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Optimal Taxation and Public Provision With Political Preferences*

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The views stated in this thesis are those of the author and not necessarily those of the supervisor, second assessor, Erasmus School of Economics or Erasmus University Rotterdam.

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Contents

1 Introduction

It has been long established that deadweight losses from distortionary labour income taxation depend on the behavioural response of taxpayers to changes in taxes. The link between the elasticity of labour supply and excess burden of taxation has already been well-established by works such as Saez (2001). However, while multiple studies have attempted to calculate these elasticities for various countries, so far limited evidence exists regarding cross-sectional differences in labour supply responses to taxation. As of yet, the drivers of tax base elasticities are unclear, however new evidence shows that ideological and preference differences between taxpayers may have a significant effect on the labour supply response to taxation. This makes for a promising new avenue of research and one which could have significant policy relevance. Another related issue is how public provision of certain goods may act as a counter-measure to the ill effects of taxation by fostering labour supply, which dates back to the works of Blomquist and Christiansen (1995) and others in the context of publicly provided private goods.

Prompted by the new experimental evidence in Huet-Vaughn, Robbett, and Spitzer (2019) on differences in behavioural responses to taxation and public spending between different political alignment groups, this paper devises a model of optimal taxation to study these effects further. The key research question it intends to answer is to what extent behavioural responses linked to political alignment and preferences for redistribution affect the optimal tax policy, and to what extent targeted public provision can be used to affect the behavioural responses to taxation. The intention of this paper is to provide intuition regarding how both tax policy as well as public spending can take into account the above-mentioned effects, which could have potentially major implications for policy-making. Moreover, our findings can provide arguments for better taxpayer-expenditure matching, especially in countries where policy is mainly influenced by economic elites like the United States (Gilens & Page, 2014).

The main model discussed in this paper explores how differences in political alignment, in addition to ability-heterogeneity, affect the optimal policy package in a social planner setting. The aims of this approach are: to determine how certain results depend on both the type and strength of preferences, to build a baseline model to study these effects, and to provide intuition for future research. The main assumptions of the model are that individuals' political alignment determines the extent of their preferences for redistributive taxation, as well their preferences for provision of public goods. As a result, we are able to study several important mechanisms, which can provide relevant policy insights. More specifically, the model follows a 2x2 structure with two ability and two political alignment types. The

political alignment types are differentiated by their preferences for redistribution as well as a certain public good, which is provided by the government. We make the clear distinction that left-wing taxpayers derive some utility from the payment of taxes itself whereas right-wing taxpayers do not. This allows us to study how a preference for redistribution may affect the behavioural response to taxation, which we show by deriving the relevant elasticities. Regarding the public good, we study how an ideological match between a right-wing agent and a public expenditure may provide an incentive to target public provision in such a way as to alleviate a part of the labour tax distortions, which is modelled after the above-mentioned literature on public provision of private goods.

We find that a preference for redistribution may indeed lead to a lower responsiveness of the labour supply to changes in taxation. This follows from the fact that labour effort provides additional utility to left-wing individuals through their anticipated tax payment for the period. This effect additionally depends on the strength of the redistributive preference, which is exogenous in our model. Moreover, the effect is stronger for high-earners as clearly their tax payment is larger and, drawing parallels to the single-crossing property of Spence-Mirrlees, a higher willingness to work at all levels of net and gross income implies a stronger redistributive motive at all times as well. These findings reaffirm the conclusions reached by Rick, Paolacci, and Burson (2018) and Huet-Vaughn et al. (2019) who find significant effects of political alignment and broadly defined preferences for redistribution on the behavioural response to taxation.

Furthermore, we show that work complementarity of public goods provides incentive for the government to target their provision to individuals with higher labour supply distortions of taxation, which will lead to lower tax distortions for the affected groups and improve the policy package. This effect is strengthened by the size of right-wing tax bases as well as by stronger work complementarity effects of the goods. Moreover, the revenue effect from additional induced labour effort results in self-financing of the public good in question. Thus, our analysis can indeed have implications regarding the composition of public spending and may provide incentives to obtain information regarding taxpayers' preferences with respect to government expenditures. Such targeted provision mechanisms are not new and can be traced to tax competition literature, where targeted spending on public inputs leads to productivity gains within certain tax bases as discussed by Keen and Marchand (1997) and Wilson (2005). Moreover, we illustrate a mechanism similar to the one discussed by Blomquist, Christiansen, and Micheletto (2008, 2010) in the context of publicly provided private goods, where we find similar effects regarding work complementarity and targeted provision.

The main model in this paper is also contrasted with an electoral competition setting in

which two political parties set their policies in such a way as to win the election, which we base on the paper of Lindbeck and Weibull (1987). Here, the results are compared with the social planner solution in order to establish the extent to which electoral competition reduces efficiency with regards to the relevant policy variables. We find sub-optimal policies in all respects and analyse factors, which affect the extent of these inefficiencies in our setting. We also explore how possible voter coalitions along political alignment, akin to political parties, may affect outcomes under electoral competition and find potential positive effects with regards to the tax policy components, which move closer to the optimum. However, we also see evidence of negative effects in some cases, especially with regards to public provision.

The rest of the paper is structured as follows. Section 2 summarises the relevant literature. Section 3 establishes the main model. Section 4 derives and discusses the social planner solution for public provision and taxation. Section 5 presents the electoral competition setting and derives the subsequent results. Section 6 compares outcomes from sections 4 and 5. Finally, section 7 concludes.

2 Literature review

There is an extensive body of past literature regarding optimal taxation and public provision. Especially relevant is the literature linking public provision to labour supply distortions, which relates directly to the concepts discussed in this paper. Moreover, we present a brief overview of political economy literature related to the above concepts, which helps us interpret results in sections 6 and 7 of this paper.

Most of the modelling aspects within this paper can be linked to the large body of optimal taxation literature. For example, the two-type model in Stiglitz (1982) or Stern (1982) forms the theoretical basis for using two ability levels and two political alignments, albeit within the context of linear taxation. Another particularly useful resource is Jacobs (2019), which covers all the basics of optimal tax modelling and is particularly useful for interpreting results for tax policy components. Moreover, Diamond (1975) importantly illustrates how the marginal social utility of private income can be used to better understand first order conditions for optimal taxation. This resource is particularly useful for interpreting our results for optimal lump-sum transfer, which forms an integral part of tax policy. In his paper, Feldstein (1972) shows how equity effects can be included in the setting of optimal prices by a public enterprise and, by defining the redistribution motive of the government, helps us to better interpret our results for optimal taxation.

Optimal public provision literature dates back to Samuelson (1954), which illustrates the well-known condition for optimal provision of public goods. Later literature on the

marginal cost of funds (MCF) such as Stuart (1984) derives the marginal welfare costs of income taxation empirically, while Snow and Warren (1996) provide additional guidance with regards to the calculations. Moreover, Ballard and Fullerton (1992) clarify existing literature on the topic and provide intuition with regards to the magnitude of MCF. Some other literature that also considers the labour supply effects of public provision with regards to distortionary taxation is Lindbeck (1982) and Snow and Warren (1989), with an emphasis on 'budget effects' of taxation arising from collateral changes in taxes and various forms of public spending. Another important body of literature covers the elasticity of taxable income. Of particular interest are the works of Feldstein (1999) and Saez (2001), as well as Gruber and Saez (2002), which illustrate the significance of behavioural responses of taxation and provide further intuition for the results described in this paper. Lastly, the targeted provision aspects of this paper can be linked to several works in tax competition, such as Keen and Marchand (1997), who illustrate that targeting spending towards public inputs may increase the tax base by fostering productivity of mobile capital. Moreover, Wilson (2005) illustrates inefficiencies in the composition of public spending due to similar mechanisms.

Direct inspiration for this paper comes from the growing literature on the effects of ideology on the labour supply. The experimental work of Rick et al. (2018) illustrates that the distortionary effects of taxation depend on the taxpayers' attitudes towards redistribution and government intervention, which directly relate to the concepts discussed in this paper. Huet-Vaughn et al. (2019) experimentally show that compared to no match, an ideological match between taxpayer and public expenditure lowers the elasticity of labour supply for self-declared political 'moderates' and illustrate a lower elasticity of labour supply for 'liberals'. This is also linked to Lamberton, De Neve, and Norton (2013) who show that taxpayer preferences play an additional role in tax compliance. Lastly, Carpenter and Gong (2016) show that work effort in organisations with a well-defined mission depends positively on ideological match between the worker and the mission, which can be substituted for performance pay for mismatched individuals.

Of particular relevance to this paper is also the existing body of literature on public provision of private goods. Relevant theoretical work such as Blomquist and Christiansen (1995), Pirttilä and Tuomala (2002) and particularly Blomquist et al. (2008, 2010) help illustrate how target provision of certain private goods, particularly those which are complementary to work such as child care, may alleviate a portion of existing labour market distortions of income taxation and allow for the setting of optimally high tax rates. The same mechanism is used in this paper to model targeted provision of certain public goods. These works also manage to shed light on why particularly high levels taxation in Scandinavian countries are sustainable, which is also covered in empirical literature such as Rogerson (2006) and Kleven

(2014).

Furthermore, a large part of this paper benefits from a variety of literature within the scope of political economy. In their seminal paper, Lindbeck and Weibull (1987) illustrate how balanced budget redistribution can be a result of electoral competition between two political parties. Moreover, they provide interpretation of both the principle of minimum differentiation and Director's law in a multidimensional setting. Their main results are consistent with the large body of electoral competition literature in the spirit of Hotelling (1929) and Downs (1957), where parties set the same platform and target the median or 'swing' voters. More insight is provided by Wittman (1983) who shows that diverging party platforms are also possible if parties care about implementing their most preferred policies. Moreover, Persson, Roland, and Tabellini (2000) show how public good provision depends on the type of political system, which is also illustrated by Lizzeri and Persico (2001) in the context of electoral systems. This is of particular relevance when contrasting the social planner solution for public provision with the outcomes of electoral competition.

Finally, some relevant papers on special-interest groups provide further intuition for our results regarding voter coalitions in the context of Downsian electoral competition. The important theoretical work of Grossman and Helpman (1996) builds a model of electoral competition with special-interests and shows how interest groups may influence election results as well as policies. Bardhan and Mookherjee (2000) further analyse how certain factors affect the extent to which the electoral process is captured by special-interest. Moreover, empirical work of Goldberg and Maggi (1999) provides supporting evidence for the model of Grossman and Helpman in the context of United States trade protection in 1983. Lastly, Claessens, Feijen, and Laeven (2008) show that campaign contributions have a significant effect on policy and result in substantial economic costs.

3 The model

We assume an economy of infinitely small one-person households living for one period with the population normalised to 1. The mass of individuals is divided into two separate political alignment groups j, which we denote with the subscripts l for left-wing and r for right-wing. We also have heterogeneous ability $i = 1, 2$, which results in productivity w_i. We assume frictionless labour markets and that individuals are always paid a wage equal to their productivity. For simplicity, we choose a model with two distinct levels of ability: $w_1 < w_2$, following the intuition in Stern (1982) and Stiglitz (1982). Here, w_1 is the hourly wage of low-ability individuals and w_2 is the hourly wage of high-ability individuals. Based on the two political alignments and two ability levels, we therefore have four groups with

four different combinations of political alignment and ability. An individual supplies labour, denoted by h_{ij}, which can be thought of as the hours worked. Therefore, an individual's gross income can be described as the product of the hours worked and the hourly wage: $z_{ij} = w_i h_{ij}$, where the double subscript $ij = 1l, 1r, 2l, 2r$ reflects that the choice of labour supply (and therefore the gross income) depends on both the agent's ability as well as his or her political alignment. The reason why this is the case will be explained below. Lastly, each agent uses their labour income to finance the consumption of a generic good c_{ij}. Additionally, we assume that ability and therefore the wage rate is independent of political alignment.[1]

In the model, the political alignment groups differ in both their attitudes towards income taxation as well as in the effect a publicly provided good R has on their utility and labour choices. The pure public good R is provided free-of-charge by the government and financed through a linear labour income tax with rate t. The choice of a linear tax system is dictated by the multidimensional heterogeneity aspect of the model. In the model, R is considered a more right-wing good and thus yields direct utility to right-wing agents, but no (dis)utility to left-wing agents. We could think of R as a good such as defence spending, which we assume would be preferred by the right-wing agents and have a negligible effect on left-wing agents' utility.[2] Then, even though a right-wing agent is considered more averse to redistributive taxation, they can recognise that revenue from taxes can be used to finance certain agencies or institutions they care about; Lamberton et al. (2013) show that expenditure preferences play a significant role in tax compliance. Consequently, we also assume that good R is complementary to labour (for right-wingers) and therefore $\frac{\partial h_r}{\partial R} > 0$ by assumption, which illustrates the incentive to work in order to indirectly fund preferred institutions through income taxes. We base this on the evidence in Huet-Vaughn et al. (2019), which suggests that the ideological match between taxpayer and tax expenditure can have a significant effect on resulting tax distortions by affecting the labour supply. In other words, labour supply distortions are lower if the taxpayer likes the tax expenditure, which is exactly the setting presented here. Moreover, Blomquist et al. (2008, 2010) illustrate how a good's complementarity to work can lead to lower labour tax distortions via the same mechanism.[3]

[1] This could very well not be the case in real life as political values may have an effect on one's productivity in an organisation depending on the identity match between employee and principal and thus affect the wage through incentive pay, etc. (see e.g. Carpenter & Gong, 2016).

[2] While this aspect of the model is somewhat stylised, the main role of R is to illustrate targeted provision by the government in order to alleviate labour market distortions introduced by the income tax. Hence, it is simpler to think of R as exclusive to right-wingers who have no preference for redistribution and face the higher distortions of the two groups. Ultimately, if the public good yields positive utility to the left-wing group as well, then the arguments for public provision are made even stronger.

[3] In Huet-Vaughn et al. (2019), a significant effect of ideological match is only found for 'moderates', so those who identify neither as 'liberal' nor 'conservative'. Therefore, the right-wing group in this paper can be thought of as moderates with preferences for typically right-wing tax expenditures (such as defence),

The left-wing agents, while unaffected by R, have a preference for redistribution and therefore derive additional positive utility from paying taxes, which we weigh with parameter $\delta > 0$ in the left-wing utility function. This effect is based again on Huet-Vaughn et al. (2019), who show lower labour supply elasticities (wrt tax) for 'liberals', and Rick et al. (2018) who provide evidence for enhanced motivation amongst those with positive attitudes towards redistribution and government intervention. Then, while deriving no direct utility from the public good, 'left-wingers' derive direct utility from tax payments instead, which are an easy way for individuals to observe the extent of redistribution. This effect is included in the left-wing utility function as direct utility from the individual's total tax payment for the period.[4]

The government implements a linear income tax system with rate t and a non-individualised transfer (lump-sum tax) T. It also chooses the level of R it provides.

We can now start by defining the agent utility functions for each political alignment group separately.

$$U_l = u(c_i) - v(h_{il}) + \delta g\left(t w_i h_{il}\right), \qquad u_c, v_h, g_h > 0,\ u_{cc}, -v_{hh}, g_{hh} < 0, \tag{1}$$

$$U_r = u(c_i) - v(h_{ir}, R) + g(R), \qquad u_c, v_h, g_R > 0,\ u_{cc}, -v_{hh}, g_{RR} < 0. \tag{2}$$

The utility functions are additively separable between utility from consumption $u(c)$, the disutility from working $v(h)$ and direct utility $g(.)$ from either the aggregate tax payment (left-wingers) or good R (right-wingers). $g(.)$ is additionally multiplied by δ for left-wingers to illustrate the degree to which they prefer redistribution. The utility function $u(.)$ is increasing and concave in c; $v(.)$ is increasing and convex in h, which are the standard conditions. Direct utility $g(.)$ is increasing and concave in h for left-wingers and R for right-wingers. Lastly, the disutilty from working for right-wingers is denoted as $v(h, R)$, which illustrates R's complementarity to working. We also assume that the (marginal) disutility from working decreases in R, such that $v_R < 0, v_{hR} < 0$. We then have the regular household budget constraint, where consumption is equal to the sum of net-of-tax income and the non-individualised lump-sum transfer T.

$$c_{ij} = (1 - t) w_i h_{ij} + T. \tag{3}$$

Using the above ingredients we can consequently set up the following household problem

which is more in line with experimental evidence. As the paper shows, 'moderates' have a higher elasticity of labour supply than 'liberals', which preserves the dichotomy used in this model.

[4]Another way this aspect could be modelled is by including the aggregate tax payment of the whole population in the individual utility function. However, due to possible complications in later derivations we elect to not use this approach.

by choosing c and h such as to maximise private utility subject to the household budget constraint.

$$\max_{\{c_i,h_{ij}\}} \mathcal{L} = U_{ij} + \lambda_{ij}[(1-t)w_i h_{ij} + T - c_{ij}].$$

From the household problem we obtain the following first order conditions:

$$u_c(c_{ij}) = \lambda_{ij}, \tag{4}$$

$$v_h(h_{il}) = \delta g_h\left(tw_i h_{il}\right) tw_i + \lambda_{il}(1-t)w_i, \tag{5}$$

$$v_h(h_{ir}, R) = \lambda_{ir}(1-t)w_i. \tag{6}$$

Here, we can see that the marginal utility of consumption depends on the agent type and is equal to the private marginal utility of income λ_{ij}. The labour choice, however, is different for each agent as long as $\delta > 0$, which results in different relative prices of labour and consumption. After combining the FOCs for c and h we get the following MRS conditions:

$$MRS^l = \frac{v_h(h_{il})}{u_c(c_{il})} = \frac{\delta g_h(tw_i h_{il})tw_i}{u_c(c_{il})} + (1-t)w_i, \tag{7}$$

$$MRS^r = \frac{v_h(h_{ir}, R)}{u_c(c_{ir})} = (1-t)w_i. \tag{8}$$

Then, we also have

$$MRS^l = MRS^r + \frac{\delta g_h(tw_i h_{il})tw_i}{u_c(c_{il})}. \tag{9}$$

Here, we can see the effect the redistributive preference of left-wingers has on the relative value of work. Consequently, we have that $MRS^l > MRS^r$, holding ability constant, because of positive marginal direct utility $g_h(.)$ and $\delta > 0$ as defined earlier. The term $\delta g_h(tw_i h_{il})tw_i/u_c(c_{il})$ is the value of marginal direct utility from the tax payment relative to the marginal utility of consuming c (for a left-winger); in other words, it is the marginal rate of substitution between direct utility $g(.)$ from paying taxes and utility from private consumption $u(c)$. As such, the higher the direct utility $g(.)$ compared to $u(c)$, the higher the relative value of working for the agent through the utility obtained via the payment of taxes (redistribution). The strength of this effect depends on δ as well as the tax and wage rates. In case $\delta = 0$ (no preference for redistribution), then naturally the MRS conditions would be identical for both types of agent. Because δ and w work in the same direction, a low-ability left-wing individual could value work similarly to a high-ability individual with right-wing preferences, which will depend on the magnitude of δ.[5] This expression also illus-

[5]With a sufficiently strong preference for redistribution, working could in itself yield net positive utility, which is why δ is implied to be fairly small and positive. With δ sufficiently low, the agent will always face

trates how the optimal choice of labour supply depends on both the ability type i as well as the political alignment j of the agent. Knowing that the choice between consumption and labour is affected by the preference for redistribution, we can also predict that agents will differ in their elasticities of labour supply, which we can define as follows:[6]

$$\varepsilon^u_{ht} \equiv \frac{\partial h^u}{\partial t}\frac{1-t}{h},\ \varepsilon^c_{ht} \equiv \frac{\partial h^c}{\partial t}\frac{1-t}{h} < 0, \tag{10}$$

where superscripts u, c denote the uncompensated and compensated variables, respectively.

We also define the relevant Slutsky equation for future reference:

$$\frac{\partial h_{ij}}{\partial t} = \frac{\partial h^c_{ij}}{\partial t} - w_i h_{ij}\frac{\partial h_{ij}}{\partial T}. \tag{11}$$

Proposition 1. *Given a positive tax rate t, the compensated tax elasticity of labour supply ε^c_{ht} for left-wingers decreases in redistributive preference δ.*

$$\frac{\partial \varepsilon^c_{h_l t}}{\partial \delta} < 0. \tag{12}$$

Proof. See Appendix A.1

This result follows from the fact that working is relatively cheaper for a left-wing agent, because of the additional benefit derived from the payment of taxes — a left-wing agent's labour supply does not only give him or her positive utility through income and the consumption of good c, but also through the act of working itself via the payment of income taxes. In this model we assume that the agent is forward-looking and anticipates the payment of income tax at rate t. As such, taxation has a different effect on the left-wing agent's utility through the distortion of relative prices and thus results in a lower compensated elasticity of labour supply wrt the tax. Consequently, the excess burden of taxation, which depends on the tax rate and the elasticity of taxable income will also be lower for left-wingers and thus allow the government to sustain a higher level of taxation (see Feldstein, 1999; Saez, 2001). As highlighted in some literature, the elasticity of taxable income is a central parameter of tax policy, thus personal preferences of taxpayers which may affect it need to be studied carefully (Gruber & Saez, 2002). Finally, it is worth remembering that the extent to which the government can use this knowledge to reduce distortions from labour income taxation will depend on the size of each group within the population as well as the strength of the redistributive preference in the left-wing groups.

a disutility from working, which is weighed against the utility from consumption.

[6] Subscripts ij are omitted.

Knowing the agents' first order conditions we can also derive the indirect utility functions $V(.) \equiv u(\hat{c}, \hat{h})$ of the exogenous variables, where hats indicate optimised values:

$$V_l(w_i, t, T, \delta) = u(\hat{c}_{il}) - v(\hat{h}_{il}) + \delta g\left(tw_i\hat{h}_{il}\right), \tag{13}$$

$$V_r(w_i, t, T, R) = u(\hat{c}_{ir}) - v(\hat{h}_{ir}, R) + g(R). \tag{14}$$

The corresponding derivatives with respect to the function variables are solved by using Roy's identity and the envelope theorem:

$$\frac{\partial V_{ij}}{\partial w_i} = \lambda_{ij}(1-t)h_{ij}, \tag{15}$$

$$\frac{\partial V_{ij}}{\partial t} = -\lambda_{ij}w_i h_{ij}, \tag{16}$$

$$\frac{\partial V_{ij}}{\partial T} = \lambda_{ij}, \tag{17}$$

$$\frac{\partial V_l}{\partial \delta} = g\left(tw_i\hat{h}_{il}\right), \tag{18}$$

$$\frac{\partial V_r}{\partial R} = -v_R(\hat{h}_{ir}, R) + g_R(R). \tag{19}$$

Lastly, we identify the standard MRS between public and private consumption using (19) as

$$MRS^R = \frac{\partial V_r/\partial R}{u_c(\hat{c}_{ir})} = \frac{g_R(R) - v_R(\hat{h}_{ir}, R)}{u_c(\hat{c}_{ir})} = \frac{g_R(R) - v_R(\hat{h}_{ir}, R)}{\lambda_{ir}}. \tag{20}$$

As indicated by hats, this condition holds at the optimum choice of labour effort and consumption, and represents the relative value of public and private consumption when individual behaviour is optimised. As the MRS increases, the relative value of public consumption increases, which should lead to an increase in consumption of the public good relative to the private good.

4 The social planner solution

We assume that the government aims to maximise social welfare by choosing t, T, R subject to its budget constraint, which equates the revenue from income taxes with the public expenditures: transfers T and provision of R. For simplicity, the cost of providing one unit of R is unity. We then obtain the following government budget constraint (GBC):

$$t\sum\nolimits_{\mathcal{N}} z_{ij}N_{ij} = T + R, \tag{21}$$

where, because the population size is normalised to 1, we multiply the income z_{ij} with the number of people in each group $N_{ij} < 1$. We also have that $z_{ij} = w_i h_{ij}$, where labour supply is a function of exogenous variables: $h_l(w_i, t, T, \delta)$, $h_r(w_i, t, T, R)$. For future reference, the ability-political-alignment combinations are provided in Table 1.

		Political alignment type	
		Left-wing (l)	Right-wing (r)
Ability type	Low (1)	1l	1r
	High (2)	2l	2r

Table 1: Matrix of ability and political alignment combinations

Next, we have the social welfare function (SWF), which aggregates the individual utility functions and weighs them, depending on the type of SWF used. Here, we opt for a simple utilitarian utility function, which weighs all utilities equally. Therefore, the SWF can be expressed simply as the sum of the indirect utility functions multiplied by their respective population shares N_{ij}:

$$\sum\nolimits_{\mathcal{N}} V_{ij} N_{ij}. \tag{22}$$

Then, we end up with the following government maximisation problem:

$$\begin{aligned} \max_{\{t,T,R\}} \mathcal{L} = [&V_{1l} N_{1l} + V_{2l} N_{2l} + V_{1r} N_{1r} + V_{2r} N_{2r}] \\ &+ \eta[tw_1 \left(h_{1l} N_{1l} + h_{1r} N_{1r}\right) + tw_2 \left(h_{2l} N_{2l} + h_{2r} N_{2r}\right) - T - R], \end{aligned} \tag{23}$$

where η is the multiplier on the GBC.

4.1 Optimal transfer T

From the Lagrangian, we obtain the following FOC:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial T} = &\frac{\partial V_{1l}}{\partial T} N_{1l} + \frac{\partial V_{2l}}{\partial T} N_{2l} + \frac{\partial V_{1r}}{\partial T} N_{1r} + \frac{\partial V_{2r}}{\partial T} N_{2r} \\ &+ \eta \left(tw_1 \left(\frac{\partial h_{1l}}{\partial T} N_{1l} + \frac{\partial h_{1r}}{\partial T} N_{1r} \right) + tw_2 \left(\frac{\partial h_{2l}}{\partial T} N_{2l} + \frac{\partial h_{2r}}{\partial T} N_{2r} \right) - 1 \right) = 0, \end{aligned} \tag{24}$$

which is comprised of both direct utility effects through the agents' budget constraint and income effects of providing T by affecting the labour supply and therefore tax revenue. By

using Roy's identity $\frac{\partial V_{ij}}{\partial T} = \lambda_{ij}$ and rearranging we obtain the following expression:

$$\sum\nolimits_{\mathcal{N}} \left(\lambda_{ij} N_{ij} + \eta t w_i \frac{\partial h_{ij}}{\partial T} N_{ij} \right) = \eta, \tag{25}$$

where $\lambda_{ij} N_{ij}$ is the direct utility effect of T on group ij and $\eta t w_i \frac{\partial h_{ij}}{\partial T} N_{ij}$ is the corresponding income effect ($\frac{\partial h_{ij}}{\partial T} < 0$). The net social benefit of the transfer (LHS) is equal to η, which represents the social cost of providing every individual with one extra euro of T. Thus, because our population is normalised to 1, the RHS is simply equal to η.

We can also derive the expression for the social marginal utility of income, also known as the *social welfare weight*, as defined in Diamond (1975):

$$b_{ij} = \frac{\lambda_{ij}}{\eta} + t w_i \frac{\partial h_{ij}}{\partial T}, \tag{26}$$

which represents the net increase in social welfare if an individual of type ij receives an additional euro. Then, by diving both sides of (25) by η we have at the optimum:

$$\sum\nolimits_{\mathcal{N}} N_{ij} \left(\frac{\lambda_{ij}}{\eta} + t w_i \frac{\partial h_{ij}}{\partial T} \right) = 1,$$

$$\rightarrow \bar{b} = \sum\nolimits_{\mathcal{N}} N_{ij} b_{ij} = 1. \tag{27}$$

The aggregate social welfare weight is equal to 1 at the optimum, because the net social benefit of private income for a population of size 1 should be equal to the cost of providing one euro of transfer T to one individual. Thus, after summing the welfare weights over all the groups, we obtain the above result. Intuitively, high-ability individuals will tend to have values of b_{ij} closer to zero due to their relatively low λ_{ij} and greater income effects (Jacobs, 2019, pp. 49–50). Conversely, low-ability individuals will tend to have values of b_{ij} closer to 1 due to both higher marginal utility of income and lower income effects.

4.2 The public provision optimum

We can continue by deriving the optimal level of provision of public good R. The FOC from the Lagrangian is as follows:

$$\frac{\partial \mathcal{L}}{\partial R} = \frac{\partial V_{1r}}{\partial R} N_{1r} + \frac{\partial V_{2r}}{\partial R} N_{2r} + \eta \left(t w_1 \frac{\partial h_{1r}}{\partial R} N_{1r} + t w_2 \frac{\partial h_{2r}}{\partial R} N_{2r} - 1 \right) = 0. \tag{28}$$

Rearranging, we obtain the following expression:

$$\underbrace{\frac{\partial V_{1r}}{\partial R}N_{1r} + \frac{\partial V_{2r}}{\partial R}N_{2r}}_{\text{indirect utility effect}} + \underbrace{\eta\left(tw_1\frac{\partial h_{1r}}{\partial R}N_{1r} + tw_2\frac{\partial h_{2r}}{\partial R}N_{2r}\right)}_{\text{self-financing effect}} = \eta. \tag{29}$$

We can additionally rewrite the indirect utility effect using the MRS in (20).

$$\frac{\partial V_r}{\partial R} = -v_R(\hat{h}_{ir}, R) + g_R(R) = \frac{g_R(R) - v_R(\hat{h}_{ir}, R)}{\lambda_{ir}}\lambda_{ir} = MRS^{iR}\lambda_{ir}. \tag{30}$$

Thus, we can decompose the indirect utility effect of R into two main components of the MRS. Firstly, we have the direct marginal utility $g_R(R)$, which is simply the additional utility obtained from public provision of an extra unit of the good. Secondly, we have $v_R(\hat{h}_{ir}, R)$, which represents the change in disutility from working due to R. Due to work complementarity, the disutility decreases in R, which is why the whole term becomes positive. Naturally, these effects are also weighted by the share of each ability group. The final expression is as follows:

$$\sum\nolimits_{\mathcal{N}}\left(N_{ir}MRS^{iR}\lambda_{ir}\right) + \eta\left(tw_1\frac{\partial h_{1r}}{\partial R}N_{1r} + tw_2\frac{\partial h_{2r}}{\partial R}N_{2r}\right) = \eta. \tag{31}$$

We can immediately draw parallels to the Samuelson condition, which is defined as $\sum MRS = MRT$. On the LHS we obtain a sum over the MRS between public and private utility multiplied by the group size and the marginal private utility of income, as well as the additional self-financing effect through work complementarity of R. The LHS therefore represents the social marginal benefit of one additional unit of R. On the RHS we have the GBC multiplier η, which converts the cost of providing one unit of R into social utils and can also be defined as the marginal social cost of one unit of public provision or the marginal social benefit of increasing the budget by one euro. The ratio between the social marginal value of one euro of public resources (η) and the social marginal value of private resources (LHS) is known as the marginal cost of public funds (MCF) (Jacobs, 2019, p. 131). As illustrated by Ballard and Fullerton (1992), replacing the MRT with the MCF is an important modification of the Samuelson condition, which allows for incorporating the negative effects of distortionary taxation, whereas MRT assumes that the marginal cost of public funds is always equal to one. Earlier, we also established that R is complementary to labour ($\frac{\partial h}{\partial R} > 0$). The additional self-financing effect portion of the above expression is therefore positive. As such, public provision of R offers benefits two-fold. Firstly, it leads to an increase in the utility of right-wingers through direct utility effects via $g(R)$ in the utility

function. Secondly, it increases welfare by reducing labour supply distortions via R's complementarity to labour. Because right-wing agents are (more) averse to redistribution and have a higher tax elasticity of labour supply, additional labour supply distortions arise within this group. However, they can be offset by 'bribing' the individuals with public provision of their preferred good — R.

In addition, by increasing labour supply, the public good becomes self-financing due to resulting higher revenue from labour taxation, which is weighted by the group's proportion in the overall population. While this is a standard effect already documented in literature, we are able to show a new effect through the MRS, which lowers the cost of working. Thus, we illustrate a new argument for public provision of certain goods based on labour supply effects which, as evidence suggests, are not limited to just publicly provided private goods, but can occur in more conventional public goods as well.

Proposition 2. *The optimal choice of the level of public provision takes into account the indirect utility effects as well as the self-financing effects of public provision. If the publicly provided good is complementary to labour and direct utility from its provision outweighs the disutility from additional labour effort it induces, then public provision carries no negative effects on social utility as both the indirect utility effect and the self-financing effect are always positive. The higher the proportion of the group benefiting from public provision, the stronger these positive effects are and the higher the incentive to provide the public good by the government.*

These findings are consistent with some previous work, which incorporates the marginal benefits of distortionary taxation via public provision of certain goods (Sepulveda, 2012; Blomquist et al., 2010). However, a novel characteristic of this approach is the incorporation of evidence regarding the work complementarity of pure public goods through 'ideological match', besides the already understood and documented scheme of public provision of private goods (see also Blomquist & Christiansen, 1995; Pirttilä & Tuomala, 2002). Furthermore, the concept of targeted provision can be linked to some tax competition literature such as Keen and Marchand (1997), where the composition of public spending is affected by 'bribing' of mobile tax bases (see also Wilson, 2005). Importantly, they find that by shifting public spending towards public inputs, the government can attract mobile capital by increasing its productivity, which in turn increases the tax base. Our results illustrate a similar fundamental reason for shifting spending towards certain goods, which is their effect on the labour supply. On the contrary, these results are in disagreement with some previous theoretical literature on the effects of public good provision, such as Lindbeck (1982), which suggests

an overall negative effect of public provision of 'collective goods' on the labour supply. However, these results generally follow from the notion that the provision of public goods leads to significant substitution effects between private and public utility, which are especially unlikely to be the case given goods such as defence spending or law enforcement, which cannot rival private consumption in terms of derived utility. Overall, the uncompensated change in labour supply is therefore likely to be positive, not negative as suggested by Lindbeck. Lastly, while not shown here, public provision which is more in-line with taxpayer preferences is likely to result in better tax compliance as illustrated in Lamberton et al. (2013). As shown by Chetty (2009), this has additional implications for the deadweight losses of taxation and thus could pose an additional argument for targeted public good provision.

4.3 Optimal tax policy

The first-order condition with respect to t has the following form:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial t} = &\frac{\partial V_{1l}}{\partial t}N_{1l} + \frac{\partial V_{2l}}{\partial t}N_{2l} + \frac{\partial V_{1r}}{\partial t}N_{1r} + \frac{\partial V_{2r}}{\partial t}N_{2r} \\ &+ \eta\left(w_1\left(h_{1l}N_{1l} + h_{1r}N_{1r}\right) + w_2\left(h_{2l}N_{2l} + h_{2r}N_{2r}\right)\right) \\ &+ \eta\left(tw_1\left(\frac{\partial h_{1l}}{\partial t}N_{1l} + \frac{\partial h_{1r}}{\partial t}N_{1r}\right) + tw_2\left(\frac{\partial h_{2l}}{\partial t}N_{2l} + \frac{\partial h_{2r}}{\partial t}N_{2r}\right)\right) = 0.\end{aligned} \tag{32}$$

Employing some familiar techniques, namely using Roy's identity $\frac{\partial V_{ij}}{\partial t} = \frac{\partial V_{ij}}{\partial M}\frac{\partial M}{\partial t} = -\lambda_{ij}w_i h_{ij}$ and the Slutsky equation in (11) we obtain the following expression:

$$\begin{aligned}&- \lambda_{1l}w_1h_{1l}N_{1l} - \lambda_{2l}w_2h_{2l}N_{2l} - \lambda_{1r}w_1h_{1r}N_{1r} - \lambda_{2r}w_2h_{2r}N_{2r} \\ &+ \eta\left(w_1\left(h_{1l}N_{1l} + h_{1r}N_{1r}\right) + w_2\left(h_{2l}N_{2l} + h_{2r}N_{2r}\right)\right) \\ &+ \eta\Bigg(tw_1\left(N_{1l}\left(\frac{\partial h^c_{1l}}{\partial t} - w_1h_{1l}\frac{\partial h_{1l}}{\partial T}\right) + N_{1r}\left(\frac{\partial h^c_{1r}}{\partial t} - w_1h_{1r}\frac{\partial h_{1r}}{\partial T}\right)\right) \\ &+ tw_2\left(N_{2l}\left(\frac{\partial h^c_{2l}}{\partial t} - w_2h_{2l}\frac{\partial h_{2l}}{\partial T}\right) + N_{2r}\left(\frac{\partial h^c_{2r}}{\partial t} - w_2h_{2r}\frac{\partial h_{2r}}{\partial T}\right)\right)\Bigg) = 0.\end{aligned} \tag{33}$$

Then, rearranging and invoking (26) we obtain the following:

$$
\begin{aligned}
&N_{1l}\left(1-\left(\frac{\lambda_{1l}}{\eta}+tw_1\frac{\partial h_{1l}}{\partial T}\right)\right)w_1h_{1l}+N_{2l}\left(1-\left(\frac{\lambda_{2l}}{\eta}+tw_2\frac{\partial h_{2l}}{\partial T}\right)\right)w_2h_{2l}\\
&+N_{1r}\left(1-\left(\frac{\lambda_{1r}}{\eta}+tw_1\frac{\partial h_{1r}}{\partial T}\right)\right)w_1h_{1r}+N_{2r}\left(1-\left(\frac{\lambda_{2r}}{\eta}+tw_2\frac{\partial h_{2r}}{\partial T}\right)\right)w_2h_{2r}\\
&+\frac{t}{1-t}N_{1l}w_1h_{1l}\left(\frac{\partial h^c_{1l}}{\partial t}\frac{1-t}{h_{1l}}\right)+\frac{t}{1-t}N_{2l}w_2h_{2l}\left(\frac{\partial h^c_{2l}}{\partial t}\frac{1-t}{h_{2l}}\right)\\
&+\frac{t}{1-t}N_{1r}w_1h_{1r}\left(\frac{\partial h^c_{1r}}{\partial t}\frac{1-t}{h_{1r}}\right)+\frac{t}{1-t}N_{2r}w_2h_{2r}\left(\frac{\partial h^c_{2r}}{\partial t}\frac{1-t}{h_{2r}}\right)=0.
\end{aligned}
\tag{34}
$$

Finally, by using the definition for compensated elasticity in (10), summing over political alignment and ability, and grouping terms we get the optimal tax result:

$$
\frac{t}{1-t}\sum\nolimits_{\mathcal{N}}N_{ij}w_ih_{ij}(-\varepsilon^c_{h_{ij}t})=\sum\nolimits_{\mathcal{N}}N_{ij}(1-b_{ij})w_ih_{ij},
\tag{35}
$$

where the LHS represents the efficiency losses of taxation and the RHS represents the equity gains from taxation. As we can see, both terms are summed over political alignment and ability and weighed with the population shares N_{ij}. Thus, the optimal tax result crucially depends on behavioural differences between groups as well as their respective shares in the population. We can further elaborate on the above result by redefining the RHS following intuition presented in Jacobs (2019, pp. 50–53) which itself is based on Feldstein (1972). Namely, we can define the marginal social value of redistribution (via the labour income tax) as the normalised covariance between the marginal social value of private income (b_{ij}) and gross labour income ($z_{ij}=w_ih_{ij}$). The reasoning behind this approach is that the covariance between b_{ij} and z_{ij} determines how both components vary with regards to each other. If high earners' income contributes little to social welfare, then the government has a greater propensity to redistribute income towards the low earners whose marginal social utility of income is larger, and vice versa. Then, we have the following:

$$
\xi\equiv\frac{-\mathrm{cov}[b_{ij},z_{ij}]}{\bar{b}\bar{z}}=1-\frac{\sum_{\mathcal{N}}N_{ij}b_{ij}z_{ij}}{\sum_{\mathcal{N}}N_{ij}b_{ij}\sum_{\mathcal{N}}N_{ij}z_{ij}},
\tag{36}
$$

where we know from (27) that $\bar{b}=1$. Then, finally we have that:

$$
\xi=\frac{\sum_{\mathcal{N}}N_{ij}(1-b_{ij})z_{ij}}{\sum_{\mathcal{N}}N_{ij}z_{ij}}>0.
\tag{37}
$$

From the formula we can easily infer how ξ is affected by the interaction of the components of the equation. Perhaps most importantly, the redistributive motive is positive and increases

in the strength of covariance between welfare weight and income, which is negative. This follows from the principle of decreasing marginal social utility of private income, which is still the case for a utilitarian SWF (constant weights on private utility). Because we assume decreasing marginal utility of consumption $u_{cc} < 0$, then even an equal valuation of individual utilities results in welfare weights decreasing in income. In other words, an additional euro of income yields less utility to high earners than to low earners, which is why social marginal utility of income decreases in income and why redistribution is preferred. Thus, because individual preferences are not linear (or quasi-linear) the preference for redistribution is positive. Here, the weight of each group in the redistributive preference additionally depends on its population share N_{ij}, which is implies that the most numerous groups have the largest effect on the level of taxation.

Finally, we can again rewrite the optimal tax expression by dividing both sides of (35) by the denominator in (37):

$$\frac{t}{1-t}\frac{\sum_{\mathcal{N}} N_{ij} z_{ij}(-\varepsilon^c_{h_{ij}t})}{\sum_{\mathcal{N}} N_{ij} z_{ij}} = \frac{\sum_{\mathcal{N}} N_{ij}(1-b_{ij}) z_{ij}}{\sum_{\mathcal{N}} N_{ij} z_{ij}}, \tag{38}$$

and defining $[\sum_{\mathcal{N}} N_{ij} z_{ij} \varepsilon^c_{h_{ij}t}][\sum_{\mathcal{N}} N_{ij} z_{ij}]^{-1}$ as the average income-weighted average compensated elasticity of labour supply $\bar{\varepsilon}^c_{ht}$, to obtain:

$$\frac{t}{1-t} = \frac{\xi}{-\bar{\varepsilon}^c_{ht}}. \tag{39}$$

Thus, we obtain an expression which is identical in structure to the classic efficiency-equity result described in past literature (e.g. Saez, 2001), which states that equity gains from redistribution must be weighed against efficiency losses from distortionary taxation. As such, at the optimum, the tax rate should strike a balance between both aspects in order to maximise social welfare. The difference here is that the compensated elasticity is also weighted by group size, which means that we can fully illustrate the effect behavioural differences between groups as well as their size have on the final result. We also know that $\varepsilon^c_{ht} < 0$ increases (becomes less negative) in δ, thus political alignment has a clear effect on the optimal tax rate. Consequently, a higher preference for redistribution amongst the left-wing groups will lead to an increase in the tax rate. This result has implications on the optimal level of taxation in real economies, which is quite significant. Most importantly, political alignment or, more specifically, attitudes towards redistribution and taxation turn out to be non-trivial components of optimal labour tax policy, at least in the linear case. This reinforces the policy relevance of the evidence from Huet-Vaughn et al. (2019) and Rick et al. (2018) previously cited in this paper. From the government's standpoint, an ideal

population composition from the taxation standpoint is one in which all individuals have left-wing preferences with a preferably top-heavy income distribution. Such a setting would consequently allow for the setting of optimally high tax rates and revenue generation at a relatively low efficiency premium.

Moreover, we have also demonstrated how another channel, namely public provision, can also help mitigate labour supply distortions through targeted provision of certain goods, which carry a net positive effect on the labour supply. This is a direct extension of the Blomquist et al. (2010) mechanism of public provision of private goods, which has a similar effect on the labour supply, albeit with a more obvious mechanism for work complementarity. Empirical evidence from Scandinavian countries suggests that public provision of certain goods is one of the mechanisms that allows the setting of high tax rates, which we also show (Rogerson, 2006; Kleven, 2014). What these results illustrate is that a setting where the preferences of taxpayers are ignored is generally inferior to one in which the government: 1. has accurate information regarding the social preferences, 2. makes use of this information by adapting the tax policy, 3. targets public spending such as to eliminate a part of the arising distortions.

In sum, in our model a higher tax is optimal if a larger proportion of the population has more left-wing or redistribution-favourable views, because the efficiency costs of taxation decrease. On the other hand, it is likely that the level of direct redistribution (through lump-sum transfer T) likely decreases, while more spending shifts towards providing targeted public goods. Through work complementarity, public provision in turn reduces the efficiency losses from income taxation and allows for the setting of higher optimal tax rates, all else equal.

5 Outcomes under electoral competition

In the main section of this paper, the emphasis was placed on normative economics and on illustrating how political preferences of taxpayers play a part in designing the optimal tax policy as well on planning tax expenditures. As we have seen, such a setting requires implementing certain assumptions — perhaps most importantly the fact that the government's ultimate goal is to maximise social welfare given a balanced budget requirement. Such a setting, while generally informative for policy making in the real world, certainly omits a variety of practical obstacles to achieving such an idealised outcome in practice like imperfect information or limited legislative power. In this section we will briefly cover existing theoretical evidence on taxation and public provision within the scope of electoral competition models. This will allow us to contrast our model with one in which political alignment plays

an additional role in elections, which ultimately have an effect on policy outcomes. We will also discuss the possible effects voter coalitions may have on the policy outcomes.

5.1 The electoral competition equilibrium

Firstly, let us turn our attention to the paper of Lindbeck and Weibull (1987), which illustrates how electoral competition can result in balanced budget redistribution between socioeconomic groups. The immediate similarities between the approach and what has been postulated in this paper are apparent, however, while Lindbeck and Weibull study the political mechanism through which a redistribution policy is reached, we are more concerned with the end result and deriving the optimum policy directly. Nevertheless, the emphasis on redistribution makes for an informative comparison between the two models and illustrates two different approaches to modelling redistributive taxation through political preferences. In the electoral competition model with two parties A and B, individuals maximise utilities of the form

$$u_i = \begin{cases} u_i(x,a) = v_i\left(w_i + x_{k(i)}\right) + a_i & \text{if A wins,} \\ u_i(y,b) = v_i\left(w_i + y_{k(i)}\right) + b_i & \text{if B wins,} \end{cases} \tag{40}$$

where x and y are redistributions, w_i is the gross income and a_i, and b_i are the utilities derived from other aspects of party platforms. Moreover, the population is divided into m groups and incomes are redistributed between the groups. Importantly, the parties treat a and b as random variables, which is a necessary condition for an equilibrium solution. Consequently, the authors formulate two special cases of voter preferences, which imply strictly different electoral outcomes. One such case is where party preferences are identical across the whole population. In this case the political equilibrium leads to an income distribution, which maximises the utilitarian sum of individual utilities — the same objective function used by the government in our model. This result is unsurprising and follows from the fact that a utilitarian SWF is apolitical and places equal weights on all individual utilities.[7] As such, our model could be thought of as a special case of electoral competition in itself, where heterogeneous party preferences are nonexistent. Of course, such a characterisation belies the fundamental assumptions of our model, however in the case where party preferences are independent of political alignment, the reasoning stands correct. The second special case, which requires identical consumption preferences across all individuals as well as identical party preferences within groups (and different preferences between groups), is shown to imply that the parties will aim to maximise the utility of the modal income earners while sacrificing

[7] While it could be argued that the choice of equal welfare weights is itself political, the utilitarian setting can be thought of as default, hence why equal preferences lead to the above result.

the utility of the low- and high-income groups assumed to have stronger political preferences. Moving onto the main results, the equilibrium solution is consistent with Hotelling's principle of minimum differentiation and implies $x = y$, that is the choice of redistributive policy is the same for both parties, which dates back to the Downsian model of electoral competition and is replicated frequently throughout literature (e.g. Downs, 1957; Larcinese, 2005).

The result in Lindbeck and Weibull is closely related to the median voter result in other literature, albeit due to the multidimensional component the interpretation is somewhat different. Nevertheless, the conclusions can be applied to our model in order to determine the equilibrium policy outcomes of electoral competition in our setting. Firstly, the preferences of our groups are related to both their level of ability as well as their political alignment, which determines their preferences for the level of taxation and public provision of R. Here, the assumption is that preferences for redistribution directly translate into party preferences, which is a necessary assumption for interpreting the result in the context of our model. It is also more realistic than assuming that e.g. left-wingers always vote for party A and right-wingers always vote for party B. Of course, in that case the parties would not have to compete at all and could set their platforms arbitrarily. Consequently, given these preferences, the political parties will target the swing voters by maximising the utility of the median voter in order to win a majority. Then, by Hotelling's law, they will both set the same platform, which was shown by Lindbeck and Weibull. Here, it is worth mentioning that diverging party platforms are also possible with electoral competition. For example, Wittman (1983) illustrates how implementing party preferences not only for winning but also for implementing their preferred platform can lead to diverging policies, which contradict the median voter result presented in Downsian models. Thus, we restrict our analysis to electoral competition consistent with the principle of minimum differentiation and median voter results. Other models, which result in diverging platforms, are not covered but such analysis could most likely provide important insights as well.

Before analysing whether a median voter policy is optimal we must first determine where the median voter lies within our model, that is which of the four groups of individuals is likely to contain the one with the median preference for the level of redistribution. In order to do that, we must order the groups in terms of their preferences such that we can determine where the median voter lies based on group sizes later on. Immediately, we can restrict further analysis to the middle groups, which are left-wing high-ability and right-wing low-ability while the remaining two groups are placed at the extremes. The relative price of work depends positively on the wage, thus high-ability individuals face a greater marginal effect of income taxation than the low-ability individuals. Thus, the left-wing low-income group prefers the greatest level of taxation and the right-wing high-income group prefers the lowest

level of taxation, given a non-individualised transfer T and some level of R. Therefore, we can begin by analysing the two middle groups based on their preferences for redistribution as well as their incomes, which also determine their preferred level of taxation. We can recall equation (16), which illustrates the effect of income tax on the indirect utility of the individual. Then, for the middle groups we have:

$$\frac{\partial V_{1r}}{\partial t} = -\lambda_{1r} w_1 h_{1r} = -\lambda_{1r} z_{1r}, \tag{41}$$

and

$$\frac{\partial V_{2l}}{\partial t} = -\lambda_{2l} w_2 h_{2l} = -\lambda_{2l} z_{2l}. \tag{42}$$

Thus, the effect of the tax depends on the individual parameter λ — the marginal private utility of income, and the gross income of the individual. Firstly, we know that the high-ability left-wing individuals have a higher gross wage than the low-ability right-wing individuals. This follows from the fact that high-ability individuals earn a higher hourly wage than the low-ability individuals. Moreover, the Spence-Mirrlees condition requires the high-ability individuals to provide more labour effort at all bundles of net and gross income. Thus, we can expect the high-ability group to always exert more effort than the low-ability group. Lastly, the left-wing group has an additional incentive to work due to its preference for redistribution, which yields positive utility from the payment of taxes and, as we have shown, leads to a lower elasticity of labour supply as well. Thus, even though the high-ability left-wing group may have a lower λ compared to the low-ability left-wing group, we assume that this effect is outweighed by the likely substantial difference in gross incomes. Additionally, the marginal private utility of income increases with δ for the left-wing groups, which dampens the difference between λ for the two groups. Thus, the effect of the income tax on utility should be higher for the high-ability left-wing group compared to the low-ability right-wing group. Consequently, the groups can be ordered as follows in increasing order of tax preference, ceteris paribus: high-ability right-wing, high-ability left-wing, low-ability right-wing, low-ability left-wing.

5.2 The median voter policies

In light of the above, the median voter can easily be found by looking at the size of the respective groups. Firstly, let us assume that all four groups are of equal size, that is $N_{1l} = N_{1r} = N_{2l} = N_{1r}$. Then, naturally, the median voter will lie somewhere between high-ability left-wing and low-ability right-wing. More generally, assuming identical ability

distributions within each political alignment group,[8] the median voter can lie in either of the four groups given a sufficiently extreme mixture of population characteristics. For example, with an overwhelming left-wing majority and extreme inequality such that nearly everyone is low-ability, the median voter will be low-ability left-wing. Of course, with relatively balanced group sizes the median voter will lie within the two middle groups, which we ensure by assuming $N_{ij} \leq 0.5$, that is no group constitutes more than half of the total poulation. Consequently, we can begin by analysing the redistributive policy, which maximises the utility of the median voter, in-line with the result illustrated by Lindbeck and Weibull. Consequently, we can write the government problem as follows:

$$\max_{\{t,T,R\}} \mathcal{L} = V_m + \eta[tw_1 \left(h_{1l}N_{1l} + h_{1r}N_{1r}\right) + tw_2 \left(h_{2l}N_{2l} + h_{2r}N_{2r}\right) - T - R], \tag{43}$$

where V_m is the median voter's indirect utility. The difference here is that the indirect utility term is not multiplied by the median group's size N_m, but by 1 which is the normalised population size. This is a realistic setting as it ensures that political parties do not ignore the remaining groups, which are also affected by their chosen policies. Instead, the parties ignore the other groups' *preferences* and act as if all individuals have the same preferences as the median voter. This ensures that the resulting platforms: 1) maximise the median voter's utility, and 2) are not superficially low by focusing on a small subset of the total population. In the case that the median voter's indirect utility were to be multiplied by the median group's size, the aggregate utility effects of all policies would be gravely underestimated, which would yield sub-optimal policies across the board. Lastly, in order to be able to draw parallels between the solutions it is important that a balanced budget setting is preserved, such that all spending must be backed up by proportional revenues, which is why the government budget constraint is identical as in the social planner section.

Next, we can immediately use our results for optimal transfer T and obtain the following expression:

$$\lambda_m + \eta \sum\nolimits_{\mathcal{N}} \left(tw_i \frac{\partial h_{ij}}{\partial T} N_{ij} \right) = \eta, \tag{44}$$

where λ_m is the marginal private utility of private income of the median voter. The interpretation is similar as before, namely we have λ_m, which is the utility gain to the median voter from a unit increase in T. On the LHS we also have the income effect of the transfer summed over all groups. Lastly, the RHS represents the cost of providing T in social marginal utility.

[8]Recall that political alignment is independent of ability type, therefore the income distribution within each group should reflect the population income distribution.

Immediately, we can see that the benefits of providing T are different than in the social planner solution, because we do not take into account the utility effects on all groups. Thus, the level of T will depend on how the preferences of the median voter differ from the average preferences of the whole population. Clearly, if the median voter has a higher λ than the group-size-weighted average, the level of T will be set higher than in the planner solution. For example, if the median voter is low-ability right-wing then their λ is likely to be higher than average, which will lead to a level of T higher than in the social planner solution. On the other hand, a high-ability left-wing median voter is likely to have a preference for T lower than average, which could even lead to a negative level of lump-sum transfer. This will be discussed in more detail in Section 6.

Next, we can look at the optimal provision of R, given the median voter policy. Interestingly, we will see that R may still be provided even if the median voter lies within a left-wing group, such that he or she does not derive any utility from the good. The reason this happens is because of the self-financing effect established earlier, which can potentially warrant public provision despite the costs involved. We can immediately use our result from earlier to obtain the following expression:

$$MRS^{mR}\lambda_m + \eta\left(tw_1\frac{\partial h_{1r}}{\partial R}N_{1r} + tw_2\frac{\partial h_{2r}}{\partial R}N_{2r}\right) = \eta, \tag{45}$$

where MRS^{mR} is the marginal rate of substitution between public and private utility for the median voter. Again, the net welfare gain from R is not summed over both right-wing groups, but instead the emphasis is on the median voter's utility. This affects the optimal level of R, because the welfare gain through the MRS will change depending on which group the median voter belongs to. In order to determine how the level of R will change in case of a low-ability right-wing voter, we need to compare the preferences for both right-wing groups, which are as follows:

$$MRS^{1r}\lambda_{1r} = g_R - v_R(\hat{h}_{1r}, R), \tag{46}$$

$$MRS^{2r}\lambda_{2r} = g_R - v_R(\hat{h}_{2r}, R). \tag{47}$$

The only difference is in the marginal disutility term, which means that the greater the reduction in disutility of working by provision of R, the higher the utility gain from the public provision. Consequently, knowing that high-ability individuals exert more effort, the marginal disutility from R will be greater for a high-ability individual compared to a low-ability individual. Thus, the low-ability individual will prefer less R than the high-ability individual. As we no longer sum the utility effects over the right-wing groups and instead

focus on the median voter's utility, the left-wing groups' preferences have no weight in the level of R and cannot drive the average MRS down. On the other hand, the solution is closer to the social planner optimum than if high-ability individuals were also taken into account.

As mentioned above, given a left-wing median voter such that $MRS^{mR} = 0$, there is still room for provision of R due to the self-financing effect portion of the above expression. Hence, we again have 'bribing', where the government can target public provision to a specific group and finance it with the additional income tax due to work complementarity of the good. The fact that this is still the case for a median voter policy is an important result and suggests that public provision may be warranted even if it does not affect the objective function, which would be the utility of a left-wing median voter. The policy implications of this result are that even in predominantly left-wing societies, one will still find right-wing goods due to their positive efficiency effects on the labour supply. On the other hand, goods which are substitutes for work should only be provided given sufficiently high indirect utility effects, as they cause additional distortions through loss of taxable income.

Lastly, we must look at how the result for optimal tax t changes for the median voter policy. Again, the objective function only contains the median group, while the budget constraint remains the same. Therefore, we end up with the following expression (see Appendix A.2 for derivation):

$$\frac{t}{1-t}\left(-\bar{\varepsilon}^{c}_{h_{ij}t}\right) = \frac{(\bar{z}-z_m) + t\left[\left(\sum_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T}\right) z_m - \sum_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} z_{ij}\right]}{\bar{z}}, \tag{48}$$

where $\bar{z}$ is the average income. As we can see, we no longer obtain the same expression as before. The first term on the RHS is the difference between average and median income, which illustrates the standard motive for income taxation in a median voter model. Then, the tax rate is higher if the median voter pays less tax than average, and vice versa. The second term illustrates the lost tax revenue from the difference between the income-weighted income effect and the income effect at $z_{ij} = z_m$. Here, a positive difference allows the government to increase the level of taxation, because the lower average income effect allows for more tax revenue, which can be redistributed. On the other hand, the efficiency motive is fully present and is equal to the compensated elasticity of labour supply weighted by group size and income over all groups. However, in order to better illustrate the difference between this result and the one found in the planner solution, we can rewrite this to include the ξ term from earlier:

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht}) = \xi + \frac{\sum_{\mathcal{N}} N_{ij} \frac{\lambda_{ij}}{\eta} z_{ij} - \frac{\lambda_m}{\eta} z_m}{\bar{z}}. \tag{49}$$

Then, we obtain the same terms as in the planner solution and an additional term on the RHS, which illustrates the difference between the median voter's utility effect of the tax and the group-size-weighted utility effect for the whole population, divided by the average income. Thus, we can clearly see that the deviation in t from the planner solution will depend on the tax preferences of the median voter. For example, if the median voter is high-ability left-wing, then their preferred level of t will be lower than the population average. This is because, as we have established, the effect of ability on tax preferences likely dominates the effect of political alignment, thus a high-ability left-wing individual will still prefer a lower level of taxation than any low-ability individual. Consequently, the whole term will be negative, which will indeed lead to a lower level of taxation. Conversely, if the median voter is low-ability right-wing, such that they likely prefer more taxes than any high-ability individual, the term will be positive, which will lead to a greater level of taxation. Generally, the tax rate will always be set inefficiently as long as groups differ in their preferences for taxation and the degree to which the outcome is inefficient will depend on the degree to which the groups differ in their preferences. On the other hand, even the median voter setting requires the parties to account for the efficiency effects of taxation through the inclusion of the weighted labour supply elasticity due to the balanced budget requirement. Moreover, income effects also reduce the available amount of redistribution to the median voter, therefore a higher elasticity of labour supply requires a lower tax rate, and vice versa. Lastly, as public provision of R can lead to an improvement in labour market efficiency, it should additionally drive the optimal level of taxation upwards.

5.3 Effect of voter coalitions

Let us furthermore consider a scenario where either two of the groups with the same political alignment can credibly form a coalition, thus agreeing to vote for the same party, which maximises their collective welfare.[9] Thus, low- and high-ability individuals with the same political alignment form a coalition, which the parties observe and must consequently revise their platforms to win the election. While seemingly a simple setup, there are a number of issues to consider in this situation. Firstly, the median voter may still play a part in the setting of party platforms depending on the size of the coalition and whether the remaining groups form a coalition of their own. In the case that the coalition constitutes a minority and does not contain the median voter, it may be the case that the parties will still choose to maximise the utility of the median voter. In that case, the policy outcomes will be identical

[9]Of course, such a setting would require voters to be organised and not act as individuals, however we could compare this setting to one where group leaders can credibly convince their constituents to vote for a certain party.

as before. However, if the coalition is sufficiently large, such that it forms a majority or if it houses the median voter, the parties may be inclined to set their platforms in such a way as to maximise the utility of the coalition, thus ensuring that they win all of the coalition's votes.

In case of a majority coalition, it is reasonable to assume that parties would simply target the coalition itself, while ignoring the median voter (if he or she lies within a different group). As a result, coalitions allow other groups to bypass the median voter and strive to obtain platforms more in-line with their preferences. The downside of this approach, however, is that for most policies a shift towards one group's preferred level will mean an equal shift away from the other group's optimum. Here, we can draw parallels to Coase (1960), such that the groups engage in efficient bargaining regarding the allocation of rents from the coalition and consequent change of party platforms. Thus, one of the groups will agree to pay the other a given amount in return for obtaining platforms closer to its optimum, and vice versa depending on the policy. Then, the coalition will have real effects on the resulting platforms. For the purpose of this paper, we will not delve too much into the mechanics of the electoral competition itself, but instead we will look at the policy bundles obtained if either a left-wing or right-wing coalition is targeted by both parties. As a result, we will be able to illustrate whether coalitions lead to better policy outcomes or whether they cause even greater deviations from the optimum than the median voter setting.

The government problem for the coalition setting is as follows:

$$\max_{\{t,T,R\}} \mathcal{L} = \frac{1}{N_{1c}+N_{2c}}(N_{2c}V_{1c}+N_{2c}V_{2c})+\eta[tw_1\left(h_{1l}N_{1l}+h_{1r}N_{1r}\right)+tw_2\left(h_{2l}N_{2l}+h_{2r}N_{2r}\right)-T-R], \tag{50}$$

where the objective function is the weighted average of the coalition groups' indirect utilities. A possible extension of this setup would be to attach different weights to the groups' utilities, depending on the outcome of bargaining over the division of rents. Next, we can move on to deriving the resulting policies.

The level of public provision of R may either change or become unaffected. In the case of a right-wing coalition, we obtain

$$\frac{1}{N_{1r}+N_{2r}}\left(N_{1r}MRS^{1R}\lambda_{1r}+N_{2r}MRS^{2R}\lambda_{2r}\right)+\eta\left(tw_1\frac{\partial h_{1r}}{\partial R}N_{1r}+tw_2\frac{\partial h_{2r}}{\partial R}N_{2r}\right)=\eta. \tag{51}$$

Here, the outcome is even further from optimum than the standard median voter result with a right-wing median voter, because the high-ability right-wing group has an even higher preference for R. On the other hand, a left-wing coalition results in the same outcome as with a left-wing median voter, that is only the self-financing effect remains and the good is

underprovided. However, there is still an incentive for the parties to bribe the right-wing voters by providing some R and fostering labour supply, despite the fact that public provision has no effect the left-wing coalition's utility.

Moving on to the tax policy, for transfer T we obtain the following result:

$$\frac{1}{N_{1c}+N_{2c}}\left(\lambda_{1c}N_{1c}+\lambda_{2c}N_{2c}\right)+\eta\sum\nolimits_{\mathcal{N}}\left(tw_i\frac{\partial h_{ij}}{\partial T}N_{ij}\right)=\eta, \tag{52}$$

where the subscript c indicates the political alignment of the coalition. Immediately, we can see that the level of T shifts either left or right depending on the political alignment of the coalition. For example, a right-wing coalition will result in a level of T lower than in the case of the low-ability right-wing median voter result, because of the high-ability group's lower λ. Thus the level of T is expected to move closer to the social planner optimum. Conversely, a left-wing coalition will lead to a higher level of T, above the level preferred by the high-ability left-wing voter, and closer to the optimum as well. On the other hand, if a coalition is able to bypass the median voter, then the resulting policies could potentially shift even further from the optimum. This would require the extreme groups to be sufficiently large and/or have sufficiently strong preferences, which would drive the coalition average below the median voter's preferred level.

Lastly, we can look at the result for the optimal level of taxation. Here, we can recall equation (49) and obtain the following expression (see Appendix A.2.1 for derivation):

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht})=\xi+\frac{\sum_{\mathcal{N}}N_{ij}\frac{\lambda_{ij}}{\eta}z_{ij}-\frac{1}{N_{1c}+N_{2c}}\left(N_{1c}\frac{\lambda_{1c}}{\eta}z_{1c}+N_{2c}\frac{\lambda_{2c}}{\eta}z_{2c}\right)}{\bar{z}}, \tag{53}$$

where the sum $\sum_{\mathcal{N}-c}$ indicates summation over the non-coalition groups. Immediately, we can see that the level of taxation will be set either higher or lower compared to the social planner result, however this deviation from the optimum should now be lesser compared to the median voter results. In case of a left-wing coalition, the low-ability left-wing group will shift the high-ability group's platform to the left, thus yielding a higher level of taxation. Because the high-ability left-wing group is assumed to have below-average preferences for taxation, this result allows for more optimal party platforms. Conversely, a right-wing coalition will cause the low-ability right-wing platform to shift to the right, resulting in a lower level of taxation closer to the social planner optimum. However, if the coalition is able to bypass the median voter then, similarly to the level of lump-sum transfer, the level of taxation may shift even further from optimum. Like before, this would require the coalition average to be more extreme than the median voter's preferences, which would drive t above of below the median voter result, depending on the type of coalition.

6 Contrasting the planner solution with outcomes under electoral competition

In this section, we will summarise the findings and attempt to contrast the outcome of electoral competition with the planner solution from section 4. First, we can look at optimal public provision, which significantly differs between the planner solution and the electoral competition result. An interesting aspect in this case is that some R can be provided even if the median group is left-wing, such that it derives no utility from public provision directly. This is due to the self-financing portion of the expression for optimal public provision, which remains the same and is positive as long as the public good is complementary to work (which we assume). Then, despite the indirect utility effect being zero, the LHS is still positive, which may warrant some public provision. As explained earlier, this result can be linked to the bribing mechanism, where the government offers targeted provision of a good in order to eliminate a part of the labour market distortions arising from distortionary taxation. Through work complementarity of R the government can then increase labour supply and induce additional tax revenue, the extent of which will depend on the exact behavioural effect of R. This effect becomes more clearly visible when the group whose utility we are trying to maximise does not care about the public provision. Moreover, the indirect utility effect of public provision through the MRS between public and private income creates additional utility, which provides further incentive for the government to provide R. As we saw, this utility effect is stronger for high-ability (right-wing) individuals due to the additional work complementarity effect of R, which is stronger the higher the labour effort. However, even assuming that only the low-ability group can house the median voter due to our assumption on group size, the median voter is likely to have a strong preference for R anyway, which is likely to result in overprovision of the public good.

Proposition 3. *Electoral competition in which parties maximise the utility of the median voter is likely to result in bribing effects due to parties overproviding targetable public goods preferred by the median voter. Conversely, goods which do not benefit the median voter will be underprovided.*

Indeed, public spending within the scope of electoral competition has also been extensively modelled. For example, Lizzeri and Persico (2001) illustrate how public good provision depends on the type of electoral system and show that a proportional system results in higher public good provision than a winner-takes-all system. This conclusion follows from the fact that a proportional system splits the spoils of office between candidates, thus providing

incentive for more public good spending as opposed to pork-barrel (targeted) spending. In case of a winner-takes-all, the potential gains from winning are higher and thus provide more incentive to target spending towards specific voters. Interestingly, the outcomes change depending on the desirability of the public good, that is the extent to which there is demand for the public good in the population. According to Lizzeri and Persico, a highly desirable public good is further from optimum in the winner-takes-all case relative to the proportional system. On the other hand, a relatively undesirable public good is more optimally provided in case of winner-takes-all. Furthermore, the authors show that party platforms become less egalitarian as the public good becomes more desirable in both systems. These findings are further reaffirmed by Persson et al. (2000) who theoretically model similar differences between a parliamentary regime and a presidential-congressional regime. Again, a different division of incentives leads to more public good provision in the former case an less in the latter, which is also consistent with empirical evidence.

Here, we can draw direct parallels between the electoral competition outcomes of public spending compared to our targeted provision of R. Again, we can clearly see that electoral competition provides incentives to deviate from the optimal level of public provision, because the winner(s) can obtain additional spoils of office, which is not the case in case of a benevolent government targeting balanced-budget redistribution. Nevertheless, additional efficiency effects of public provision in our model give incentive for some public provision even in case of the (left-wing) median voter's indifference towards the publicly provided good, which is not the case in a typical winner-takes-all scenario. In turn, even disadvantaged voters who want more public provision (right-wingers) are catered to through the public spending choices due to the bribing mechanisms described above. Moreover, such public provision allows the parties to better achieve their objectives with regards to taxes, because of the positive efficiency effects of public provision on the labour supply. As such, we can again draw parallels to tax competition literature such as Keen and Marchand (1997), where targeted spending has an efficiency motive through which the government attracts mobile capital. The same logic could be applied to left-wing goods as well, which would be provided even in case of a right-wing median voter, however because of left-wingers' lower labour supply elasticities the efficiency motive could be less important in that case.

Next, we can look at the tax policy, which consists of the non-individualised lump-sum transfer T which, at the optimum, balances the income effects of provision with the indirect utility effects through the budget constraint, and the linear tax rate t. In the planner solution both the utility gains and the income effect losses are summed over all groups within the population in order to optimise the total social utility in the economy. This outcome is efficient, because the government optimises total welfare and does not need to engage in

electoral competition in order to win an election, which yields inefficiencies. In the case of the median voter result the level of T is set inefficiently, because the preferences of other types of voters are ignored. In the case of a low-ability right-wing median voter, the level of T will be set at a too high level due to a higher than average marginal private utility of income for the voter, who consequently prefers to receive more direct income. On the other hand, a high-ability left-wing median voter is likely to prefer a significantly lower level of T due to his or her low marginal private utility of income, despite the additional redistributive preference. Consequently, the level of T will reflect these preferences and be set at a too low level and, with substantial income effects, could even be negative. The degree to which the electoral competition scenario is inefficient additionally depends on the individual characteristics of the median voters and how closely their preferences reflect the weighted average of the whole population.

The result for optimal taxation also illustrates that maximising the utility of the median group leads to inefficient outcomes. Equation (49) clearly shows that electoral competition creates an additional wedge between the efficient level of taxation and the policy required to win the election. Then, the tax rate will move either up or down depending on the preferences of the median voter, which in most cases will not reflect the preferences of the entire population. Importantly, the most efficient result in this scenario can be obtained if the individual with his or her preferred level of taxation as closest to the weighted population average is the median voter. On the other hand, the median voter result preserves the efficiency motive for income taxation and includes the weighted elasticity of labour supply. This aspect is important because, as we have established, different political preferences may result in significantly different labour supply responses to taxation. Thus, because of the balanced budget requirement even electoral competition can fully account for behavioural responses to labour income taxation, assuming perfect information. Moreover, a portion of the distortions arising from income taxation can be eliminated through public provision of R, which should allow the parties to set a higher t and generate more revenue.

Proposition 4. *Electoral competition in which parties maximise the utility of the median voter will always result in a sub-optimal tax policy, given non-identical preferences across the population subgroups. The chosen tax rate as well as the lump-sum transfer will deviate from the optimum in the direction of the median voter's preferred policies, the extent of which will depend on the variance between preferences of the groups.*

In contrast to electoral competition literature already discussed in previous sections, our approach introduces several mechanisms through which tax policy can be affected by

the way public spending is structured. Firstly, we have the bribing effect arising from work complementarity of R, which leads to a higher labour supply and more revenue from taxation as a result. Secondly, as seen in empirical findings by Huet-Vaughn et al. (2019) and others, a better ideological match between taxpayer and public expenditure can lead to a lower elasticity of labour supply for the relevant groups, which improves efficiency of the tax system as a whole. In contrast to standard electoral competition, these motives are preserved when the median voter does not benefit from the public good directly, i.e. does not derive direct utility from public provision. Thus, in our setting public provision can be thought of as an instrument of tax policy rather than a completely separate aspect altogether.

Finally, voter coalitions may play an important role in bringing the electoral competition outcomes more in-line with the social planner optimum, but could also result in stronger deviations from it, depending on the exact policy. For example, a right-wing majority coalition is likely to yield a level of R that is even further from optimum than the median voter result due to the high-ability right-wing group's higher preference for R. On the other hand, a left-wing majority coalition leads to no efficiency improvement due to the lack of effect of R on left-wing utility and an underprovision of the public good overall. Moreover, a majority coalition with either political alignment will likely lead to more optimal levels of lump-sum transfer T and taxation t due to the the interaction between the coalition groups' preferences. For example, because the low-ability left-wing group has a notably higher preference for taxation than its high-ability counterpart, it will cause the tax rate to move upwards towards the social planner optimum. The inverse is true for a right-wing coalition and a similar mechanism occurs for the lump-sum transfer. For example, if a high-ability left-wing voter were to prefer a zero or negative lump-sum transfer, entering into a coalition with his or her low-ability counterpart will move T upwards towards the efficient level. On the other hand, coalitions which bypass the median voter can quite easily shift the policies further from optimum, the extent of which will depend on both the coalition group sizes and the strength of preferences. For example, a right-wing coalition bypassing a high-ability left-wing median voter could bring the level of taxation even more to the right as long as the high-ability right-wing group is sufficiently large or has a much lower preferred level of t, which clearly exacerbates the negative effect of electoral competition. This result can be linked to a two-party system where each party's base is comprised of groups with various levels of earnings and thus different preferences for taxation. Overall, the party will likely choose middle-ground policies in order to win as many votes as it can, which is what we see here. Lastly, in order for coalitions to form it may be required for one of the groups to be compensated for allowing the policy outcomes to deviate from its preferred levels, such

as through Coasian bargaining. Like in real life, such compensation could be done through concessions with regards to other policies.

Proposition 5. *Coalitions between two groups with the same political alignment in an electoral competition setting can lead to efficiency improvements with regards to the level of lump-sum transfer and income taxation when they do not bypass the median voter. On the other hand, they are likely to result in greater inefficiencies when it comes to the level of targeted public good provision by over- or underproviding the good depending on the political alignment of the coalition.*

The coalition setting described here, while not a true coalition such as that between political parties, can be compared to several other concepts in political economy. For example, Grossman and Helpman (1996) illustrate how interest groups may influence party policies in an electoral competition setting in order to obtain policy outcomes more in-line with their preferences. Here, we could think of the far-right or far-left coalition group as the special-interest group, which engages in rent-seeking behaviour by influencing the equilibrium platforms to bring them more in-line with its preferences. Moreover, Bardhan and Mookherjee (2000) show that the capture of the electoral process by special-interest groups depends on several factors, including electoral competition and interest group cohesiveness, which are both relevant to our setting. Empirical evidence from Claessens et al. (2008) suggests that influence activities such as campaign contributions by firms, can result in significant economic costs over time. In our case, inefficient within-coalition bargaining over the division of rents would also result in some economic costs, however the extent to which these costs would overshadow efficiency improvements in party platforms is uncertain.

7 Conclusion and final remarks

In this paper we showed that, besides ability level, political alignment and preferences of taxpayers have a significant effect on the optimal level of taxation as well as the composition of public spending. Moreover, we contrasted optimal policy outcomes of the social planner setting with outcomes under electoral competition in a median voter setting.

Firstly, we proved that implementing direct utility from paying taxes for left-wing individuals leads to a lower tax elasticity of labour supply. This effect additionally depends on the strength of preferences for redistribution, which are set exogenously in our model. This is an important result and is consistent with the findings of Huet-Vaughn et al. (2019) who find lower labour supply elasticities for liberals. This also has important implications for

optimal taxation as labour supply elasticities are one of the main components of the classic equity-efficiency result discussed in literature. Moreover, larger groups have a disproportionately large effect on tax policy compared to smaller groups, so population composition with regards to political alignment is especially important.

Secondly, we showed that taxpayer preferences with regards to public spending have a significant effect on the optimal level of public provision of certain goods. By implementing work complementarity for a 'right-wing' good, such as defence spending, we showed that the government can target provision in order to foster labour supply amongst the right-wing taxpayers who are (more) averse to taxation. Moreover, targeted provision is likely to lower the labour supply elasticity for some individuals by lowering the utility cost of working. As a result, we find that the government has an incentive to 'bribe' the right-wing taxpayers by providing their preferred good and thus increase their labour supply, which is consistent with the findings of some tax competition literature already discussed in this paper. The broad implications of our findings are that better ideological matching of taxpayer and expenditure is advisable, which might be especially helpful in countries where most taxpayers have very little influence on policy like the US. It is also possible that the amount of military spending may be in part dictated by taxpayers' preferences for this type of expenditure, which may shed light on why the US spends so much in comparison to other countries.

Moreover, we showed that Downsian electoral competition in which parties target the median voters results in significant inefficiencies in both tax policy as well as public spending, given a balanced budget requirement. By maximising the utility of the median voter the level of taxation is set consistently with his or her preferences and largely depends on how well the median voter reflects the average sentiment of the population. The same is true with regards to the lump-sum transfer, which reflects the preferred policy of the median voter. Naturally, low-ability individuals will prefer a higher transfer, because they benefit more from additional income compared to high-ability individuals. Targetable public goods are likely to be over- or underprovided depending on the preferences of the median voter as well, but due to bribing effects the amount of public good is always non-zero.

Lastly, we looked at the effects of voter coalitions along political alignment on the policy outcomes and found significant effects with regards to all policies. When it comes to public provision, a right-wing coalition is likely to favour a shift to an even higher, more inefficient level, whereas a left-wing coalition can possibly bypass a right-wing median voter and achieve a much lower level of public provision, which is also inefficient. On the other hand, coalitions can lead to improvements in tax policy depending on where their preferences lie with regards to the median voter. Generally, some improvements in both the tax rate and the lump-sum transfer are possible, however this is likely to depend on several factors, such as the extent

to which preferences vary within the population as well as group sizes. It is also worth noting that efficiency improvements arising from voter coalitions are likely to be dampened by bargaining costs between groups and other possible issues arising from such cooperation. In sum, the conclusions here could potentially be used to explain how political parties in a two-party system might set their policies.

While the conclusions in this paper can have substantial relevance to policy-making, it is worth discussing some of the limitations with respect to the modelling choices and results. Perhaps most significant is the linear taxation setting, which is of limited practical relevance, however due to multidimensional heterogeneity issues a similar model with non-linear taxation may prove to be extremely difficult to work with. Moreover, the political alignment aspect of the model is somewhat stylised and would ideally cover a range of preferences to better reflect the political spectrum. However this may pose additional challenges and implementing a broader set of political alignments may lead to radically different outcomes. Lastly, in sections 5 and 6 we only cover Downsian electoral competition with identical party platforms, which some empirical evidence shows to be inconsistent with real-life political competition. Our conclusions in this regard need to be treated with caution, however even diverging party platforms are likely to yield inefficient outcomes with regards to the relevant policies.

A Appendix

A.1 Derivation of compensated elasticities

We only derive the compensated elasticities for left-wingers, but the same procedure can be used to find the right-wing elasticities. First, we totally differentiate the utility function (1), keeping utility constant. δ is fixed as it is assumed to be a constant population characteristic. All subscripts are omitted to avoid notational clutter:

$$\tilde{U} = u_c c\tilde{c} - v_h h\tilde{h} + \delta\left(g_t \frac{1-t}{t}\tilde{t} + g_w\tilde{w} + g_h\tilde{h}\right) twh = 0, \tag{A.1}$$

where '~' denotes the relative change such that $\tilde{U} = \mathrm{d}U/U,\ \tilde{c} = \mathrm{d}c/c,\ \tilde{h} = \mathrm{d}h/h,\ \tilde{w} = \mathrm{d}w/w$ and lastly $\tilde{t} = \mathrm{d}t/(1-t)$.

Then from (A.1) we can obtain

$$\frac{v_h h}{u_c c}\tilde{h} = \tilde{c} + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w} + g_h\tilde{h})twh}{u_c c}. \tag{A.2}$$

Then, substituting the FOC into (A.2) we get

$$\left(\frac{\delta g_h tw}{u_c} + (1-t)w\right)\frac{h}{c}\tilde{h} = \tilde{c} + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w} + g_h\tilde{h})twh}{u_c c}, \tag{A.3}$$

$$(1-t)w\frac{h}{c}\tilde{h} = \tilde{c} + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w} + g_h\tilde{h})twh}{u_c c} - \frac{\delta g_h twh}{u_c c}\tilde{h}, \tag{A.4}$$

$$(1-t)w\frac{h}{c}\tilde{h} = \tilde{c} + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c}. \tag{A.5}$$

We then totally differentiate the left-wing MRS:

$$\begin{aligned} v_{hh}h\tilde{h} - u_{cc}c\tilde{c}(1-t)w = \delta\left(g_{ht}\frac{1-t}{t}\tilde{t} + g_{hw}\tilde{w} + g_{hh}\tilde{h}\right)\left(t^2w^2h\right) + \delta\left(g_h\frac{1-t}{t}\tilde{t} + g_h\tilde{w}\right)tw \\ + u_c(1-t)w\tilde{w} - u_c(1-t)\tilde{t}w. \end{aligned} \tag{A.6}$$

We can also immediately simplify by dividing both sides by u_c and defining $\rho = \frac{-u_{cc}c}{u_c} > 0$ as the coefficient of relative risk aversion.

$$\frac{v_{hh}}{u_c}h\tilde{h} = \frac{\delta(g_{ht}\frac{1-t}{t}\tilde{t} + g_{hw}\tilde{w} + g_{hh}\tilde{h})(t^2w^2h)}{u_c} + \frac{\delta g_h(\frac{1-t}{t}\tilde{t} + \tilde{w})tw}{u_c} + (1-t)w\left(\tilde{w} - \tilde{t} - \rho\tilde{c}\right). \tag{A.7}$$

Then, we can find an expression for $\tilde{h}$ by isolating terms

$$\tilde{h}\left(\frac{v_{hh}}{u_c}h - \frac{\delta g_{hh}t^2w^2h}{u_c}\right) = \frac{\delta(g_{ht}\frac{1-t}{t}\tilde{t} + g_{hw}\tilde{w})(t^2w^2h)}{u_c} + \frac{\delta g_h(\frac{1-t}{t}\tilde{t} + \tilde{w})tw}{u_c} + (1-t)w\left(\tilde{w} - \tilde{t} - \rho\tilde{c}\right), \tag{A.8}$$

$$\tilde{h} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)}{u_c\Delta} + \frac{(1-t)w}{\Delta}\left(\tilde{w} - \tilde{t} - \rho\tilde{c}\right), \tag{A.9}$$

where

$$\Delta = \frac{v_{hh}}{u_c}h - \frac{\delta g_{hh}t^2w^2h}{u_c} > 0. \tag{A.10}$$

Consequently, we can write an expression for $\tilde{c}$ using (A.5)

$$\begin{aligned} \tilde{c}\left(1 + \rho\frac{(1-t)^2w^2h}{c\Delta}\right) = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)(1-t)wh}{u_c c\Delta} \\ + \frac{(1-t)^2w^2h}{c\Delta}\left(\tilde{w} - \tilde{t}\right) - \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c}, \end{aligned} \tag{A.11}$$

$$\tilde{c} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)(1-t)wh}{u_c c\Delta\epsilon} + \frac{(1-t)^2w^2h}{c\Delta\epsilon}\left(\tilde{w} - \tilde{t}\right) - \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c\epsilon}, \tag{A.12}$$

where

$$\epsilon = 1 + \rho\frac{(1-t)^2w^2h}{c\Delta} > 0. \tag{A.13}$$

Finally, by substituting for $\tilde{c}$ in (A.9) we get

$$\tilde{h} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)}{u_c\Delta} + \frac{(1-t)w}{\Delta}\left(\tilde{w} - \tilde{t}\right) - \tilde{c}\rho\frac{(1-t)w}{\Delta}, \tag{A.14}$$

$$\tilde{h} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)}{u_c\Delta}\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) + \frac{(1-t)w}{\Delta}\left(\tilde{w} - \tilde{t}\right)\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c\epsilon}\left(\rho\frac{(1-t)w}{\Delta}\right). \tag{A.15}$$

Therefore, the solution to the model can be written as

$$\tilde{c} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)(1-t)wh}{u_c c\Delta\epsilon} + \frac{(1-t)^2w^2h}{c\Delta\epsilon}\left(\tilde{w} - \tilde{t}\right) - \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c\epsilon}, \tag{A.16}$$

$$\tilde{h} = \frac{\delta\left(\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)\tilde{t} + \left(g_{hw} + g_h\frac{1}{twh}\right)\tilde{w}\right)(t^2w^2h)}{u_c\Delta}\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) + \frac{(1-t)w}{\Delta}\left(\tilde{w} - \tilde{t}\right)\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) + \frac{\delta(g_t\frac{1-t}{t}\tilde{t} + g_w\tilde{w})twh}{u_c c\epsilon}\left(\rho\frac{(1-t)w}{\Delta}\right). \tag{A.17}$$

The tax elasticities can be then solved by taking a derivative of the above expressions for $\tilde{c}$ and $\tilde{h}$ with respect to $\tilde{t}$:

$$\varepsilon_{ct} = \frac{\delta\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)(t^2w^2h)(1-t)wh}{u_c c\Delta\epsilon} - \frac{(1-t)^2w^2h}{c\Delta\epsilon} - \frac{\delta g_t\frac{1-t}{t}twh}{u_c c\epsilon}, \tag{A.18}$$

$$\varepsilon_{ht} = \frac{\delta\left(g_{ht}\frac{1-t}{t} + g_h\frac{1-t}{t}\frac{1}{twh}\right)(t^2w^2h)}{u_c\Delta}\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) - \frac{(1-t)w}{\Delta}\left(1 - \rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right) + \frac{\delta g_t\frac{1-t}{t}twh}{u_c c\epsilon}\left(\rho\frac{(1-t)w}{\Delta}\right). \tag{A.19}$$

Immediately, we can also solve the expression $1-\rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}$, which yields $1-\frac{\rho(1-t)^2w^2h}{c\Delta\left(1+\rho\frac{(1-t)^2w^2h}{c\Delta}\right)} = 1-\frac{\rho(1-t)^2w^2h}{c\Delta+\rho(1-t)^2w^2h} > 0$, which is increasing in δ. Furthermore, we assume that the substitution effect is dominant such that $\varepsilon^c_{ht} < 0$, which is the standard labour supply behaviour. This means that the negative effect on labour supply of the tax via the substitution effect is greater than the sum of the income effect and the direct utility effect from redistribution. Consequently, we can see that δ will decrease the magnitude of the tax elasticity of labour supply, because both terms which are multiplied by δ are positive and increasing in δ. Moreover, the second term in the labour elasticity decreases in δ as well, as shown below:

$$\frac{(1-t)w}{\Delta}\left(1-\rho\frac{(1-t)^2w^2h}{c\Delta\epsilon}\right), \tag{A.20}$$

$$\left(\frac{(1-t)w\left(c\Delta+\rho(1-t)^2w^2h\right)}{\Delta\left(c\Delta+\rho(1-t)^2w^2h\right)}-\rho\frac{(1-t)^3w^3h}{c\Delta^2+\Delta\rho(1-t)^2w^2h}\right), \tag{A.21}$$

$$\left(\frac{(1-t)w\left(c\Delta+\rho(1-t)^2w^2h\right)-\rho(1-t)^3w^3h}{c\Delta^2+\Delta\rho(1-t)^2w^2h}\right), \tag{A.22}$$

$$\left(\frac{c(1-t)w}{c\Delta+\rho(1-t)^2w^2h}\right), \tag{A.23}$$

where Δ increases in δ. Thus, the tax elasticity, which is negative, decreases in magnitude in δ.

A.2 Derivation of the optimal level of taxation (median voter)

We begin by taking a derivative of equation (43) with respect to the tax rate t.

$$\begin{aligned}\frac{\partial\mathcal{L}}{\partial t} &= \frac{\partial V_m}{\partial t}+\eta\left(w_1\left(h_{1l}N_{1l}+h_{1r}N_{1r}\right)+w_2\left(h_{2l}N_{2l}+h_{2r}N_{2r}\right)\right)\\ &+\eta\left(tw_1\left(\frac{\partial h_{1l}}{\partial t}N_{1l}+\frac{\partial h_{1r}}{\partial t}N_{1r}\right)+tw_2\left(\frac{\partial h_{2l}}{\partial t}N_{2l}+\frac{\partial h_{2r}}{\partial t}N_{2r}\right)\right)=0.\end{aligned} \tag{A.24}$$

Using Roy's identity $\frac{\partial V_{ij}}{\partial t} = \frac{\partial V_{ij}}{\partial M}\frac{\partial M}{\partial t} = -\lambda_{ij}w_ih_{ij}$ and the Slutsky equation in (11) we obtain the following expression:

$$\begin{aligned}&-\lambda_m w_m h_m+\eta\left(w_1\left(h_{1l}N_{1l}+h_{1r}N_{1r}\right)+w_2\left(h_{2l}N_{2l}+h_{2r}N_{2r}\right)\right)\\ &+\eta\Bigg(tw_1\left(N_{1l}\left(\frac{\partial h^c_{1l}}{\partial t}-w_1h_{1l}\frac{\partial h_{1l}}{\partial T}\right)+N_{1r}\left(\frac{\partial h^c_{1r}}{\partial t}-w_1h_{1r}\frac{\partial h_{1r}}{\partial T}\right)\right)\\ &+tw_2\left(N_{2l}\left(\frac{\partial h^c_{2l}}{\partial t}-w_2h_{2l}\frac{\partial h_{2l}}{\partial T}\right)+N_{2r}\left(\frac{\partial h^c_{2r}}{\partial t}-w_2h_{2r}\frac{\partial h_{2r}}{\partial T}\right)\right)\Bigg)=0.\end{aligned} \tag{A.25}$$

Then, dividing by η and collecting the income effects, we obtain the following:

$$
\begin{aligned}
&-\frac{\lambda_m}{\eta} w_m h_m - t \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} w_i h_{ij} + w_1 \left(h_{1l} N_{1l} + h_{1r} N_{1r}\right) + w_2 \left(h_{2l} N_{2l} + h_{2r} N_{2r}\right) \\
&+ \frac{t}{1-t} N_{1l} w_1 h_{1l} \left(\frac{\partial h^c_{1l}}{\partial t} \frac{1-t}{h_{1l}}\right) + \frac{t}{1-t} N_{2l} w_2 h_{2l} \left(\frac{\partial h^c_{2l}}{\partial t} \frac{1-t}{h_{2l}}\right) \\
&+ \frac{t}{1-t} N_{1r} w_1 h_{1r} \left(\frac{\partial h^c_{1r}}{\partial t} \frac{1-t}{h_{1r}}\right) + \frac{t}{1-t} N_{2r} w_2 h_{2r} \left(\frac{\partial h^c_{2r}}{\partial t} \frac{1-t}{h_{2r}}\right).
\end{aligned}
\tag{A.26}
$$

Then, by using the definition for elasticity of labour supply and defining the average income as $\bar{z}$, we obtain the following equation:

$$
\frac{t}{1-t} \sum\nolimits_{\mathcal{N}} N_{ij} z_{ij} \left(-\varepsilon^c_{h_{ij}t}\right) = -\frac{\lambda_m}{\eta} z_m - t \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} z_{ij} + \bar{z}. \tag{A.27}
$$

By adding and subtracting the income effects and weighing them with z_m, we obtain the following:

$$
\begin{aligned}
\frac{t}{1-t} \sum\nolimits_{\mathcal{N}} N_{ij} z_{ij} \left(-\varepsilon^c_{h_{ij}t}\right) = &-\frac{\lambda_m}{\eta} z_m - t \left(\sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} - \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T}\right) z_m \\
&- t \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} z_{ij} + \bar{z},
\end{aligned}
\tag{A.28}
$$

which gives

$$
\begin{aligned}
\frac{t}{1-t} \sum\nolimits_{\mathcal{N}} N_{ij} z_{ij} \left(-\varepsilon^c_{h_{ij}t}\right) = &-\left(\frac{\lambda_m}{\eta} + t \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T}\right) z_m + t \left(\sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T}\right) z_m \\
&- t \sum\nolimits_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} z_{ij} + \bar{z}.
\end{aligned}
\tag{A.29}
$$

Then, using the optimality condition in equation (44) and dividing by average income, we obtain:

$$
\frac{t}{1-t} \left(-\bar{\varepsilon}^c_{h_{ij}t}\right) = \frac{(\bar{z} - z_m) + t \left[\left(\sum_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T}\right) z_m - \sum_{\mathcal{N}} N_{ij} w_i \frac{\partial h_{ij}}{\partial T} z_{ij}\right]}{\bar{z}}. \tag{A.30}
$$

We can also rewrite this by adding and subtracting the indirect utility terms for the remaining groups in (A.24) in order to obtain an expression for the deviation from the social

planner optimum:

$$\frac{t}{1-t}\sum\nolimits_{\mathcal{N}} N_{ij}z_{ij}\left(-\varepsilon^{c}_{h_{ij}t}\right)=\sum\nolimits_{\mathcal{N}} N_{ij}\left(1-b_{ij}\right)z_{ij}-\sum\nolimits_{\mathcal{N}-m} N_{ij}\frac{\partial V_{ij}}{\partial t}\frac{1}{\eta}+(N_m-1)\frac{\lambda_m}{\eta}z_m, \tag{A.31}$$

which, after dividing both sides by $\sum_{\mathcal{N}} N_{ij}z_{ij}$ and simplifying $\frac{\partial V_{ij}}{\partial t}=-\lambda z_{ij}$ we obtain:

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht})=\xi+\frac{\sum_{\mathcal{N}-m} N_{ij}\frac{\lambda_{ij}}{\eta}z_{ij}+(N_m-1)\frac{\lambda_m}{\eta}z_m}{\sum_{\mathcal{N}} N_{ij}z_{ij}}. \tag{A.32}$$

Then, the final expression is as follows:

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht})=\xi+\frac{\sum_{\mathcal{N}} N_{ij}\frac{\lambda_{ij}}{\eta}z_{ij}-\frac{\lambda_m}{\eta}z_m}{\bar{z}}. \tag{A.33}$$

A.2.1 Coalition setting

For the coalition setting we have

$$\begin{aligned}\frac{t}{1-t}\sum\nolimits_{\mathcal{N}} N_{ij}z_{ij}\left(-\varepsilon^{c}_{h_{ij}t}\right)=&\sum\nolimits_{\mathcal{N}} N_{ij}\left(1-b_{ij}\right)z_{ij}-\sum\nolimits_{\mathcal{N}-c} N_{ij}\frac{\partial V_{ij}}{\partial t}\frac{1}{\eta}\\&+\left(N_{1c}-\frac{N_{1c}}{N_{1c}+N_{2c}}\right)\frac{\lambda_{1c}}{\eta}z_{1c}+\left(N_{2c}-\frac{N_{2c}}{N_{1c}+N_{2c}}\right)\frac{\lambda_{2c}}{\eta}z_{2c},\end{aligned} \tag{A.34}$$

where $\sum_{\mathcal{N}-c}$ denotes summation over non-coalition groups. Then, after dividing both sides by $\sum_{\mathcal{N}} N_{ij}z_{ij}$ and simplifying $\frac{\partial V_{ij}}{\partial t}=-\lambda z_{ij}$ we obtain:

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht})=\xi+\frac{\sum_{\mathcal{N}-c} N_{ij}\frac{\lambda_{ij}}{\eta}z_{ij}+\left(N_{1c}-\frac{N_{1c}}{N_{1c}+N_{2c}}\right)\frac{\lambda_{1c}}{\eta}z_{1c}+\left(N_{2c}-\frac{N_{2c}}{N_{1c}+N_{2c}}\right)\frac{\lambda_{2c}}{\eta}z_{2c}}{\sum_{\mathcal{N}} N_{ij}z_{ij}}, \tag{A.35}$$

which finally results in the following expression:

$$\frac{t}{1-t}(-\bar{\varepsilon}^{c}_{ht})=\xi+\frac{\sum_{\mathcal{N}} N_{ij}\frac{\lambda_{ij}}{\eta}z_{ij}-\frac{1}{N_{1c}+N_{2c}}\left(N_{1c}\frac{\lambda_{1c}}{\eta}z_{1c}+N_{2c}\frac{\lambda_{2c}}{\eta}z_{2c}\right)}{\bar{z}}. \tag{A.36}$$

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