Hence, even if the benevolent type is purely benevolent, s/he has reelection concerns that induce populism.

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55 All the residents are assumed to have the same belief about the incumbent's type.

56 The reelection probability is discontinuous at $\pi_1 = 0.5$ in this setting. Instead, we can consider the model where the reelection probability is continuous with respect to π_1. For instance, denote the incumbent's valence advantage relative to the challenger by θ that is additively added in residents' payoff when the incumbent is reelected. If this value follows a distribution G and is unobservable to the incumbent, we have the continuous reelection probability.

7.4 Objective Function of the Leviathan Type

In the basic model, the objective function of the leviathan type is the weighted sum of the net tax revenue and reputation concern. Though maximizing the budget/ tax revenue has been used as the reduced form (e.g., Pal and Sharma 2013; Kawachi, Ogawa, and Susa 2017), one may wonder why the leviathan type has this type of objective function. In this subsection, we provide micro-foundation.

Without changing any result, suppose that there exist a finite number of residents in each country and denote its number by N. We define the benevolent type's objective function by exactly the same way. Let $T' \equiv NT$ and $K_i \equiv Nk_i$. We define the leviathan type's objective function as follows:

$$\max_{t_1} \theta(T' + t_1 K_1) + \lambda p\big(\pi_1(t_1)\big).$$

The total (net) revenue of country 1 for the provision of public goods is $T' + t_1 K_1$. Suppose that the leviathan type can extract θ faction of the revue,[57] and thus the leviathan type maximizes $\theta(T' + t_1 K_1) + \lambda p\big(\pi_1(t_1)\big)$. The above objective function represents such situation. The objective function we adopted in the basic model is a special case of this objective function i.e., that is equivalent to the case where $\theta = 1/N$.[58]

7.5 General Model for Closed Economy

We adopted the linear preferences and the exogenous supply of capital to make our analysis for tax competition tractable. However, this makes our result for the closed economy extreme. Since the provision of capital is inelastic in the closed economy model, linear preferences imply that country 1's welfare is maximized when the tax rate reaches the upper bound determined by the non-negativity constraint of the interest rate. In other words, the optimal tax rate is the corner solution. The same is true for the tax rate maximizing the revenue. One may doubt that our result for the closed economy model crucially depends on this extreme property. This is not the case. To demonstrate it, consider the following model, which is based on that of Keen and Kotsogiannis (2002). Our result for the closed economy still holds.

There are two periods ($t = 1, 2$) between the incumbent's choice on tax rates and the election. In period 1, each resident has an endowment $\bar{k}$ that can be either the

57 This type of setting for the leviathan type is adopted by several papers (e.g., Keen and Kotsogiannis 2003).

58 $\theta \neq 1/N$ is equivalent that the value of λ is different between the two types. We obtain the qualitatively same result even if λ can take different values between the two types as discussed in footnote 54.

consumption in period 1 (c^1) or saving for period 2's consumption $\left(s = \bar{k} - c^1\right)$.[59] In period 2, residents receive income $c^2 = rs + w$. The utility is given by $u_1(c^1) + u_2(c^2) + v(g)$ where $u_t' \geq 0$, $u_t'' \leq 0$, $v' > 0$, and $v'' \leq 0$.[60]

In period 2, the production is based on labor L and capital accumulated by residents s. Hence, the production function per capita is given by $f(s)$ where $f' > 0$ and $f'' < 0$. As in the basic model, tax is imposed on capital s so that $g = T + ts$.[61] In addition, $r = f'(k) - t$.

In this model, when $u_t' > 0$, capital supply is endogenous so that $s = 0$ under too high t. Hence, the tax rate maximizing the tax revenue is no longer the corner solution. Furthermore, when $\lim_{c \to 0} u_t'(c) = \infty$, the tax rate maximizing welfare is also no longer the corner solution.

Then, we obtain the same welfare implications, meaning that our result for the closed economy does not depend on our specific preferences.

Theorem 9. *Suppose that for some $\lambda > 0$, there is a right-wing populism equilibrium. Then, country 1's expected welfare in the right-wing populism equilibrium is strictly less than that in the equilibrium under $\lambda = 0$.*

8. Concluding Remarks

One feature of right-wing populism is anti-taxation (i.e., the extreme reduction of tax rates). We studied the consequences of such a taxation policy by focusing on how globalization (particularly an increase in the mobility of tax bases across countries) changes its properties. To this end, we constructed a two-country capital tax competition model in which the residents in one of the two countries face information asymmetry about their policymaker's type (benevolent or leviathan). Here, we particularly investigated capital taxation since capital is a typical mobile tax base and the tax competition literature has been developing in its direction. We then compared the equilibrium in this model with that in a closed economy where capital is immobile.

First, we showed that extremely low taxation on capital arises when the policymaker

[59] Under tax competition, the amount of capital in each country is endogenously determined without saving. Hence, we do not have to introduce saving decisions to make the model be well-behaved. Note that this does not mean that introducing saving decisions does not change any results because even the supply of capital in the whole world is endogenous in the presence of saving decisions. However, with a few exceptions, most studies of strategic tax competition omit saving decisions. In particular, the analysis on asymmetric strategic tax competition under saving decisions is quite hard. Hence, we do not use such a model in the analysis of tax competition. See also Section 8.

[60] The model presented in Section 4 can be regarded as the case where $u_1(c^1) = 0$ and $v(g) = g$.

[61] We assume that the model is well-behaved so that the tax rate maximizing the tax revenue and that maximizing welfare are unique.

has reputation concerns. Furthermore, globalization changes the properties of this populism such as the welfare implications. Since extremely low taxation is not optimal by definition, it seems to be obvious that reputation concerns inducing populism are harmful to welfare. Indeed, this is the case in a closed economy. However, this is not necessarily the case under tax competition. We showed that reputation concerns inducing populism can improve world welfare under tax competition when the populist country is rich in terms of the production technology. In addition, we showed that under tax competition, the populist country's welfare can be improved when the country is poor. Notice that these welfare-enhancing effects are obtained only when countries are asymmetric. When countries' characteristics are similar, we still obtain welfare-reducing effects.

Before closing this paper, we discuss the remaining challenges for future researchers. First, in the model, there is information asymmetry only about country 1's policymaker's type. In reality, however, populism may arise in both countries. Examining such a situation may be worthwhile. Second, although we focused on the leviathan type as a bad politician, other types of bad politicians could exist. Studying such a possibility could also be promising. Third, other effects of populism outside of the model could exist. For instance, we can consider a model in which the supply of capital in a region consisting of two countries depend on the interest rate of the region. Then, we might find another positive effect of reputation concerns such that the interest rate decreases and thus the supply of capital in the region increases. These issues are left to future work.

Appendices

A. Intuitive Criterion

For the convenience of readers, we define the intuitive criterion (Cho and Kreps 1987) in the framework of our specific model.

We start by introducing some notations. Define the type space for country 1's policymaker's type by $\Theta \equiv \{B, L\}$ with its generic element θ, where B represents that country 1's policymaker is benevolent. Let $v_1(t_1, t_2, \pi_1, \theta)$ be the payoff of country 1's policymaker given t_1, t_2, and π_1 when her/his type is θ. In particular, we denote her/his equilibrium payoff by $v_1^*(\theta)$.

Given these notations, we introduce the following set. For each t_1, define

$$\Theta(t_1) = \left\{\theta \in \Theta | \, v_1^*(\theta) \leq \max_{\pi_1 \in [0,1]} v_1(t_1, t_2^*, \pi_1, \theta)\right\}$$

This is the set of types for which country 1's policymaker can be better-off by deviating from the equilibrium strategy to t_1 depending on π_1. Thus, if $\Theta(t_1) = \{B\}$, it implies that the leviathan type never has an incentive to deviate to t_1. In such a case, residents in country 1 should not think that the policymaker who chose t_1 is the leviathan type. The intuitive criterion imposes such restriction on off-path belief formations.

Definition 3. *A perfect Bayesian equilibrium* $(t_1^{B*}, t_1^{L*}, t_2^*, \pi_1^*)$ *satisfies the intuitive criterion if for each* t_1, *(i)* $\pi_1^*(t_1) = 1$ *when* $\Theta(t_1) = \{B\}$ *and (ii)* $\pi_1^*(t_1) = 0$ *when* $\Theta = \{L\}$.

B. Omitted Proofs

B.1 Proof of Theorem 1

Step 1: Prove that (4) must hold in separating equilibria satisfying the intuitive criterion (if exist).

$t_{1C}^{L*}\bar{k} \geq t_{1C}^{B*}\bar{k} + \lambda$ must hold from the incentive compatibility condition of the leviathan type. Thus, it suffices to show that if this inequality holds with strict inequality, the intuitive criterion is not satisfied. Prove by contradiction.

Suppose that the inequality holds with strict inequality. Then, $t_{1C}^{B*} \neq t_{1C}^{B*}(0)$. Thus, for any $\varepsilon > 0$, there exists $t \in [t_{1C}^{B*} - \varepsilon, t_{1C}^{B*} + \varepsilon]$ such that $U(c_1, g_1)$ given t is higher than that given t_{1C}^{B*}. This implies that if $\pi_1(t) = 1$ for such t (say t_d), the benevolent type has a strict incentive to deviate from t_{1C}^{B*}. Thus, for such t, $\pi_1(t) \neq 1$ must hold at the equilibrium.

However, this belief restriction does not satisfy the intuitive criterion. To see this, examine the leviathan type's incentive. Since $t_{1C}^{L*}\bar{k} \geq t_{1C}^{B*}\bar{k} + \lambda$ holds, there exists some $\bar{\varepsilon} > 0$ such that for any $t \in [t_{1C}^{B*} - \bar{\varepsilon}, t_{1C}^{B*} + \bar{\varepsilon}], t_{1C}^{L*}\bar{k} > t\bar{k} + \lambda$ also holds. This means that the leviathan type never has an incentive to choose $t \in [t_{1C}^{B*} - \bar{\varepsilon}, t_{1C}^{B*} + \bar{\varepsilon}]$. Thus, for $t \in [t_{1C}^{B*} - \bar{\varepsilon}, t_{1C}^{B*} + \bar{\varepsilon}]$, $\pi_1(t) = 1$ from the intuitive criterion. This contradicts with $\pi_1(t_d) \neq 1$.

Step 2: It is straightforward that the derived tax rates constitute a perfect Bayesian equilibrium satisfying the intuitive criterion. ■

B.2 Proof of Lemma 1

As in Step 1 in the proof of Theorem 1, we can easily verify that

$$t_{1O}^{L*}\bar{k} = t_{1O}^{B*}\bar{k} + \lambda. \tag{26}$$

must hold if $t_{1O}^{B*} \neq t_{1O}^{B*}(0)$.[62] Substituting (2), (3), (11), and (12) into (26) yields

[62] This is because t_{1O}^{B*} does not maximize the residents' utility given t_{2O}^*. Hence, we can apply the

$$\frac{5t_{1O}^{B*}-\Omega}{5+\rho}=\pm 2\sqrt{\lambda},$$

which can be rewritten as

$$t_{1O}^{B*}=\frac{\Omega\pm(5+\rho)2\sqrt{\lambda}}{5}. \blacksquare$$

B.3 Proof of Lemma 2

Step 1: Since the deviation incentive of each player depends on the belief formation and the belief formation is restricted by the intuitive criterion, we first examine how the belief formation is restricted by the intuitive criterion.

Suppose that the benevolent type has a strict incentive to deviate from t_{1O}^{B*} to t if $\pi_1(t)=1$. Given t_{1O}^{B*}, the belief such that $\pi_1(t)=0$ satisfies the intuitive criterion if the leviathan type has an incentive to deviate to t depending on the belief formation. In other words, $\pi_1(t)=0$ satisfies the intuitive criterion if and only if

$$t_{1O}^{L*}\bar{k}\leq t\bar{k}+\lambda.$$

By substituting (2), (3), (11), and (12) into this, we have

$$\left(t_1-\frac{\Omega+\rho t_{1O}^{B*}}{5+\rho}\right)^2\leq\lambda.$$

which can be rewritten as

$$\frac{\Omega+\rho t_{1O}^{B*}}{5+\rho}-2\sqrt{\lambda}\leq t_1\leq\frac{\Omega+\rho t_{1O}^{B*}}{5+\rho}+2\sqrt{\lambda}. \tag{27}$$

Step 2: Consider the deviation incentive of country 1's benevolent policymaker from t_{1O}^{B*}. Since the residents' utility function has a quadratic form, there exists a unique maximizer of the residents' utility; that is

$$t_1^{*d}=\frac{\Delta+t_2}{3}$$

as seen in equation (6). By substituting (12) into this, we have the maximizer od the residents' utility given t_{2O}^*:

$$t_1^{*d}=\frac{2}{9}\Delta+\frac{1-\rho}{5+\rho}\frac{\Omega}{9}+\frac{2\rho}{5+\rho}\frac{t_{1O}^{B*}}{3}. \tag{28}$$

Step 2.1: If and only if t_1^{*d} satisfies (27), $\pi(t_1^{*d})=0$ satisfies the intuitive criterion. Derive this condition. First, consider the case where $t_{1O}^{B*}=\frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$. In this case, t_1^{*d} satisfies (27) if and only if

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argument of Step 1 in the proof of Theorem 1.

$$\sqrt{\lambda} \geq \frac{16\bar{k} + \Delta}{15 + \rho}, \sqrt{\lambda} \geq -\frac{16\bar{k} - \Delta}{15 - \rho}.$$

Here, the second inequality always holds because the right-hand side of the inequality is always non-positive. Hence, these conditions are summarized by

$$\sqrt{\lambda} \geq \bar{R}. \tag{29}$$

Second, consider the case where $t_{1O}^{B*} = \frac{\Omega + (5+\rho)2\sqrt{\lambda}}{5}$. In this case, t_1^{*d} satisfies (27) if and only if

$$\sqrt{\lambda} \geq -\frac{16\bar{k} + \Delta}{15 - \rho}. \tag{30}$$

Step 2-2: Even if $\pi_1\left(t_1^{*d}\right) = 0$, the benevolent type may still have an incentive to deviate to t_1^{*d}. The incentive compatibility condition for this deviation. This condition is given by

$$U\left(c_1, g_1 |\, t_1^{*d}, t_{2O}^{*}\right) \leq U(c_1, g_1 | t_{1O}^{B*}, t_{2O}^{*}) + \lambda.$$

Substituting (2) and (3) into this yields

$$\frac{3}{16}\left(t_1^{*d} - t_{1O}^{B*}\right)^2 \leq \lambda. \tag{31}$$

Consider, first, the case where $t_{1O}^{B*} = \frac{\Omega - (5+\rho)2\sqrt{\lambda}}{5}$. In this case, (31) can be rewritten as

$$\left[30 - \sqrt{3}(15 + \rho)\right]\sqrt{\lambda} \geq -\frac{\sqrt{3}}{30}\left(16\bar{k} + \Delta\right).$$

Since the left-hand side is positive and the right-hand side is negative, this always holds i.e., the benevolent type has no incentive to deviate from $t_{1O}^{B*} = \frac{\Omega - (5+\rho)2\sqrt{\lambda}}{5}$.

Next, consider the case where $t_{1O}^{B*} = \frac{\Omega + (5+\rho)2\sqrt{\lambda}}{5}$. In this case, (31) can be rewritten as

$$\sqrt{\lambda} \geq \frac{\sqrt{3}\left(16\bar{k} + \Delta\right)}{30 - \sqrt{3}(15 + \rho)}. \tag{32}$$

Step 2-3: Lastly, the benevolent type may deviate to the tax rate in which $\pi_1(t) = 0$ cannot be satisfied i.e., t for which (27) does not hold.

First, consider the case where $t_{1O}^{B*} = \frac{\Omega - (5+\rho)2\sqrt{\lambda}}{5}$. Observe that $\frac{\Omega + \rho t_{1O}^{B*}}{5+\rho} - 2\sqrt{\lambda}$, which is the lower bound of t_1 for (27), is equal to $t_{1O}^{B*} = \frac{\Omega - (5+\rho)2\sqrt{\lambda}}{5}$. Furthermore, the residents' utility has a quadratic form and the unique maximizer. Thus, if the unique maximizer t_1^{*d} is weakly closer to the lower bound of t_1 for (27) than to the upper bound, the benevolent type has no deviation incentive. This condition can be written as

$$\frac{\Omega + \rho t_{1O}^{B*}}{5+\rho} \geq t_1^{+d},$$

which can be rewritten as

$$\sqrt{\lambda} \leq \frac{16\bar{k} + \Delta}{\rho}.$$

This is satisfied by the assumption about λ so that the benevolent type has no deviation incentive.

Next, consider the case where $t_{1O}^{B*} = \frac{\Omega+(5+\rho)2\sqrt{\lambda}}{5}$. Observe that $\frac{\Omega+\rho t_{1O}^{B*}}{5+\rho} + 2\sqrt{\lambda}$, which is the upper bound of t_1 for (27), is equal to $t_{1O}^{B*} = \frac{\Omega+(5+\rho)2\sqrt{\lambda}}{5}$. Similarly in the above, the benevolent type has no deviation incentive if

$$\frac{\Omega + \rho t_{1O}^{B*}}{5+\rho} \leq t_1^{*d},$$

which can be rewritten as

$$\sqrt{\lambda} \leq -\frac{16\bar{k} + \Delta}{\rho}.$$

This never holds because the right-hand side is negative.

By combining these steps, we have Lemma 2. ■

B.4 Proof of Lemma 3

Only if part: Suppose that there exists a separating equilibrium in which $(t_{1O}^{B*}, t_{1O}^{L*}, t_{2O}^{*}) = \left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$. Consider the leviathan type's deviation incentive. The leviathan type has no incentive to deviate from $t_{1O}^{L*}(0)$ to $t_{1O}^{B*}(0)$ if and only if

$$t_{1O}^{L*}(0)k_1 \geq t_{1O}^{B*}(0)k_1 + \lambda.$$

Substituting (6), (7), (8), and (2) into this yields $\bar{R}^2 \geq \lambda$. Thus, only if $\sqrt{\lambda} \leq \bar{R}$, $\left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$ can constitute an equilibrium.

If part: It is straightforward that $\left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$ constitutes an equilibrium satisfying the intuitive criterion. ■

B.5 Proof of Theorem 3

Combining Lemmas 2 and 3, we obtain the theorem. Notice that when $\sqrt{\lambda} = \bar{R}$,

$t_{1O}^{B*}(0) = \frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$. ■

B.6 Proof of Proposition 1

(i) When $\sqrt{\lambda} \leq \bar{R}$, the equilibrium is $(t_{1O}^{B*}, t_{1O}^{L*}, t_{2O}^{*}) = \left(t_{1O}^{B*}(0), t_{1O}^{L*}(0), t_{2O}^{*}(0)\right)$. Thus, obviously, t_{1O}^{B*} maximizes the residents' utility given by t_{2O}^{*}.

(ii) When $\sqrt{\lambda} > \bar{R}$, the equilibrium such that $t_{1O}^{B*} = \frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5}$ exists. Remember that

$$t_1^{*d} = \text{argmax}_{t_1}(A_1 - k_1)k_1 + r\left(\bar{k} - k_1\right) \text{ s.t.} (2), (3), \text{and } t_2 = t_{2O}^{*}.$$

Here, as discussed in Step 2-1 in the proof of Lemma 2, $\frac{\Omega-(5+\rho)2\sqrt{\lambda}}{5} < t_1^{*d}$ if and only if $\sqrt{\lambda} > \bar{R}$. ■

B.7 Proof of Proposition 2

A)

$$t_{1O}^{B*} - t_{1O}^{B*}(0) = -\frac{2}{5}(5+\rho)\left(\sqrt{\lambda} - \bar{R}\right) < 0.$$

Using this, we obtain $t_{1O}^{L*} < t_{1O}^{L*}(0)$ and $t_{2O}^{*} < t_{2O}^{*}(0)$. ■

B)

$$r_O^{B*} - r_O^{B*}(0) = \frac{t_{1O}^{B*}(0) + t_2^{*}(0) - (t_{1O}^{B*} + t_{2O}^{*})}{2} = \frac{5+3\rho}{2(5+\rho)}(t_{1O}^{B*}(0) - t_{1O}^{B*}) = \frac{5+3\rho}{5}\left(\sqrt{\lambda} - \bar{R}\right).$$

The first equality comes from equation (3), the second equality comes from (12), and the third equality comes from (a). Similarly, we obtain the value of $r_O^{L*} - r_O^{L*}(0)$. ■

C)

$$k_{1O}^{B*} - k_{1O}^{B*}(0) = \frac{t_{1O}^{B*}(0) - t_2^{*}(0) + t_{2O}^{*} - t_{1O}^{B*}}{2} = \frac{5-\rho}{4(5+\rho)}(t_{1O}^{B*}(0) - t_{1O}^{B*}) = \frac{5-\rho}{10}\left(\sqrt{\lambda} - \bar{R}\right).$$

The first equality comes from equation (2), the second equality comes from (12), and the third equality comes from (a). Similarly, we obtain the value of $k_{1O}^{L*} - k_{1O}^{L*}(0)$.■

B.8 Proof of Proposition 3

B) and C) imply A).

B) Observe that $W_{1O}^{B*} - W_{1O}^{B*}(0)$ can be rewritten as

$$W_{1O}^{B*} - W_{1O}^{B*}(0) = f(k_{1O}^{B*}) - f\left(k_{1O}^{B*}(0)\right) - r_O^{B*}\left(k_{1O}^{B*} - k_{1O}^{B*}(0)\right) \quad (33)$$

$$+ \left(r_O^{B*} - r_O^{B*}(0)\right)\left(\bar{k} - k_{1O}^{B*}(0)\right).$$

$$= \left(k_{1O}^{B*} - k_{1O}^{B*}(0)\right)\left[A_1 - r_O^{B*} - \left(k_{1O}^{B*} + k_{1O}^{B*}(0)\right)\right] + \left(r_O^{B*} - r_O^{B*}(0)\right)\left(\bar{k} - k_{1O}^{B*}(0)\right)$$

$$= \left(\sqrt{\lambda} - \bar{R}\right)\left\{\frac{5-\rho}{10}\left[A_1 - r_O^{B*} - \left(k_{1O}^{B*} + k_{1O}^{B*}(0)\right)\right] + \frac{5+3\rho}{5}\left(\bar{k} - k_{1O}^{B*}(0)\right)\right\}.$$

The second equality comes from the definition of $f(k)$, and the third equality comes from the values of $k_{1O}^{B*} - k_{1O}^{B*}(0)$ and $r_O^{B*} - r_O^{B*}(0)$ derived in Proposition 2.
Here, $A_1 - r_O^{B*} - \left(k_{1O}^{B*} + k_{1O}^{B*}(0)\right)$ can be rewritten as

$$A_1 - r_O^{B*} - \left(k_{1O}^{B*} + k_{1O}^{B*}(0)\right) = \frac{1}{4}\left(3t_{1O}^{B*} + t_{2O}^{*} + t_{1O}^{B*}(0) - t_{2O}^{*}(0)\right) \quad (34)$$

$$= \frac{11+\rho}{15+\rho}\frac{\Delta}{2} + \frac{7+\rho}{15+\rho}4\bar{k} - \frac{3+\rho}{2}\sqrt{\lambda}..$$

In addition, $\bar{k} - k_{1O}^{B*}(0)$ can be rewritten as

$$\bar{k} - k_{1O}^{B*}(0) = -\frac{2}{15+\rho}\left[\Delta + (1-\rho)\bar{k}\right] \quad (35)$$

Substituting (34) and (35) into (33) yields

$$\left(\sqrt{\lambda} - \bar{R}\right) \times K, \quad (36)$$

where

$$K = \frac{-\rho^2 - 30\rho + 15}{20(15+\rho)}\Delta + \frac{4\rho^2 + 60}{5(15+\rho)}\bar{k} - \frac{(5-\rho)(3+\rho)}{20}\sqrt{\lambda}$$

Since $\sqrt{\lambda} > \bar{R}$, the sign of (33) is equal to the sign of K. Thus, it suffices to focus on the sign of K.

First, when $\Delta = 0, K < \frac{-8\rho}{5(15+\rho)}\bar{k} < 0$. Here, the first inequality comes from $\sqrt{\lambda} > \bar{R}$.

Hence, when $\Delta = 0$, $W_{1O}^{B*} < W_{1O}^{B*}(0)$.
Second, observe that whether K is increasing or decreasing in Δ depends on the sign of $-\rho^2 - 30\rho + 15$.
(i) When $\rho > 4\sqrt{15} - 15$, $-\rho^2 - 30\rho + 15 < 0$ i.e., K (i.e., (33) is decreasing in Δ. Hence, the first part of (i) in (b) is proven. For the second part, it suffices to show that there exists (k, λ, ρ) under which (37) is negative when $\Delta = \rho\sqrt{\lambda} - 16\bar{k}$. When$\Delta$takes this value, K is rewritten as

$$\frac{\sqrt{\lambda}}{20(15+\rho)}(-17\rho^2 - 30\rho - 15^2) + \frac{\bar{k}}{5(15+\rho)}(8\rho^2 + 120\rho), \quad (37)$$

Since the first-term is negative, (37) is negative when λ is sufficiently high.

(ii) When $\rho = 4\sqrt{15} - 15$, $-\rho^2 - 30\rho + 15 = 0$ i.e., K is independent of Δ. Thus, $K < 0$ for anyΔ.

(iii) When $\rho < 4\sqrt{15} - 15$, $-\rho^2 - 30\rho + 15 > 0$ i.e., K is increasing inΔ. Then, for any $\Delta < 0$, $K < 0$ holds. Focus on $\Delta > 0$. Here, the upper bound of Δ is $(15+\rho)\sqrt{\lambda} - 16\bar{k}$ because $\sqrt{\lambda} > \bar{R}$ must hold. Hence, if $K > 0$ holds when $\Delta = (15+\rho)\sqrt{\lambda} - 16\bar{k}$, $W_{1O}^{B*} < W_{1O}^{B*}(0)$ holds for any $\Delta > 0$. Suppose that $\Delta = (15 + \rho)\sqrt{\lambda} - 16\bar{k}$. Then,

$$K = \frac{-\rho^2 - 30\rho + 15}{20}\sqrt{\lambda} - \frac{-\rho^2 - 30\rho + 15}{5(15+\rho)}4\bar{k} + \frac{4\rho^2 + 60}{5(15+\rho)}\bar{k} - \frac{(5-\rho)(3+\rho)}{20}\sqrt{\lambda}$$

$$= \frac{8\rho}{5}\left(\bar{k} - \sqrt{\lambda}\right).$$

Since $\sqrt{\lambda} > \bar{R}$ holds for non-negativeΔ, this is negative. Hence, $K < 0$ for any Δ. Combine these arguments, we have B) and the first part of A) ■

C) Observe that $W_{1O}^{L*} - W_{1O}^{L*}(0)$ can be rewritten as

$$W_{1O}^{L*} - W_{1O}^{L*}(0) = \left(\sqrt{\lambda} - \bar{R}\right)\left\{-\frac{\rho}{10}\left[A_1 - r_O^{L*} - \left(k_{1O}^{L*} + k_{1O}^{L*}(0)\right)\right] + \frac{3\rho}{10}\left(\bar{k} - k_{1O}^{L*}(0)\right)\right\} \quad (38)$$

Here, $A_1 - r_O^{L*} - \left(k_{1O}^{L*} + k_{1O}^{L*}(0)\right)$ can be rewritten as

$$A_1 - r_O^{L*} - \left(k_{1O}^{L*} + k_{1O}^{L*}(0)\right) = \frac{12+\rho}{15+\rho}\frac{\Delta}{2} + \frac{9+\rho}{15+\rho}4\bar{k} - \frac{\rho}{2}\sqrt{\lambda}.. \quad (39)$$

In addition, $\bar{k} - k_{1O}^{L*}(0)$ can be rewritten as

$$\bar{k} - k_{1O}^{L*}(0) = \frac{1}{15+\rho}\left[-\frac{3}{2}\Delta + (3+\rho)2\bar{k}\right] \quad (40)$$

Substituting (39) and (40) into (38) yields

$$\left(\sqrt{\lambda} - \bar{R}\right) \times K', \quad (41)$$

where

$$K' = \frac{\rho}{5}\left(-\frac{30+\rho}{15+\rho}\frac{\Delta}{4} + \frac{4\rho}{15+\rho}\bar{k} - \frac{\rho}{4}\sqrt{\lambda}\right), \quad (42)$$

Since $\sqrt{\lambda} > \bar{R}$, the sign of (38) is equal to the sign of K'. Thus, it suffices to focus on the sign of K'. When $\Delta = 0$, it is straightforward that $K' > 0$. This implies the second part of A). In addition, K' is obviously decreasing in Δ. Hence, we have C). ■

D) Substituting (36) and (41), $\rho\left(W_{1O}^{B*} - W_{1O}^{B*}(0)\right) + (1-\rho)\left(W_{1O}^{L*} - W_{1O}^{L*}(0)\right)$ can be rewritten as

$$\rho\left(W_{1O}^{B*} - W_{1O}^{B*}(0)\right) + (1-\rho)\left(W_{1O}^{L*} - W_{1O}^{L*}(0)\right) = \frac{\rho}{20}\left(\sqrt{\lambda} - \bar{R}\right) \times K'', \qquad (43)$$

where

$$K'' = -\Delta + 16\bar{k} - (15+\rho)\sqrt{\lambda}. \qquad (44)$$

Since $\sqrt{\lambda} > \bar{R}$, the sign of (43) is equal to the sign of K''.

First, observe that when $\Delta = 0$, $K'' < 0$ because $\sqrt{\lambda} - \frac{16\bar{k}}{15+\rho} > 0$. Second, K'' is decreasing in Δ.

For the second part, it suffices to show that there exists (k, λ, ρ) under which K'' is positive when $\Delta = \rho\sqrt{\lambda} - 16\bar{k}$. Then, K'' is also positive when Δ is close to $\rho\sqrt{\lambda} - 16\bar{k}$ under the same (k, λ, ρ). Substituting $\Delta = \rho\sqrt{\lambda} - 16\bar{k}$ into (44) yields

$$-(15+2\rho)\sqrt{\lambda} + 32\bar{k}.$$

This is positive when $\sqrt{\lambda} = \frac{16\bar{k}}{15+\rho}$. Hence, when $\sqrt{\lambda}$ is close to be $\frac{16\bar{k}}{15+\rho}$, K'' is positive. Thus, the second part of D) is obtained. ■

B.9 Proof of Proposition 4

$\rho\left(W_{2O}^{B*} - W_{2O}^{B*}(0)\right) + (1-\rho)\left(W_{2O}^{L*} - W_{2O}^{L*}(0)\right)$ can be rewritten as

$$\rho\left(W_{2O}^{B*} - W_{2O}^{B*}(0)\right) + (1-\rho)\left(W_{2O}^{L*} - W_{2O}^{L*}(0)\right) = \frac{\rho}{20}\left(\sqrt{\lambda} - \bar{R}\right)N'', \qquad (45)$$

where

$$N'' = \frac{385+47\rho}{5(15+\rho)}\Delta + \frac{34\rho - 130}{5(15+\rho)}8\bar{k} + \frac{25+23\rho}{5}\sqrt{\lambda}.$$

Since $\sqrt{\lambda} > \bar{R}$, the sign of (45) is equal to the sign of N''. Furthermore, N'' is increasing in Δ. Hence, we have the proposition. ■

B.10 Proof of Proposition 5

By using the proof of Proposition 3 D) and Proposition 4, $\rho\left(W_{O}^{B*} - W_{O}^{B*}(0)\right) + (1-\rho)\left(W_{O}^{L*} - W_{O}^{L*}(0)\right)$ can be rewritten as

$$\rho\left(W_{O}^{B*} - W_{O}^{B*}(0)\right) + (1-\rho)\left(W_{O}^{L*} - W_{O}^{L*}(0)\right) = \frac{\rho}{50}\left(\sqrt{\lambda} - \bar{R}\right)N''', \qquad (46)$$

where

$$N''' = \frac{155+21\rho}{15+\rho}\Delta + \frac{176\rho + 80}{15+\rho}8\bar{k} + (9\rho - 25)\sqrt{\lambda}.$$

Since $\sqrt{\lambda} > \bar{R}$, the sign of (46) is equal to the sign of N'''. When $\Delta = 0$, $N''' < 0$. Furthermore, N''' is increasing in Δ. Hence, we have the proposition.

In addition, as seem in Figure 2, there exist (k, λ, ρ) under N''' is negative for some Δ. Thus, the second part is also obtained. ■

B.11 Proof of Theorem 5

The proof is almost the same as those of Lemmas 1, 2, 3 and Theorem 3. The only difference is the condition under which the country 1's benevolent type does not deviate from t_{1O}^{B*} to the tax rate that maximizes the residents' utility. This was examined in Step. 2-2 of Lemma 2 for the case where $\alpha = 0$. As in Lemma 2, let the tax rate that maximizes the residents' utility given t_{2O}^{*} be t_1^{*d}.

Even if $\pi_1\left(t_1^{*d}\right) = 0$, the benevolent type may still have an incentive to deviate to t_1^{*d}. The incentive compatibility condition for this deviation is given by

$$U\left(c_1, g_1 |\, t_1^{*d}, t_{2O}^{*}\right) \le U(c_1, g_1 |\, t_{1O}^{*B}, t_{2O}^{*}) + \lambda.$$

Substituting (2) and (3) into this yields

$$\frac{3+4\alpha}{16}\left(t_1^{*d} - t_{1O}^{B*}\right)^2 \le \lambda. \tag{47}$$

Substituting $t_{1O}^{B*} = \frac{\Omega_1 - [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}}{5+6\alpha}$ into (47) yields

$$-2\sqrt{\lambda}\left(\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right) - \rho(1+2\alpha)\right) \le \frac{4\bar{k}(A+B\rho) + 2(1+\alpha)\Delta(C+D\rho)}{E}.$$

If $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right) - \rho(1+2\alpha) \ge 0$ holds, the above inequality always holds[63] i.e., the benevolent type has no incentive to deviate from $t_{1O}^{B*} = \frac{\Omega_1 - [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}}{5+6\alpha}$.

Next, consider the case where $\sqrt{3+4\alpha}(5+6\alpha)\left(2-\sqrt{3+4\alpha}\right) - \rho(1+2\alpha) < 0$. Then, if and only if the following inequality holds, the benevolent type has no incentive to deviate from $t_{1O}^{B*} = \frac{\Omega_1 - [5+\rho+2\alpha(3+\rho)]2\sqrt{\lambda}}{5+6\alpha}$:

$$\sqrt{\lambda} \le \frac{2(A+B\rho)\bar{k} + (1+\alpha)(C+D\rho)\Delta}{E\left[(1+2\alpha)\rho + (3+4\alpha)(5+6\alpha) - 2\sqrt{3+4\alpha}(5+6\alpha)\right]}. \blacksquare$$

B.12 Proof of Theorem 8

Divide politicians' utilities in the extension by $(1+\delta)$. Such normalization does not change any result.

Observe that Theorems 1 and 4 hold under the alternative setting that $\lambda p\left(\pi_i(t_i)\right)$ in politicians' utilities is replaced by $h\left(\pi_i(t_i)\right)$ where $h(1) - h(0) = \lambda$ and h is a weakly increasing function. Given residents' voting strategy, politicians' utilities in the extension can be rewritten as the sum of economic utilities ($U(c_i, g_i)$ or $T + t_i k_i$) and h. Thus, it suffices to prove that h in this extension satisfies two properties that $h(1) -$

[63] This is because the left-hand side is negative, whereas the right-hand side is positive.

$h(0) = \lambda$ and h is a weakly increasing function.

To begin with, it is easily verified that the residents in country 1 vote for the incumbent (the new candidate) if $\pi_1(t_1) > \rho$ ($\pi_1(t_1) < \rho$). Thus,

$$h(1) = \frac{\delta}{1+\delta} b; h(0) = -\frac{\delta}{1+\delta} \frac{(x_i^* - x_{iL}^*)^2}{2},$$

which implies that

$$h(1) - h(0) = \frac{\delta}{1+\delta}\left[b + \frac{(x_i^* - x_{iL}^*)^2}{2}\right] = \lambda.$$

Furthermore, it is straightforward that h is a weakly increasing function.

Therefore, we obtain the theorem. ■

B.13 Proof of Theorem 9

Welfare under the benevolent policymaker: When $\lambda = 0$, the benevolent type maximizes country 1's welfare. On the contrary, from Definition 2, in the right-wing populism equilibrium, the benevolent type chooses a tax rate different from that maximizing welfare. Hence, welfare under the benevolent policymaker in the right-wing populism equilibrium is smaller than that when $\lambda = 0$.

Welfare under the leviathan policymaker: When $\lambda = 0$, the leviathan type maximizes the tax revenue. On the contrary, from Definition 2, the right-wing populism equilibrium is a separating equilibrium and in separating equilibria, the leviathan type maximizes the tax revenue. Hence, the tax rate chosen by the leviathan type in the right-wing populism equilibrium is the same as that when $\lambda = 0$, implying that welfare under the leviathan policymaker is the same.

Therefore, country 1's expected welfare in the right-wing populism equilibrium is smaller than that when $\lambda = 0$. ■

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Chapter 5. International Capital Market and Repeated Tax Competition

1. Introduction

Since the seminal work of Zodrow and Mieszkowski (1986) and Wilson (1986), many studies have examined the inefficiency in the tax competition environment. When a country increases its tax rate, the outflow of the tax base generates a positive fiscal externality. As a result, tax competition induces an inefficiently low tax rate and a low public service level [Wildasin (1989)]. In addition to this, a further source of inefficiency is inherent in the tax competition economy. A change in a country's tax rate affects the price of capital and, thus, other countries' returns on trade in capital, generating a terms-of-trade externality [DePeter and Myers (1994)]. Because the loss in terms of resource allocation is too big to ignore, measures to rectify inefficient tax policies have been sought.[1]

No matter which distortion a government faces, the potential for long-term tax cooperation is well known. Thus, the repeated interaction models of tax competition provide a better perspective on the conditions under which efficient tax coordination is sustainable.[2] This study follows existing works on the repeated interaction model of tax competition, but focuses on the role of endogenous capital supply, which enables us to examine whether the improvement of access to international capital market enhances or blocks interregional tax cooperation within a country. Previous studies using the repeated game model assume that the total amount of capital with which governments compete is constant, under all circumstances, which means the elasticity of capital supply is always zero. However, this assumption is not necessarily realistic. Considering that the source of capital is savings, it is natural to think that the amount of capital depends on the interest rate. In addition, if we assume some regions in a country compete over capital, the amount

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[1] For instance, the loss of resources caused by tax competition has been measured as equivalent to 5% to 8% of total public expenditure [Wildasin (1989), Parry (2003)].

[2] The first repeated tax competition model was presented by Cardarelli et al. (2002), who show that a smaller disparity between countries makes it easier to achieve tax coordination. Kawachi and Ogawa (2006) extended this model to incorporate the benefit spillovers of public goods. In the latter case, the authors show that the cooperative outcome tends to be realized as the magnitude of the spillovers becomes significant. Taugourdeau (2004) and Catenaro and Vidal (2006) use the Leviathan tax competition model with repeated interactions to show that tax coordination is not sustainable when region sizes are too different. Itaya et al. (2008) isolate the issue of capital allocation from the problem of public goods by assuming there are no public goods in the economy. In this way, they show that a larger disparity between countries makes it easier to achieve tax coordination. Then, Itaya et al. (2014, 2016) and Wang et al. (2017) extend the analysis to deal with partial coordination in a three-country repeated game model. Kiss (2012) shows that introducing an agreement on a lower bound for admissible tax rates triggers a “race to the bottom”, thereby worsening the status of all countries. Eggert and Itaya (2014) present a model in which countries are allowed for renegotiation in the tax harmonization process. Wang et al. (2014) and Ogawa and Wang (2016) examine how the existence of an equalization transfer system affects the sustainability of tax cooperation. Prior to these studies, Coates (1993) investigated the open-loop equilibrium of a dynamic game of property tax competition.

invested in the country by the international capital market will change according to the domestic interest rate, which is determined by interregional tax competition. As such, we can interpret the magnitude of the capital supply elasticity as a proxy for a country's degree of integration in the international capital market: if the elasticity is zero (infinity), countries are completely isolated from (integrated with) the global capital market.

Some studies on tax competition have incorporated the endogenous supply of capital, finding that it sometimes plays an important role, urging modifications to the accepted and standard views.[3] While empirical evidence provides mixed results on the magnitude of the capital supply elasticity with respect to the interest rate, it proves that this elasticity is not zero, at least in the long run. Assuming the trend of globalization captured by market integration will continue and, thus, the capital supply of a country will not be constant, this study examines whether the link to the international capital market enhances interregional tax cooperation within a country. The results show that improved access to the international capital market works towards achieving interregional policy cooperation by reducing incentives for wasteful competition within a country. Conversely, the more closed the domestic capital market is, the more each region has an incentive to deviate from the cooperative tax setting.

The rest of this paper is organized as follows. In Section 2, we present the basic model. Then, Section 3 presents a one-shot Nash equilibrium, and Section 4 presents a model of symmetric repeated tax competition. In section 5, the analysis is extended to the case of asymmetric tax competition, in which the asymmetry is captured by the difference between the initial endowments of capital between two regions within a country. Section 6 concludes the paper.

2. Model

Environment. This study analyzes a small country that is integrated with the international capital market. The country is very similar to that presented in Petchey and Shapiro (2002) and Petchey (2015), which consists of two symmetric regions $(i = 1, 2)$, where each region contains homogeneous residents, normalized to 1. The two regions compete for investment by domestic and overseas investors. We begin by describing the symmetric

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[3] For instance, Keen and Kotsogiannis (2002) find that the elasticity of the capital supply critically affects the relationship between horizontal and vertical fiscal externalities in a federation. Eichner and Runkel (2012) verified that capital supply elasticity plays an important role in the efficiency of policymaking in a decentralized economy with mobile capital and spillovers among jurisdictions. Petchey (2015) shows that the efficiency in a decentralized policy setting depends on the capital supply elasticity in a large, open economy with mobile capital and public bads. See also Bucovetsky and Wilson (1991), Yakita (2014), and Wang and Ogawa (2018) for an analysis of tax competition with an endogenous capital supply.

regions in their simplest form, deferring a discussion on asymmetric regions until later.

We assume that residents have a high attachment to where they live, and so do not migrate between regions. A resident in each region is endowed k units of capital, which is invested in one of the two regions or in the international capital market, depending on the net return to the investment. Regional governments compete for the investment by choosing their capital tax rates.

Production. The production of private goods in region i requires capital and labor, along with technology that exhibits constant returns to scale. The per capita production function in region i is given by $y_i = f(k_i)$, where k_i is the amount of capital per capita used in region i. A firm's profit is given by $\pi_i = f(k_i) - rk_i - t_i k_i - w_i$, where r is the price of capital, t_i is the unit tax on capital employment imposed by the regional government, and w_i is the wage. Profit maximization gives $w_i = f(k_i) - k_i f_k(k_i)$ and $r = f_k(k_i) - t_i$, which yields the capital demand function, $k_i = k(t_i, r)$.

Domestic capital market. The supply function of capital in the country is expressed in reduced form, and is assumed to be linear in the interest rate: $2k + c \times (r - r^*)$, where r is the interest rate (rate of return) the country can offer, r^* is a given rate of return determined in the world capital market, and $c(\geq 0)$ is the responsiveness of the capital supply to the interest differential, which has a positive relation with the capital supply elasticity with respect to the gap in interest rates [Eichner and Runkel (2012) and Wang and Ogawa (2018)].[4] If $r = r^*$, capital of $2k$ units in the country is invested in one of the domestic regions. However, if $r < r^*$, some of the capital will flow out from the domestic market. Conversely, if $r > r^*$, capital flows from overseas, attracted by high domestic interest rates compared to the interest rate in the world market. This setting allows us to deal with the endogenous supply of capital without modelling savings.

If $c = 0$, the model reduces to the standard capital tax competition model, in which the capital market of the country is closed to the international market and, thus, the total amount of capital in the two regions is constant. As the parameter c increases, the capital supply responds sensitively to the interest rate. Here, c can be interpreted as a proxy for the connection between the domestic market and the international capital market. The larger the value of c, the more the country's market is open to the international market.

The capital market equilibrium for the two-region economy is reached when the sum

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[4] Although we assumed the linear supply function for simplicity, this assumption might be justified for two reasons. First, the supply function of each investor living outside the country can be convex or concave. If there is a sufficiently large number of investor, then the total supply function would be approximately represented by the linear supply function. Second, the linear supply function of capital would be obtained if the external investors incur a convex sunk cost when investing abroad, which has been widely assumed in the models of tax competition (Bacchetta and Espinosa, 1995; Cardarelli et al., 2002).

of the capital demand in the two regions is equal to the total capital supply:

$$k_1(t_1, r) + k_2(t_2, r) = 2k + c \times (r - r^*). \tag{1}$$

To obtain a clear solution, we specify the form of production as $f(k_i) = (A - k_i)k_i$, where A represents the productive efficiency.[5] Under this specification, we have

$$r = \frac{A}{1+c} + \frac{r^* c}{1+c} - \frac{4k + t_1 + t_2}{2(1+c)}. \tag{2}$$

$$k_i = \frac{k}{1+c} - \frac{r^* c}{2(1+c)} - \frac{t_j - t_i + 2(A - t_i)c}{4(1+c)}. \tag{3}$$

Budget constraint. A resident's preference in region i is given by $U_i = c_i$, where c_i is the consumption of a private numeraire good. A resident in region i receives labor income $w_i \left(= f^i(k_i) - k_i f_k^i(k_i)\right)$, a return on her capital investmentrk, and a lump-sum transfer from the regional governmentg_i. Hence, the budget constraint of the resident is given as follows:

$$c_i = w_i + rk + g_i. \tag{4}$$

The government in each region can only use a unit tax on mobile capital. Thus, the government budget constraint in region i becomes

$$g_i = t_i k_i. \tag{5}$$

3. One-shot game

3.1. Nash Equilibrium

Using (4) and (5) with $w_i = f^i(k_i) - k_i f_k^i(k_i)$ and $r = f_k(k_i) - t_i$, the resident's utility can be written as $U_i = f(k_i) - r(k_i - k)$. This means the resident's utility is equal to the per capita domestic product minus the payment for capital borrowing. The government in each region is assumed to be benevolent, and maximizes the utility of a representative resident of the region by selecting a capital tax rate. The maximization problem is given by

$$\max_{t_i} U_i = f(k_i) - r(k_i - k)$$

where r and k_i are given by (2) and(3). Because the capital investment in a region

[5] The production function is assumed to be quadratic, so that the marginal product of capital is a linear function of the capital labor ratio. Although this is a strong assumption, it has been often used in the literature to get analytical solutions. See Keen and Konrad (2013, p.270).

could be made from abroad, the regional governments have an incentive to manipulate the rate of return in the country. Thus, they consider the tax effect on the domestic interest rate, r, but are sufficiently small that they cannot affect the rate of return in the international capital market, r^*. Solving the problem, we obtain the following tax rates in the Nash equilibrium:

$$t_1^N = t_2^N = \frac{\Omega\, c}{2c^2 + 4c + 1}. \tag{6}$$

where $\Omega \equiv A - 2k - r^*$. In (6), the superscript N denotes the *Nash* equilibrium. Substituting (6) into (2) and (3), we obtain the price of capital in the country and the capital allocation in the Nash equilibrium:

$$r^N = r^* + \frac{\Omega(2c+1)}{2c^2 + 4c + 1}, \tag{7}$$

$$k_1^N = k_2^N = k + \frac{\Omega(2c+1)c}{2(2c^2 + 4c + 1)}. \tag{8}$$

Here, (8) shows that the regions in the country import capital in equilibrium (i.e., $k < k_i^N$) if $\Omega > 0$, where productivity A is sufficiently high and the world interest rate r^* is sufficiently small. In contrast, the regions export capital (i.e., $k > k_i^N$) if $\Omega < 0$. In the following analysis, we focus on the case of $\Omega > 0$, assuming an emerging economy that invites investment from the international capital market. However, we do not exclude $\Omega \leq 0$.

From (6), we find that the regional governments choose a positive (non-positive) tax rate on mobile capital if $\Omega > 0$ ($\Omega \leq 0$). The reason for taking such a sign is simple. When $\Omega > 0$, the two regions import capital from the international capital market. In this case, they prefer a low interest rate in order to curtail interest payments. Since the rate of return (interest rate) has a negative relation with the tax rate, as in (2), in order to induce low interest rates, the regional governments have an incentive to use tax to manipulate the interest rate and set positive tax rates. The opposite holds if $\Omega < 0$, in which regions export capital. In this case, they choose a negative tax rate in order to increase the interest rate, which yields greater capital income. Furthermore, there is no incentive to manipulate interest rates using tax if the two regions do not export and import capital ($\Omega = 0$).

Using the equilibrium values, the utility in the one-shot Nash game is obtained as

$$U_1^N = U_2^N = \frac{\Omega^2(2c+1)(2c+3)c^2}{4(4c + 2c^2 + 1)^2} + k(\Omega + r^*) + k^2. \tag{9}$$

3.2. Tax Coordination

The condition for a cooperative outcome in the two regions can be found by maximizing the sum of the utilities:

$$\max_{\{t_1,t_2\}} W = U_1 + U_2.$$

The first-order conditions are

$$\frac{\partial W}{\partial t_1} = \frac{t_2 - (2c^2 + 4c + 1)t_1 + 2c\Omega}{4(c+1)^2} = 0,$$

$$\frac{\partial W}{\partial t_2} = \frac{t_1 - (2c^2 + 4c + 1)t_2 + 2c\Omega}{4(c+1)^2} = 0.$$

When $c = 0$, the optimal choices of t_1 and t_2 yield $t_1 = t_2$, suggesting that the common cooperative tax rate is indeterminate. However, if $c > 0$, the coordinated tax rate is determined uniquely by

$$t_1^C = t_2^C = \frac{\Omega}{2+c}. \tag{10}$$

suggesting that $\partial t_i^C/\partial c < 0$ if $\Omega > 0$, and $\partial t_i^C/\partial c \geq 0$ otherwise.

Here, we mention two particular features of our result. First, in previous studies that assume a constant capital supply ($c = 0$), the optimal tax rate for cooperation is not determined uniquely [Itaya et al. (2008)]. That is, as long as two governments set identical tax rates, any common tax rate that provides a positive interest rate maximizes the sum of the utilities, because this is tantamount to maximizing the total output of the economy. The condition for total output maximization is that the marginal products of capital are equal, which holds when the two tax rates are identical. However, in this study, in addition to total output maximization, tax coordination is used to attract investment from abroad. Therefore, it is necessary to coordinate the two tax rates to induce the domestic interest rate to the desired level for both regions in a same country. As a result, the interest rate under the cooperative regime is given as follows:

$$r^C = r^* + \frac{\Omega}{2+c}. \tag{11}$$

Second, a comparison of (6) and (10) reveals that $t_i^C - t_i^N = \Omega(c+1)^2(c+2)^{-1}(4c + 2c^2 + 1)^{-1}$, which shows that the equilibrium tax rate is lower (higher) than the cooperative tax rate, $t_i^C > (<) t_i^N$, if $\Omega > (<) 0$. The reason why there is a tax gap between t_i^C and t_i^N is explained by the existence of externalities: Suppose $\Omega > 0$, in which two regions import capital from the international capital market. When a region decreases its tax rate to invite capital, it increases the net of tax price of capital, r, $\partial r/\partial t_i < 0$. The region reducing its tax rate takes into account the fact that changing its capital tax increases r and that this will have an impact on its payments for capital imports. However, an increase in r will also have a negative impact on the other region by increasing other region's payment for capital imports, and this is not accounted for by a region changing its capital tax. Therefore, the regional governments choose inefficiently low tax rates in the Nash equilibrium, which means a coordinated increase in capital tax is required. The reason for having $t_i^C < t_i^N$, if $\Omega < 0$ can be explained in the same way.

Using (10) and (11) with (3), the amount of capital in the cooperative phase is determined as follows:

$$k_1^C = k_2^C = k + \frac{\Omega c}{2(c+2)}, \tag{12}$$

which can be used with (10) and (11) to obtain the utility levels in the cooperative phase:

$$U_1^C = U_2^C = \frac{c\Omega^2}{4(c+2)} + k(\Omega + r^*) + k^2. \tag{13}$$

From (9) and (13), we easily find that $U_i^C > U_i^N$.

4. Repeated Game

We now consider a repeated game between the two regions. The discount factor of region i is denoted by $\delta_i \in [0,1)$. We assume that each region cooperates in tax competition on the current stage if the other region cooperated in the previous stage. If a region defects, then the cooperation between two regions collapses, triggering the punishment stage and indicating that the Nash equilibrium persists forever.

As usual, $\hat{\delta}_i$ exists as the critical value of δ_i for region i so that they choose a cooperative tax rate: for all $\delta_i \geq \hat{\delta}_i$, region i chooses the cooperative tax rate, t_i^C, while for $\delta_i < \hat{\delta}_i$, the cooperative outcome cannot be supported. The critical value of δ_i is obtained by

$$\hat{\delta}_i = \frac{U_i^D - U_i^C}{U_i^D - U_i^N}. \tag{14}$$

where U_i^j, for $j = C, D, N$. The superscripts C, D, and N denote the utility levels of cooperation, deviation by region i, and punishment phases, respectively. Given that the rival region's tax rate is t_j^C, the best-deviation tax rate of region i, t_i^D, maximizes the utility of region i's residents. The tax rate can then be derived as follows:

$$t_i^D = \frac{\Omega(2c^2 + 4c + 1)}{(2c+1)(2c+3)(c+2)}. \tag{15}$$

Since $t_i^D < (>) t_i^C$, the government in each region deviates from the cooperative tax rate by reducing (increasing) its tax rate when $\Omega > (<) 0$. From (15) and (2)—(3), we obtain the interest rate and the amount of capital in region i as

$$r^D = r^* + \frac{\Omega(4c^2 + 9c + 4)}{(2c+3)(2c+1)(c+2)}, \tag{16}$$

$$k_i^D = k + \frac{\Omega(2c^2 + 4c + 1)}{2(c + 2)(2c + 3)}. \tag{17}$$

respectively. From (15)—(17), the utility level of region i when region i deviates and region j maintains a cooperative tax rate is

$$U_i^D = \frac{\Omega^2(2c^2 + 4c + 1)}{4(2c + 3)(2c + 1)(c + 2)^2} + k(\Omega + r^*) + k^2. \tag{18}$$

Substituting (9), (13), and (18) into (14) allows us to obtain the threshold of the discount factor in each region i, as

$$\hat{\delta}_i = \hat{\delta}_j = \frac{(2c^2 + 4c + 1)^2}{8c^4 + 32c^3 + 39c^2 + 14c + 1}. \tag{19}$$

where $\lim_{c \to 0} \hat{\delta}_i = 1$ and $\lim_{c \to \infty} \hat{\delta}_i = 0.5$. From(19), our main finding can be summarized as follows.

Proposition 1.
Tax coordination may be easier to achieve as the responsiveness of capital supply with respect to the interest rate increases: $\hat{\delta}_i$ is continuously decreasing in c: $d\hat{\delta}_i/dc < 0$.
Proof.
From (19),

$$\frac{d\hat{\delta}_i}{dc} = -\frac{2(c + 1)(2c^2 + 4c + 1)(2c^2 + 4c + 3)}{(8c^4 + 32c^3 + 39c^2 + 14c + 1)^2} < 0.$$

■

Proposition implies that an improvement of the access of the domestic capital market to (from) the international market increases the possibility that the regions in the country can sustain tax cooperation. The mechanism behind the result can be explained by considering the incentive to deviate from tax cooperation. From (10) and (15), the extent to which each region deviates from a cooperative tax rate is obtained by

$$t_i^C - t_i^D = \frac{2\Omega(c + 1)^2}{(2c + 3)(2c + 1)(c + 2)}. \tag{20}$$

which gives

$$\frac{\partial\left(t_i^C - t_i^D\right)}{\partial c} = \frac{2\Omega(4c^4 + 16c^3 + 25c^2 + 20c + 7)}{(4c^3 + 16c^2 + 19c + 6)^2}. \tag{21}$$

First, assume $\Omega > 0$, in which two regions import capital from the international capital market. Then, (20) and (21) show that each region has incentive to reduce its tax rate from the coordinated level, $t_i^C > t_i^D$ but such incentives are reduced as the domestic market becomes more integrated with the international capital market, $\partial\left(t_i^C - t_i^D\right)/\partial c < 0$. The reason is as follows. When a region deviates and decreases its tax rate to invite capital, the domestic interest rate, r, is increased, which causes a large amount of capital inflow when c is large. Increased interest rates and large capital inflows increase payment for capital imports, which discourage the region to deviate from cooperative tax rate. In contrast, when c is zero (or sufficiently small), increased interest rate induced by the tax reduction does not change capital imports (very much). Then, there will be no (less) significant increase in payments for capital imports although there is an increase in payment for the rise in interest rates. Hence, when c is small, the regions do not care much about the increase in payment for capital import, which gives stronger incentive for them to deviate from tax cooperation.[6]

To put it differently, as the domestic capital market strengthens its tie with global markets, each region reduces incentives to manipulate interest rates. In our model, the domestic interest rate can be manipulated unilaterally with tax policy, which gives incentives for the regional governments to deviate from the tax cooperation. Such manipulation creates an interregional externality that shifts part of the cost of the policy onto other regions. However, gains from self-oriented policies relative to coordination are likely to be minor when the domestic capital market is involved in the global market. That is, as c increases, domestic interest rate converges to the interest rate in the international capital market, and thus, regional governments lower incentive to set tax rate different from cooperative tax rate.[7] In other words, as the domestic market strengthens ties with global market, the strategic usage of capital tax becomes less effective in manipulating the domestic interest rate, lowering the incentive to deviate from tax cooperation.

5. Asymmetric Regions

The analysis in the previous section assumes that all regions in a country have identical technology and initial endowment of capital. This assumption is well justified when analyzing the equilibrium efficiency, because it avoids the distributional issues due to regional disparities. This assumption is also reasonable because the differences between regions in one country are much smaller than those between countries. However, some studies have examined the effects on the equilibrium outcome of regional asymmetries in terms of preferences, technology, and initial endowments (Bucovetsky, 1991). In this section, we provide an example that is useful for examining the effects of regional

[6] Similar logic applies to the case of $\Omega < 0$ because $t_i^D > t_i^C$ and $\partial\left(t_i^D - t_i^C\right)/\partial c < 0$ hold. Therefore, the larger the value of c, the easier it is for regional governments to achieve cooperative solutions.

[7] This can be confirmed from (7) and (20)that $r \to r^*$ and $t_i^N \to t_i^C$ as $c \to \infty$.

asymmetries on the possibility of achieving tax coordination. This is not merely a formal generalization with which to consider regional asymmetry, but also an examination of the robustness of the results obtained.

The basic setup and notation of the previous sections are preserved here, except for the initial endowment of capital. Now, we assume that the initial capital in the country, $2k$, is owned by the residents in region 1, and that the residents in region 2 have no initial capital as an endowment. This assumption makes it possible to simplify expression and to show the effects of regional disparity in the most extreme form. In this setting, the residents of region 1 gain capital income by investing their money in region 2 (and, possibly, abroad), while the residents of region 2 must import capital from region 1 and from international capital markets.[8] Since the analysis is based on the model in sections 3 and 4, the description of the results will be brief.

5.1. Equilibrium

Nash equilibrium. In the one-shot Nash equilibrium, the tax rates in regions 1 and 2 are chosen as

$$t_1^N = \frac{\Omega\, c}{4c + 2c^2 + 1} - \frac{k}{c+1} \text{ and } t_2^N = \frac{\Omega\, c}{4c + 2c^2 + 1} + \frac{k}{c+1},$$

respectively. Hence, the capital-rich region chooses a lower capital tax rate than that of the capital-poor region: $t_1^N - t_2^N = -2k/(c+1) < 0$. This result is induced by the pecuniary externality or the terms-of-trade effect (DePeter and Myers, 1994; Itaya et al., 2008; Ogawa, 2013). Since the tax rate and the domestic interest rate have a negative relationship, the capital-exporting region 1 attempts to increase the capital price by selecting a lower tax rate. In contrast, the capital-importing region 2 prefers a lower capital price and, thus, selects a higher tax rate.

Using the equilibrium tax rates, we obtain the utility levels in the Nash equilibrium as follows:

$$U_1^N = \Omega^2 \frac{c^2(2c+3)(2c+1)}{4(4c+2c^2+1)^2} + k^2 \frac{(2c+1)(2c+3)}{4(c+1)^2} + \Omega k \frac{17c + 16c^2 + 4c^3 + 4}{2(c+1)(4c+2c^2+1)} + 2kr^*, \qquad (22)$$

$$U_2^N = \Omega^2 \frac{c^2(2c+3)(2c+1)}{4(4c+2c^2+1)^2} + k^2 \frac{(2c+1)(2c+3)}{4(c+1)\text{^}2} + \Omega k \frac{c(2c+3)(2c+1)}{2(c+1)(4c+2c^2+1)}. \qquad (23)$$

The utility gap in the Nash equilibrium is given as

$$U_1^N - U_2^N = \frac{k\Omega\,(7c + 4c^2 + 2)}{(c+1)(4c+2c^2+1)} + 2kr^*.$$

---

[8] The same situation can be reproduced by assuming the interregional gap in productivity or population.

Cooperative outcome. When two regions cooperate to maximize the total utility in the country, the tax rates must be set as

$$t_1^C = t_2^C = \frac{\Omega}{2+c}. \tag{24}$$

Without depending on the regional asymmetries, the cooperative tax rate is identical between the two regions. This is simply because the cooperative tax rate is required to maximize the sum of the output and the capital income of the two regions. The utilities in regions 1 and 2 in the cooperative equilibrium are

$$U_1^C = \frac{c}{4(c+2)}\Omega^2 + k^2 + k\Omega\frac{c+3}{c+2} + 2kr^*, \tag{25}$$

$$U_2^C = . \frac{c}{4(c+2)}\Omega^2 + k^2 + k\Omega\frac{c+1}{c+2}. \tag{26}$$

respectively, which suggest there is the utility gap in the cooperative outcome:

$$U_1^C - U_2^C = \frac{2k\Omega}{c+2} + 2kr^* \tag{27}$$

When region 1 deviates. Assume that the government in region 1 deviates from the tax cooperation, while the government in region 2 keeps choosing t_2^C. In this case, the tax rate chosen by region 1 is given by

$$t_1^D = \frac{\Omega\,(4c+2c^2+1) - 4k(c+2)(c+1)}{(2c+3)(2c+1)(c+2)}. \tag{28}$$

When region 1 deviates from the tax cooperation, the utility of the residents in region 1, U_1^D, is obtained as follows:

$$U_1^D = \frac{\Omega^2(4c+2c^2+1)^2}{4(2c+1)(2c+3)(c+2)^2} + \frac{4k^2(c+1)^2}{(2c+3)(2c+1)} + \frac{2\Omega k(14c+10c^2+2c^3+5)}{(2c+1)(2c+3)(c+2)} + 2kr^*, \tag{29}$$

where the superscript D denotes that region 1 deviates from the tax cooperation, while region 2 maintains the tax cooperation.

When region 1 deviates. Finally, assume that region 2 deviates from the tax cooperation, while the government in region 1 keeps choosing t_1^C. In this case, the tax rate chosen by region 2 is given by

$$t_2^D = \frac{\Omega\,(4c+2c^2+1) + 4k(c+2)(c+1)}{(2c+3)(2c+1)(c+2)}. \tag{30}$$

Then, we have

$$U_2^D = \frac{\Omega^2(4c+2c^2+1)^2}{4(2c+1)(2c+3)(c+2)^2} + \frac{4k^2(c+1)^2}{(2c+3)(2c+1)} + \frac{2\Omega k(c+1)(4c+2c^2+1)}{(2c+1)(2c+3)(c+2)}, \tag{31}$$

where U_2^D is the utility of the residents in region 2 when region 2 deviates from the tax cooperation, while region 1 chooses the cooperative tax rate.

5.2. Repeated Game

Using (22)-(31) with (14), the minimum discount factors to sustain tax cooperation are obtained as follows:

$$\hat{\delta}_1 = \frac{(c+1)^2(2c^2+4c+1)^2[2(c+2)k+\Omega(1+c)]^2}{\Delta_1\Phi_1}. \tag{32}$$

$$\hat{\delta}_2 = \frac{(c+1)^2(2c^2+4c+1)^2[2(c+2)k-\Omega(1+c)]^2}{\Delta_2\Phi_2}. \tag{33}$$

where

$$\Delta_1 \equiv k(c+2)(16c+8c^2+7)(4c+2c^2+1) - \Omega(c+1)(14c+39c^2+32c^3+8c^4+1),$$

$$\Phi_1 \equiv k(c+2)(4c+2c^2+1) - \Omega(c+1)^3,$$

$$\Delta_2 \equiv k(c+2)(16c+8c^2+7)(4c+2c^2+1) + \Omega(c+1)(14c+39c^2+32c^3+8c^4+1),$$

$$\Phi_2 \equiv k(c+2)(4c+2c^2+1) + \Omega(c+1)^3.$$

To determine which region has a greater incentive to deviate from tax cooperation, we compare two critical discount factors:

$$\hat{\delta}_1 - \hat{\delta}_2 = \frac{4k\Omega(2c+3)(2c+1)(c+2)(4c+2c^2+1)^2(c+1)^3\Gamma}{\Delta_1\Phi_1\Delta_2\Phi_2}, \tag{34}$$

where $\Gamma \equiv \Omega^2(18c+41c^2+32c^3+8c^4+2)(c+1)^2 + 2k^2(16c+8c^2+5)(4c+2c^2+1)(c+2)^2 > 0$. From (34), we obtain the following result.

Proposition 2.

Assume $\Omega > (\leq) 0$. Then, the capital-poor region 2, which imports capital, has a greater (smaller) incentive to cooperate than the capital-rich region 1 does, $\hat{\delta}_1 > (\leq) \hat{\delta}_2$.

Proposition 2 has a possible link with the result of Itaya et al. (2008), who show that a capital importer has a stronger incentive to cooperate when the cooperative tax rate is positive, but a weaker incentive to do so when the rate is negative. The result shown in Proposition 2 is analogous to their result, but advances the analysis. A major weakness of the result of Itaya et al. (2008) is that the cooperative tax rate is indeterminate. Therefore, they cannot identify the level at which the cooperative tax rate is set, or the kind of external environment that is likely to lead regions to choose a positive or negative cooperate tax rate. In our study, we show that the cooperative tax rate is determined uniquely: when the regions in the country import capital from the international capital market ($\Omega > 0$), the cooperative tax rate is positive; however, the rate is negative when the capital owners of the regions in the country invest abroad ($\Omega < 0$). Hence, the analysis succeeds in identifying the environment that determines the level of the cooperative tax rate, and therefore, we can identify the condition that determines which region has a greater incentive to deviate from cooperation.

Furthermore, our analysis in this section makes it possible to show our main result in Section 4 still holds in asymmetric tax competition. That is, the market integration increases the possibility that domestic interregional cooperation is maintained, even if we allow regional asymmetries.

Corollary.

Assume region 1 is endowed with $2k$ units of capital, while region 2 is endowed with nothing. Tax coordination between the asymmetric regions becomes easier as the capital supply elasticity with respect to the interest rate, c, increases.

For reference purposes, Fig. 1 shows the critical discount factor, $\hat{\delta}_i$, when $\Omega = 0.2 > 0$. Here, as shown in Proposition 2, the capital-rich region 1 is more likely to deviate from tax cooperation than is region 2, $\hat{\delta}_1 > \hat{\delta}_2$. In this case, tax cooperation between the two regions is more likely to be achieved if the possibility of region 1 cooperating increases. Fig 1 shows that $\hat{\delta}_1$ decreases as c increases, suggesting that an increase in c enhances the tax coordination between the asymmetric regions.

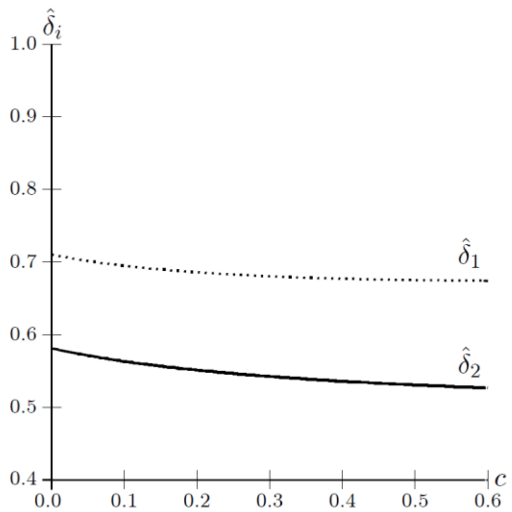

Figure 1. Changes in the critical discount factors, $\hat{\delta}_i$, with c, when $\Omega > 0$.
($\Omega = 0.2, k = 1,$ and $A - r^* = 2.2$)

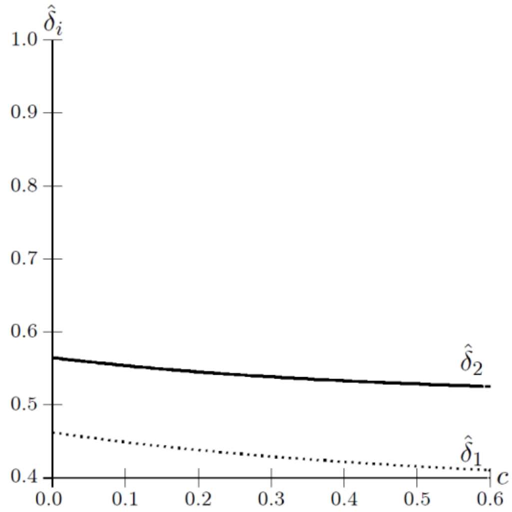

Figure 1. Changes in the critical discount factors, $\hat{\delta}_i$, with c, when $\Omega < 0$.
($\Omega = -0.2, k = 1,$ and $A - r^* = 1.8$)

Fig. 2 shows the critical discount factor, $\hat{\delta}_i$, when ($\Omega = -0.2 < 0$. As Proposition 2 suggests, in this case, region 2 is more likely to deviate from tax cooperation than is region 1, $\hat{\delta}_1 < \hat{\delta}_2$. Fig. 2 also shows that an increase in c enhances tax coordination by decreasing $\hat{\delta}_2$.

Intuitively, a higher value of c means it is more likely that the two regions will cooperate in choosing t_i^C, as explained in Section 4. First, suppose the target country imports capital from the international capital market,$\Omega > 0$. In this case, $t_1^C > t_1^D$ and $\partial\left(t_i^C - t_i^D\right)/\partial c < 0$, meaning that region 1 has an incentive to deviate from the cooperative tax rate by reducing its tax rate, but this incentive becomes weaker as the market integration increases (see Appendix A). If c is sufficiently small (e.g., zero), there is little, or no capital inflow from the international capital market. Thus, region 1 exports its capital to region 2. In this case, region 1 has a significant incentive to increase the domestic interest rate by lowering its tax rate from the cooperative tax level in order to receive higher capital income. However, when c is sufficiently large, there is a significant capital inflow from abroad, and therefore, the export from region 1 to region 2 decreases. Since capital export to region 2 decreases, region 1 receives relatively small capital income, which induces region 1 to have less incentive to raise interest rates. The weaker incentive to raise the interest rate means region 1 has less of an incentive to deviate from tax cooperation.

Next, we consider the case of $\Omega < 0$. As Proposition 2 shows, region 2 has a greater incentive to deviate from tax cooperation, $\hat{\delta}_1 < \hat{\delta}_2$. This can be explained using a similar mechanism. In this case, since $t_2^D > t_2^C$ and $\partial\left(t_i^D - t_i^C\right)/\partial c < 0$, region 2 has an incentive to deviate from the cooperative tax rate by increasing its tax rate, but that such incentives become weaker as market integration increases (see Appendix B). Since region 2 has no capital endowment, it always imports capital. However, the capital owned by region 1 is more likely to flow out to the international market when $\Omega < 0$. In such a case, region 2 has two incentives to manipulate the interest rate: (i) to decrease the domestic interest rate (by increasing the tax rate) in order to reduce the cost of borrowing capital; and (ii) to increase the interest rate (by lowering the tax rate) in order to prevent capital outflows from region 1 to abroad. When c is small, the incentive to increase the tax rate from (i) outweighs the incentive to reduce the tax rate in (ii), because the capital outflow to the international market is not sensitive to a change in the domestic interest rate. In this case, region 2 has a greater incentive to deviate from the cooperative tax rate by increasing its own tax rate. This lowers the interest rate, which benefits region 2 by reducing its interest payments. In contrast, when c is high, region 2 has less of an incentive to deviate by increasing its tax rate, because the capital outflow is sensitive to the change in the domestic interest rate. Therefore, a reduction in the interest rate, accompanied by a tax increase, would have a significant negative impact, causing the outflow of capital from the country to accelerate. Therefore, region 2 has less of an incentive to deviate from tax cooperation by choosing a higher tax rate when c is large.

In all cases, the incentive for tax cooperation increases as the domestic capital market strengthens its ties with the international capital market. Thus, our main result (Proposition 1) is preserved. In addition, the market opening contributes to the reduction of regional disparity. From (27), we can easily find that $\partial(u_1^C - u_2^C)/\partial c < 0$, suggesting that opening up the domestic market not only solves the inefficiency of the tax setting by encouraging tax cooperation, but also improves regional equity.[9]

6. Concluding Remarks

This study proposed a repeated tax competition model with an endogenous capital supply to examine whether a link to the international capital market enhances interregional tax cooperation within a country. The results show that tax cooperation between regions in a country is more likely to be achieved when the country is integrated with the international capital market.

The paper succeeds in presenting the theoretical hypothesis about the effects of integration in international markets on policy coordination within a country. In addition

[9] This result holds even if the initial capital endowment is generally assumed to be $\bar{k}_1$ and $\bar{k}_2$, where $\overline{k_1} + \bar{k}_2 = 2k$; $\partial(u_1^C - u_2^C)/\partial c = -\left(\overline{k_1} - \bar{k}_2\right)\left(A - \bar{k}_1 - \bar{k}_2 - r^*\right)/(c+2)^2 < 0$.

to this, it also contributes to solve an issue faced by previous research: In the repeated tax competition models, the cooperative tax rate is not uniquely determined, which causes the problem that makes the analysis of government size and welfare difficult in the cooperative phase (Itaya et al, 2008). In this paper, we propose a model in which the cooperative tax rate is uniquely determined, so that the tractability of repeated interaction model of tax competition is improved.

Previous tax competition studies have argued that inefficiencies in decentralized policymaking increase with tax competition accompanied by market integration, which encourages competition to lower taxes on capital *between* countries. In contrast, we show that integration with the capital market enhances the incentives for tax coordination *within* a country. A stronger connection to the international capital market decreases the regional incentive to manipulate domestic interest rates, which increases the incentive for the regions in the country to cooperate when setting tax rates.

Our results show that an outside market encourages regional governments within a country to cooperate. That is, because regional governments have a common purpose of manipulating the domestic interest rate to invite investment from the international market, they cooperate to set the tax rate within the country.

In conclusion, we mention two assumptions made in this study. First, the model is restricted to the case of two countries. A model with $n(>2)$ symmetric regions can be formulated, and in such a case, the regions will be more likely to cooperate since the larger the number of regions in the country, the less each region can manipulate capital price in the domestic market, thus giving less incentive for each region to deviate from the cooperation. Extensions to the case of more than three asymmetric regions might change our results, but this makes our analysis too complicate as we need to account for any combinations of partial cooperation [Itaya et al. (2016)]. The second is that we here rely on a notion of standard repeated-game equilibrium backed by a simple trigger strategy. Another equilibrium concept we may be able to apply is weakly renegotiation-proof equilibrium (WRPE), where regions can communicate and renegotiate the agreements. Although some studies, i.e., Pecorino (1999, p.128), have shown that the employment of the WRPE concept would only affect the result in a quantitative sense, the extension allowing renegotiation and changing the punishment period will be one of the tasks for the future research.

Appendices

Appendix A.

When $\Omega > 0$, from (24) and (28), we have

$$t_1^C - t_1^D = \frac{2(c+1)[2k(c+2)+\Omega(c+1)]}{(2c+3)(2c+1)(c+2)} > 0,$$

which gives

$$\frac{\partial(t_1^C - t_1^D)}{\partial c} = -\frac{2[\Omega(c+1)(13c+12c^2+4c^3+7)+2k(8c+4c^2+5)(c+2)^2]}{(4c^3+16c^2+19c+6)^2}.$$

Appendix A.

When $\Omega < 0$, from (24) and (30), we have

$$t_2^D - t_2^C = \frac{2(c+1)[2k(c+2)-\Omega(c+1)]}{(2c+3)(2c+1)(c+2)} < 0,$$

which gives

$$\frac{\partial(t_2^D - t_2^C)}{\partial c} = -\frac{2[\Omega(c+1)(13c+12c^2+4c^3+7)-2k(8c+4c^2+5)(c+2)^2]}{(4c^3+16c^2+19c+6)^2}.$$

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