Economics and Politics of Student Debt Relief*

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Abstract

We study student debt relief as the product of probabilistic voting by an electorate that includes both college graduates and non-college laborers. While politicians favor the most homogeneous group in a probabilistic voting setup, we identify conditions under which politicians forgive student debt even when laborers are more homogeneous than graduates. This political asymmetry in favor of student debt relief gives rise to a double equilibrium that is driven by strategic complementarities among a pivotal mass of citizens: When laborers are not sufficiently more homogeneous than graduates, either this pivotal mass banks on student debt relief, thus going to college, and forcing politicians to forgive student debt, or they reject college, thus preempting politicians from forgiving student debt. Income-driven repayments make politicians forgive fewer students' debt but under a wider range of parameters. We finally identify conditions under which student debt relief and a redistribution in favor of laborers act as strategic complements or substitutes from politicians' perspective.

Keywords: student loans, credit-rationing, voting

JEL Classification: D72, G51, H52, I22

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1 Introduction

Student debt has reached alarming levels in the US, where 45 million people owe, on aggregate, \$1.8 trillion (Looney and Yannelis, 2024). This distress hinders graduates' future financial performance, and since this pertains to a substantial share of the population, it is expected to have a negative impact on the economy as a whole. Student loan forgiveness has risen as a major policy tool to address this problem. But insofar as student loans are offered by government entities, it is inevitable that student debt relief has redistributional effects, and thus enters the political discourse. In this paper we study the interaction between the economics and politics of student debt relief.

We do so in a stylized setup where there are practically-inclined and scholarly-inclined citizens, who are also voters. Every citizen earns a salary, and he or she can also pursue implementation of a project. Implementing the project requires financing, which may or may not be achieved because households are subject to moral hazard. We employ, in particular, a textbook credit-rationing model (Tirole, 2006, Chapter 3) where, after obtaining a loan, citizens can choose low effort and extract a private benefit.

At the beginning of time every citizen, regarding of scholar or practical inclinations, decides whether to go to college (thus becoming student and then college graduate), or work without a college degree (thus becoming a laborer). Both graduates and laborers have access to a salaried job, and a project, as described above, but their respective income may depend on whether, or not, they went to college. Graduates and laborers also differ in that the former have been borrowed from the government in order to cover their tuition fees.

This means that when graduates aim to finance their project, they (as opposed to laborers) are burdened by their student debt. This tightens their incentive-compatibility constraint, which can be relaxed if their student debt is forgiven. We assume that the decision on student debt relief is made by the winner of a democratic election that takes place right after college graduation. This aims to capture contemporary discussions in the US about ex post student debt relief, that is justified by advocates as a means to alleviate graduates' credit-rationing.

Since student loans are provided by the government, which is assumed to provide a public good to everyone after collecting student loan repayments, student debt relief implies a redistribution that hurts laborers and favors graduates. This is the economic consideration of citizens at the time they vote. In the tradition of probabilistic voting (Lindbeck and Weibull, 1987), citizens' vote depends on economic considerations, as well as on random political biases, and we assume that the distribution of such biases depends on college education. As is standard in a probabilistic voting setup, politicians favor the group with the most homogeneous preferences, i.e., whose members' vote depends less on random biases.

Indeed, we show that politicians offer student debt relief when graduates are more homogeneous than laborers. But we also reveal a political asymmetry in favor of student debt relief in that politicians may forgive student debt even when laborers are more homogeneous, yet not enough more. This happens if among graduates, there are practically inclined citizens whose (i) salary income (after graduation) is assumed insufficient for fully repaying their student loan, and (ii) incentive-compatibility for financing their project depends on student debt relief.

As soon as such citizens go to college, at least a part of their tuition fees becomes a sunk cost: If student debt relief is not offered, these citizens will remain incentive-incompatible, thus they will fail to finance their project, and they will not be able to repay their outstanding debt from their project income. If student debt relief is offered, then again these graduates do not repay their student loan. In other words, student debt relief favors graduates more than it harms laborers, thus becoming the optimal strategy for politicians as soon as laborers are not sufficiently more homogeneous than graduates.

An implication of the above mechanism is a dual equilibrium that arises as the result of strategic complementarities among the aforementioned pivotal mass of citizens: Either they go to college, thus making student debt relief a political necessity, and self-fulfilling their choice to go to college; or they do not go to college, thus preempting politicians from forgiving student debt, and again self-fulfilling their initial choice to work without a college degree.

We also consider specifications where politicians can forgive all students' debt, or may restrict their forgiveness only to low-salary students. In these cases, the range over which politicians offer student debt relief despite laborers being more homogeneous becomes wider. But this decision harms laborers to a lower extent because politicians indeed choose income-driven repayments, i.e., they limit the eligibility of forgiveness. Politicians forgive all student debt as soon as graduates become more homogeneous than laborers, and accordingly, they reject student debt relief for everyone if laborers are excessively more homogeneous than graduates.

Moreover, we study the case where politicians are able to further restrict eligibility, among the low-income graduates, only to those who need student debt relief to access credit. We refer to this strategy as income-and-incentive driven repayment. We show that as soon as these citizens go to college, then they are offered student debt relief, even under extreme laborers' homogeneity. As explained above, these graduates' tuition fees are paid one way or another by the entire society, and thus rejecting student debt relief for these specific graduates creates no economic benefits for the rest of the society.

Finally, we study the interaction of student debt relief with a distinct policy that (as opposed to forgiving student debt) causes a redistribution from graduates to laborers. The equilibrium structure remains the same: Politicians reject student debt relief if laborers are sufficiently more homogeneous than graduates; they may, or may not, offer student debt relief (depending on how strategic complementarities among a pivotal mass of citizens play out) if laborers are not sufficiently more homogeneous than graduates; they forgive student debt as soon as graduates are more homogeneous than laborers. At the same time, a redistribution from graduates to laborers acts as a strategic (political) substitute when laborers are sufficiently more homogeneous than graduates (by offering a subsidy to laborers while rejecting student debt relief), and when graduates are more homogeneous than laborers (by refusing to redistribute from graduates to laborers while forgiving student debt). But over the range where politicians may forgive student debt despite laborers being more (yet not enough) homogeneous, a subsidy to laborers complements student debt relief.

Relation to Literature. Our work falls within the broad literature on student loans (see Avery and Turner (2012), Amromin and Eberly (2016), Yannelis and Tracey (2022), and Looney and Yannelis (2024) for comprehensive overviews). It relates, in particular, to studies on student loan forgiveness (see Di Maggio et al. (2020), Catherine and Yannelis (2023), and Jacob et al. (2024) for recent empirical analyses on economic effects), including income-driven repayment plans (see Mueller and Yannelis (2022), Herbst (2023) for empirical analyses).

Theoretical papers on the topic focus on the design of education aid, including income-contingent loans, from the perspective of a benevolent welfare-maximizing planner. Ionescu (2011) studies how different student loan bankruptcy schemes perform from a welfare perspective in a life cycle economy. Hanushek et al. (2014) explore welfare implications of income-contingent loans within an overlapping generation framework. Findeisen and Sachs (2016) characterize a Pareto optimal system of income-contingent student loans. Stantcheva (2017), focusing on life-cycle human capital accumulation, shows that income-contingent loans can approach the welfare-maximizing solution.

We complement the above papers by studying student debt relief from a political economy perspective. Thus, a central point of distinction between our paper and the existing theoretical literature is that, in our setup, decisions are made by politicians who are neither benevolent (in that they are concerned with winning votes, not maximizing aggregate welfare), not dictators (in that they are allowed to make policy decisions only upon winning an election).

A second point of distinction that follows is that the decision on student debt relief is not ex ante embedded into the design of a student loan in our setup. Rather, this decision (though we account for citizens' ex ante anticipation) is only made ex post, after student loans have been granted.[1] In particular, in our setup, an (ex post) political decision on student debt relief is made as a result of citizens casting their vote at a time they know whether they are non-college laborers or graduates. When an (ex ante) economic decision is made by citizens on whether they go to college, not, they do not know (though they anticipate) the aforementioned political decision.

A third point of distinction is that our paper considers a static and highly stylized economic setup, as opposed to the dynamic and much richer economic frameworks that are considered by the aforementioned existing theoretical papers. In particular, in our setup, decisions are made by citizens calculating and anticipating at most second-order economic effects of student debt relief. Namely, we focus on effects that are substantial (and direct) enough for them to be considered by citizens when casting their vote (along with their non-policy considerations that are also accounted for via probabilistic voting). Specifically, we allow for (i) the harm (in terms of a reduced public good) on both non-college laborers and graduates in case government-funded student loans are not repaid, (ii) the benefit on college graduates as soon as their salary is not directed to repaying their student loan, and (iii) the benefit on college graduates in case student debt relief alleviates credit-rationing, thus allowing them to again access credit (for a productive

[1]Note the distinction between (i) student loan forgiveness (which is the subject of this paper) that is decided ex post at the discretion of the government, and (ii) student loan guarantees that are decided as an ex ante government commitment (which lies beyond the scope of this paper).

project after graduation).

We hence make a contribution that pertains specifically to the political economy of student debt forgiveness, which is a topic that (across disciplines) only recently attracted research attention. From a political science perspective, recent empirical studies suggest that student debt is a topic that boosts political participation, and that student debt relief can be electorally profitable (SoRelle and Laws, 2023; Macdonald, 2025). Moreover, a legal argument for student debt relief by the executive branch of the US government is made by Herrine (2020). Our paper contributes a first political economic theory of student debt relief.

We proceed as follows: In Section 2 we present the model. We obtain preliminary results in Section 3, and we characterize the equilibrium in Section 4. We extent the analysis in Section 5, and we conclude in Section 6. All proofs are in the Appendix.

2 Model

In a three period economy (t=0,1,2), there is a continuum of citizens of mass one, and a government. Let $i \in [0,1]$ denote an individual citizen. Everyone is risk-neutral, and there is no discount of future consumption. A citizen is either of type a, or of type b. Let $\tau_i = 0$ denote that citizen i is of type a, and $\tau_i = 1$ denote that citizen i is of type b. The values $\{\tau_i\}_{i\in[0,1]}$ are exogenously given at the beginning of time. We assume that citizens are ranked so that $\{\tau_i\}_{i\in[0,\mu_a]} = 0$, and $\{\tau_i\}_{i\in(1-\mu_b,1]} = 1$, where μ_a denotes the mass of type a citizens, and μ_b denotes the mass of type b citizens (with $\mu_a + \mu_b = 1$).

We will interpret type a citizens as those whose talents make them better suited for a manual (non-scholarly) job. Accordingly, type b citizens are interpreted as those whose talents make them better suited for a non-manual (scholarly) job. Nonetheless, at $t = 0$ every citizen (regardless of type) decides whether to go to college, or to work without a college degree. Let $\pi_i \in \{0,1\}$ denote whether citizen i chose to go to college ($\pi_i = 1$), or not ($\pi_i = 0$). We will use the term *social mobility* to refer to cases where $\pi_i \neq \tau_i$, i.e., when a type a citizen goes to college, or when a type b citizen does not.

We refer to citizens with $\pi_i = 0$ as laborers. We refer to citizens with $\pi_i = 1$ as students. We assume that all students eventually graduate at the end of $t = 0$, and thus use the terms students and graduates interchangeably. Let $\lambda \equiv \int_0^1 (1 - \pi_i)di$ and $\phi \equiv \int_0^1 \pi_i di$ denote the mass of laborers and students, respectively (with $\lambda + \phi = 1$). For the sake of exposition, we refer to laborers as males, and to students/graduates as females.

At $t = 1$, every laborer has access to a salaried job that offers a wage ω. Every graduate has also access to a salaried job at $t = 1$. The wage of a graduate depends on her type. In particular, we assume that the college functions as a signal that certifies a citizen's type. The wage of a type a graduate is $\underline{w}$, whereas the wage of a type b graduate is $\overline{w}$, where $\underline{w} < \overline{w}$ (reflecting the aforementioned interpretation of a type b citizen as better suited for college).

At $t = 2$, every citizen can pursue a project that requires a fixed cost of one unit. This cost is covered via a productive loan (to be distinguished from a student loan that is introduced below) that is granted at the beginning of $t = 2$ from a deep-pocketed credit market that is assumed to operate under perfect competition, and is otherwise passive. Therefore, citizens that obtain a productive loan have to return to their creditor the exact same amount they borrowed, i.e., one unit, at the end of $t = 2$, when the project is completed.

A citizen that obtains a loan decides afterward whether to exert low ($e_i = 0$) or high ($e_i = 1$) effort as in Tirole (2006, Chapter 3). If a borrower exerts low effort, the project returns nothing, yet the borrower receives a private non-monetary benefit β_i that draws from a uniform distribution with support $[0,1]$. Every citizen i is aware of his or her

β_i. Moreover, we assume that creditors are capable of learning β_i (which is an inverse measure of individual entrepreneurial capabilities) at no cost when citizen i applies for a loan. If a citizen exerts high effort, there is no private benefit, and the project generates a net outcome (i.e., production minus financing cost) x for a laborer, and y for a graduate.

As in Tirole (2006, Chapter 3), a loan is offered only if high effort is guaranteed (i.e., only if the borrower is incentive-compatible) since otherwise the creditor incurs losses with certainty. Let $\eta_i = 0$ denote that citizen i is incentive-incompatible as a laborer, in which case he has no access to credit, and does not implement his project at $t = 2$. Let $\eta_i = 1$ denote that citizen i is incentive-compatible as a laborer, in which case he obtains a loan and implements his project with high effort. Accordingly, $\xi_i = 0$ means that citizen i is incentive-incompatible as a graduate, and thus does not implement her project, whereas $\xi_i = 1$ means that citizen i is incentive-compatible as a graduate, in which case she obtains a loan and exerts high effort.

Citizens choosing to go to college borrow from the government, at $t = 0$, the amount T to pay their tuition fees. Graduates repay their student loan as they generate income at $t = 1$ and $t = 2$. An implication is that a graduate consumes nothing as long as she has outstanding student debt. A graduate defaults on outstanding student debt at the end of $t = 2$ if the cumulative income from her salaried job at $t = 1$, and her project at $t = 2$ is less than T. Any amount of student debt that is not repaid implies a loss for the government insofar as student loans are unsecured. Throughout the paper we assume that student loans are unsecured (which is the prevalent practice in the US).

A graduate's ability to repay her student loan does not automatically mean that the loan is repaid. It may remain unpaid if the government decides to offer student debt relief. Let $\rho \in \{0, 1\}$ denote this decision, where $\rho = 0$ means that students still have to repay their loan (as long as they can), whereas $\rho = 1$ means that the government forgives

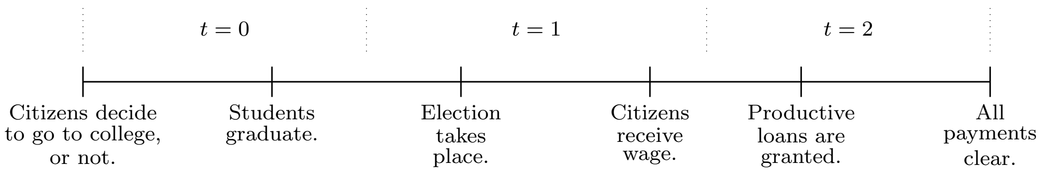


Figure 1: Timeline

student debt (regardless of a graduate's ability to repay).[2]

At the end of $t = 2$, upon collection of any student loan repayments, the government provides the public good

$$g(\rho) = I - \phi T + (1 - \rho) \int_0^1 \pi_i \left(\tau_i \min\{T, \overline{w} + \xi_i y\} + (1 - \tau_i) \min\{T, \underline{w} + \xi_i y\} \right) di, \quad (1)$$

where I is a given public endowment out of which student loans are financed. The public endowment is assumed to be sufficiently large so that a budget constraint is not binding.

The government is run by the winner of an electoral competition. As shown in Figure 1, the election takes place at $t = 1$, right after the completion of college (and before citizens seeking access to credit at $t = 2$). As stated in the Introduction, this timing aims at capturing contemporary discussions in the US about ex post student debt relief as a means to alleviate graduates' financial constraints.

There are two candidates (r and l). Let $\rho_j \in \{0, 1\}$ denote the student debt relief candidate $j \in \{r, l\}$ will implement upon winning the election.[3] Candidates are not aware of the private benefit β_i that corresponds to every individual citizen i. But we assume that the distribution of $\beta_i \sim \mathcal{U}(0, 1)$ is publicly known at the beginning of time. Moreover, candidates are non-ideological in that they merely aim at maximizing their probability of winning the election.

The electorate is composed of all citizens, and each citizen-voter has exactly one

[2]We study income-driven repayment in Section 5.

[3]Allowing politicians to choose only between the corner values is not consequential, as a result of our setup's linearity.

vote. We adopt the standard assumptions that every citizen votes, and that citizens vote sincerely for their preferred policy, i.e., they vote for the candidate whose policy would generate the highest individual utility (see Riker and Ordeshook (1973), among many others).

Following probabilistic voting (Lindbeck and Weibull, 1987; Yang, 1995; Persson and Tabellini, 1999), we assume that citizen i's individual utility reads

$$u_i(\rho_r, \rho_l) = \begin{cases} c_i^1(\rho_r) + (1-\pi_i)b_l + \pi_i b_g & \text{if r wins} \\ c_i^1(\rho_l) + B & \text{if l wins,} \end{cases} \tag{2}$$

where $b_l \in \mathcal{U}(-1/(2\psi_l), 1/(2\psi_l))$ and $b_g \in \mathcal{U}(-1/(2\psi_g), 1/(2\psi_g))$ represent laborer-specific and graduate-specific biases, respectively, $B \in \mathcal{U}(-1/(2\chi), 1/(2\chi))$ represents general political biases, and

$$\begin{aligned} c_i^1(\rho) =& (1-\pi_i)\left(\omega + \eta_i x\right) \\ &+\pi_i(1-\tau_i)\left(\max\{0, \underline{w} - (1-\rho)T\} + \xi_i \max\{0, y - \max\{0, (1-\rho)T - \underline{w}\}\}\right) \\ &+\pi_i\tau_i\left(\max\{0, \overline{w} - (1-\rho)T\} + \xi_i \max\{0, y - \max\{0, (1-\rho)T - \overline{w}\}\}\right) \\ &+g(\rho) \end{aligned} \tag{3}$$

denotes the economic payoff of citizen i if policy ρ is implemented, as perceived at the beginning of period $t = 1$, namely, before the election takes place, and after the values $\{\pi_i\}_{i\in[0,1]}$ have been determined.[4] The first line in Equation (3) pertains to the individual income of a laborer, the second line describes the individual income of a type a graduate, the third line describes the individual income of a type b graduate, and the fourth line pertains to the public good (as described by Equation (1)) that is provided to everyone.

[4]As explained above, there is no solution where a citizen obtains a loan and exerts low effort. That is, $\eta_i = 1$ or $\xi_i = 1$ means that citizen i accesses credit and exerts high effort at $t = 2$, whereas $\eta_i = 0$ or $\xi_i = 0$ means that citizen i has no access to credit, and thus earns no income at $t = 2$.

The distribution parameters ψ_l, ψ_g and χ are inverse measures of the extent to which voters' behavior is driven by random biases (or, more generally, by issues other than ρ). We work with the standard assumption in probabilistic voting that ψ_l, ψ_g and χ are small enough so that every candidate has a chance to compete for every individual citizen's vote. Moreover, we define

$$\Psi \equiv \psi_g/\psi_l \in (0, +\infty) \tag{4}$$

as the extent to which laborers' voting behavior is driven by random biases relative to graduates'. We say that laborers' preferences are more homogeneous than graduates' if $\Psi < 1$, and vice versa.

Throughout the paper we make the otherwise inconsequential assumptions that (i) a candidate j chooses $\rho_j = 0$ in case of indifference between $\rho_j = 0$ and $\rho_j = 1$, and (ii) a citizen i chooses $\pi_i = 0$ in case of indifference between $\pi_i = 0$ and $\pi_i = 1$.

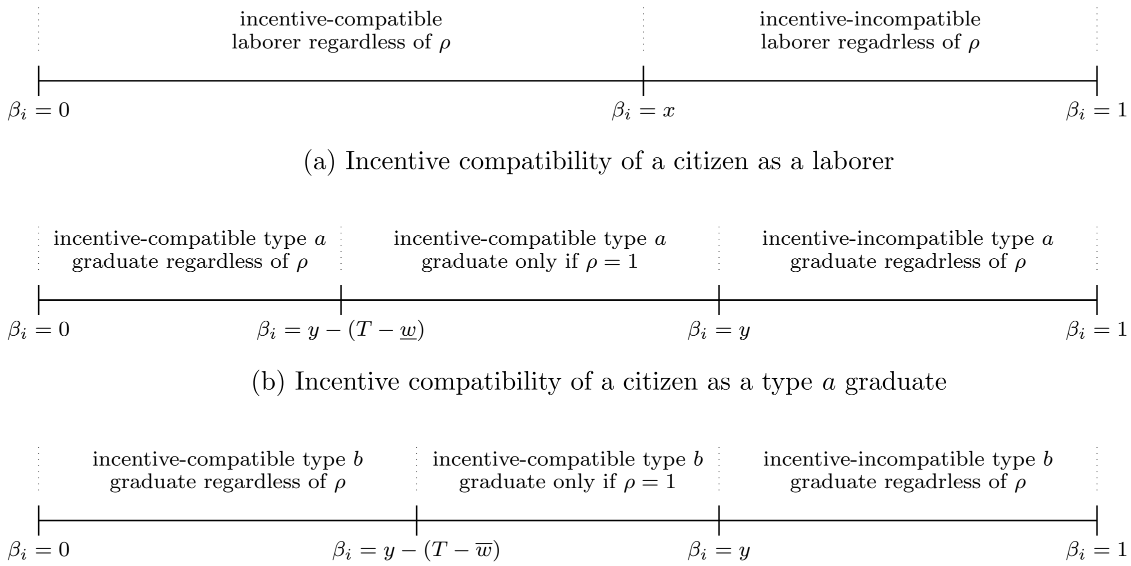
3 Preliminary Analysis

We proceed to study the incentive compatibility constraint for a citizen to access credit at $t = 2$, and the participation constraint for a citizen to choose college at $t = 0$.

3.1 Incentive Compatibility Constraint

The incentive compatibility constraint that needs to be satisfied for a creditor to grant a productive loan to a laborer (because otherwise the repayment is zero) at $t = 2$, reads

$$\beta_i < x. \tag{5}$$



(a) Incentive compatibility of a citizen as a laborer

(b) Incentive compatibility of a citizen as a type a graduate

(c) Incentive compatibility of a citizen as a type b graduate

Figure 2: Segmentation of citizens based on their incentive compatibility in a specification where $-y < \underline{w} - T < \overline{w} - T < 0$.

Therefore, we obtain that citizen i is incentive-compatible as a laborer as follows:

$$\eta_i = \begin{cases} 1 & \text{if } \beta_i < x \\ 0 & \text{if } x \leq \beta_i. \end{cases} \tag{6}$$

As shown in the graphical illustration by Figure 2a, the incentive compatibility of laborers (who are not burdened by student debt) depends neither on type nor on student debt relief. A laborer's incentive compatibility depends only on his private benefit: He is incentive compatible if his private benefit is small enough, and he is incentive incompatible otherwise.

On the contrary, the incentive compatibility of graduates (bearing student debt) depends both on type and student debt relief. In particular, the incentive compatibility constraint that needs to be satisfied for a creditor to grant a productive loan to a graduate, reads

$$\beta_i < y - \tau_i \max\{0, (1-\rho)T - \overline{w}\} - (1-\tau_i)\max\{0, (1-\rho)T - \underline{w}\}. \tag{7}$$

Substituting for $\rho = 1$ and $\rho = 0$, we obtain that a type a graduate ($\tau_i = 0$) with private benefit β_i obtains a productive loan or fails to do so, as follows:

$$\{\xi_i\}_{i\in[0,\mu_a]} = \begin{cases} 1 & \begin{array}{l} \text{if } \beta_i < y - \max\{0, T - \underline{w}\} \text{ and } \rho \in \{0,1\}, \\ \text{ or } y - \max\{0, T - \underline{w}\} \leq \beta_i < y \text{ and } \rho = 1 \end{array} \\ 0 & \begin{array}{l} \text{if } y - \max\{0, T - \underline{w}\} \leq \beta_i < y \text{ and } \rho = 0, \\ \text{ or } y \leq \beta_i \text{ and } \rho \in \{0,1\}. \end{array} \end{cases} \tag{8}$$

As also shown in the graphical illustration by Figure 2b, type a graduates with an intermediate private benefit, i.e., with $y - \max\{0, T - \underline{w}\} \leq \beta_i < y$, will need student debt relief to obtain a loan at $t = 2$. At the same time, the incentive compatibility of type a graduates with too small or too large private benefit does not depend on policy: Regardless of ρ, a type a graduate with $\beta_i < y - \max\{0, T - \underline{w}\}$ is incentive compatible, whereas a type a graduate with $y \leq \beta_i$ is incentive incompatible.

Finally, substituting for $\rho = 1$ and $\rho = 0$ into condition (7), we obtain that a type b graduate ($\tau_i = 1$) with private benefit β_i obtains a productive loan or fails to do so, as follows:

$$\{\xi_i\}_{i\in(1-\mu_b,1]} = \begin{cases} 1 & \begin{array}{l} \text{if } \beta_i < y - \max\{0, T - \overline{w}\} \text{ and } \rho \in \{0,1\}, \\ \text{ or } y - \max\{0, T - \overline{w}\} \leq \beta_i < y \text{ and } \rho = 1 \end{array} \\ 0 & \begin{array}{l} \text{if } y - \max\{0, T - \overline{w}\} \leq \beta_i < y \text{ and } \rho = 0, \\ \text{ or } y \leq \beta_i \text{ and } \rho \in \{0,1\}. \end{array} \end{cases} \tag{9}$$

The segmentation of type b graduates (see Figure 2c) is analogous to the segmentation of type a graduates. The only difference is that the threshold value of private benefit above which a type b graduate's access to credit depends on policy increases (as compared to the respective threshold for type a graduates). The reason is that type b graduates earn a larger wage at $t = 1$, and thus they enter $t = 2$ (i.e., they seek access to credit for their project) with a smaller amount of outstanding student debt.

3.2 Participation Constraint

The consumption of citizen i, as perceived at the beginning of period $t = 0$ (i.e., at the time citizens choose π_i), reads as follows:

$$c_i^0(\pi_i) = (1 - \pi_i)(\omega + \eta_i x) + \pi_i (\mathbb{E}[w]_i + \mathbb{E}[y]_i) + \mathbb{E}[g], \tag{10}$$

where

$$\begin{aligned}\mathbb{E}[w]_i =&(1 - \tau_i) \sum_{j\in\{r,l\}} \Pr(\text{j wins}) \max\{0, \underline{w} - (1 - \rho_j)T\} \\ &+ \tau_i \sum_{j\in\{r,l\}} \Pr(\text{j wins}) \max\{0, \overline{w} - (1 - \rho_j)T\}\end{aligned} \tag{11}$$

is the expected income of citizen i from her salaried job as a graduate at $t = 1$,

$$\begin{aligned}\mathbb{E}[y]_i =&(1 - \tau_i) \sum_{j\in\{r,l\}} \Pr(\text{j wins})\xi_i(\rho_j) \max\{0, y - \max\{0, (1 - \rho_j)T - \underline{w}\}\} \\ &+ \tau_i \sum_{j\in\{r,l\}} \Pr(\text{j wins})\xi_i(\rho_j) \max\{0, y - \max\{0, (1 - \rho_j)T - \overline{w}\}\}\end{aligned} \tag{12}$$

is the expected income of citizen i as a graduate at $t = 2$, and

$$\mathbb{E}[g] = \sum_{j\in\{r,l\}} \Pr(\text{j wins})g(\rho_j) \tag{13}$$

denotes the expected public good as perceived at the beginning of $t = 0$.

From Equation (10) we obtain the participation constraint

$$\omega + \eta_i x < \mathbb{E}[w]_i + \mathbb{E}[y]_i \tag{14}$$

that needs to be satisfied for a citizen at the beginning of $t = 0$ to choose to go to college (i.e., to choose $\pi_i = 1$). It becomes apparent from Equations (11) and (12) that student debt relief looses the participation constraint (14) (besides loosing the incentive compatibility constraint (7)): To the extent student debt relief is anticipated, citizens understand that tuition fees will eventually be shifted to the entire society, and thus they decide on π_i without internalizing T. As a result, the choice of college is perceived more profitable than it would otherwise be.

4 Equilibrium

We proceed to characterize the equilibrium solution. We first restrict our focus to cases with no social mobility in the sense that all type a citizens choose to work without a college degree, and all type b citizens go to college. We will then consider cases with social mobility where type a citizens may end up in college.

4.1 Without Social Mobility

To focus on the basic electoral mechanics, we consider a setup with no social mobility, i.e., $\{\pi_i\}_{i\in[0,1]} = \tau_i$. This would endogenously occur as every individual citizen's decision in a specification where $\underline{w} < \omega < \overline{w} - T$ and $x = y < 1$.[5] This specification is assumed to hold in this subsection. This refers to a setup where (i) the salary of a type b citizen

[5]The individual income of a type a citizen with private benefit β_i is, at best, $\underline{w} + \xi_i y$ as a graduate, whereas it is $\omega + \eta_i x$ as a laborer. The individual income of a type b citizen with private benefit β_i is, at worst, $\overline{w} - T + \xi_i y$ as a graduate, whereas it is $\omega + \eta_i x$ as a laborer. Under $\underline{w} < \omega < \overline{w} - T$ and $x = y < 1$, which also implies that $\xi_i \leq \eta_i$ for a type a citizen, whereas $\xi_i = \eta_i$ for a type b citizen, $\{\pi_i\}_{i\in[0,1]} = \tau_i$ maximizes the payoffs (as perceived at the beginning of $t = 0$) of every individual citizen.

as a graduate is larger than the same citizen's salary as a laborer, even after subtracting the student loan repayment, (ii) a type a graduate ends up in the same job as a type a laborer, but the latter enjoys higher income (say due to earlier entrance), and (iii) the outcome of an entrepreneurial project does not depend on college education.[6]

Let $\mathcal{G}^{\text{nsm}}$ denote the game with *no social mobility* where candidates, having observed that $\{\pi_i\}_{i\in[0,1]} = \tau_i$, and knowing that citizen i's utility is determined by Equations (2) and (3), set ρ_r and ρ_l aiming at maximizing their probability of winning the election. An *equilibrium* of game $\mathcal{G}^{\text{nsm}}$ refers to a pair $(\rho_r^{\text{nsm}^*}, \rho_l^{\text{nsm}^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

Proposition 1. *Consider the game $\mathcal{G}^{\text{nsm}}$, where $\underline{w} < \omega < \overline{w} - T$ and $x = y < 1$.*

- *For $\Psi \leq 1$, candidates set $(\rho_r^{\text{nsm}^*}, \rho_l^{\text{nsm}^*}) = (0, 0)$.*
- *For $1 < \Psi$, candidates set $(\rho_r^{\text{nsm}^*}, \rho_l^{\text{nsm}^*}) = (1, 1)$.*

When political candidates decide on student debt relief in game $\mathcal{G}^{\text{nsm}}$ are solely driven by the redistributional effects on laborers and graduates. In particular, candidates maximize their probability of winning by pivoting the redistributional effects so that they favor the group of citizens whose voting behavior depends less on random biases. Indeed, as in standard probabilistic voting (Lindbeck and Weibull, 1987), office-motivated candidates cater to the most homogeneous group of citizens-voters: Laborers are rewarded with $(\rho_r^{\text{nsm}^*}, \rho_l^{\text{nsm}^*}) = (0, 0)$ when $\Psi \leq 1$, whereas graduates are rewarded with $(\rho_r^{\text{nsm}^*}, \rho_l^{\text{nsm}^*}) = (1, 1)$ when $1 < \Psi$.

Apart from redistribution between laborers and graduates, student debt relief has no other economic effect in game $\mathcal{G}^{\text{nsm}}$: Regardless of the political equilibrium, every type a citizen becomes a laborer, and thus generates ω at $t = 1$, and x at $t = 2$ as long as his

[6] From Subsection 4.2 onward we consider specifications where the entrepreneurial project generates a higher income with college education. Parametric restrictions throughout the paper merely facilitate the exposition, and are not necessary for the analysis. It is straightforward to extend the analysis under specifications that are not confined to such parametric restrictions.

private benefit β_i is less than x (as known from Equation (6)). Accordingly, regardless of the political equilibrium, every type b citizen goes to college, and thus receives $\overline{w} - T$ at $t = 1$, and y at $t = 2$ as long as his private benefit β_i is less than y (according to Equation (9) when $\underline{w} < \omega < \overline{w} - T$ as in game $\mathcal{G}^{\text{nsm}}$). But student debt relief is supposed to generate an economic impact by alleviating credit-rationing, and student loans are supposed to trigger social mobility in the first place. Do the political considerations change when these economic effects are active?

4.2 With Social Mobility

We proceed to consider a setup where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. This refers to a setup where (i) the salary of a type b citizen as a graduate is larger than the same citizen's salary as a laborer, even after subtracting the student loan repayment, (ii) the salary of a type a graduate at $t = 1$ not only is lower than the same citizen's salary as a laborer, but it is also insufficient to repay the student loan, and (iii) the outcome of an entrepreneurial project is much larger with college education so that it suffices for repaying any outstanding student debt, and (some) type a citizens may pursue a college degree.

Let $\mathcal{G}^{\text{wsm}}$ denote the sequential game *with social mobility* where (i) at $t = 0$, every citizen $i \in [0, 1]$ sets π_i aiming at maximizing individual economic payoffs as determined by Equation (10), and (ii) at $t = 1$, candidates, having observed $\{\pi_i\}_{i\ \in[0,1]}$, and knowing that citizen i's utility is determined by Equations (2) and (3), set ρ_r and ρ_l aiming at maximizing their probability of winning the election. An *equilibrium* of game $\mathcal{G}^{\text{wsm}}$ refers to a tuple $(\{\pi_i^{\text{wsm}^*}\}_{i\in[0,1]}, \rho_r^{\text{wsm}^*}, \rho_l^{\text{wsm}^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

It is useful to define

$$z = \begin{cases} 0 & \text{if } y - T + \underline{w} \leq x + \omega \\ 1 & \text{if } x + \omega < y - T + \underline{w} \end{cases} \tag{15}$$

as the dummy variable identifying whether, conditioned on being incentive-compatible, a type a citizen is more productive when going to college ($z = 1$), or when working without a college degree ($z = 0$).

Proposition 2. *Consider the game* $\mathcal{G}^{\text{wsm}}$ *where* $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ *and* $x + \omega < y < 1$. *Let*

$$\zeta \equiv \frac{1}{1 + \dfrac{(T - \underline{w})y}{(1 - y)\left((\mu_b + \mu_a(y - T + \underline{w}))T - \mu_a(T - \underline{w})\underline{w}\right)}} \in (0, 1). \tag{16}$$

- *For* $\Psi \leq \zeta$, *then* $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})} = z$, $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w},1]} = 0$, $\{\pi_i^{\text{wsm}^*}\}_{i \in (1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{wsm}^*}, \rho_l^{\text{wsm}^*}) = (0, 0)$.

- *For* $\zeta < \Psi \leq 1$, *then either* $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})} = z$, $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w},1]} = 0$, $\{\pi_i^{\text{wsm}^*}\}_{i \in (1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{wsm}^*}, \rho_l^{\text{wsm}^*}) = (0, 0)$, *or* $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0,y)} = 1$, $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y,1]} = 0$, $\{\pi_i^{\text{wsm}^*}\}_{i \in (1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{wsm}^*}, \rho_l^{\text{wsm}^*}) = (1, 1)$.

- *For* $1 < \Psi$, *then* $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0,y)} = 1$, $\{\pi_i^{\text{wsm}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y,1]} = 0$, $\{\pi_i^{\text{wsm}^*}\}_{i \in (1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{wsm}^*}, \rho_l^{\text{wsm}^*}) = (1, 1)$.

As in game $\mathcal{G}^{\text{nsm}}$, candidates in game $\mathcal{G}^{\text{wsm}}$ cater to the demands of laborers for small enough values of Ψ, and they cater to the demands of graduates for large enough values of Ψ. But there is an intermediate range of Ψ, i.e., for $\zeta < \Psi \leq 1$, over which the seeds of redistribution may go in either direction since two different equilibria can occur.

The reason for the dual equilibrium when $\zeta < \Psi \leq 1$ is the strategic complementarities that characterize the decisions of citizens who need student debt relief to gain access to credit, which in turn spill onto politicians' decisions. If these citizens go to college, while $\zeta < \Psi \leq 1$, then student debt relief becomes an electoral necessity for politicians. In turn, this makes college the most profitable choice for these citizens, thus self-fulfilling their choice. Accordingly, politicians are preempted from offering student debt relief if the same pivotal mass of citizens does not go to college while $\zeta < \Psi \leq 1$. In the absence of student debt relief, these citizens decision is indeed self-fulfilled.

We have thus shown that the economic effects of student loans and student debt relief shape the political considerations in a substantial manner. Comparing Propositions 1 and 2, we observe that these economic effects make the political appeal of student debt relief asymmetric. According to Proposition 1, the group that is more homogeneous is rewarded in game $\mathcal{G}^{\text{nsm}}$. According to Proposition 2, when graduates are more homogeneous than laborers, student debt relief is guaranteed. But student debt relief may be offered even when graduates are less homogeneous (specifically, when $\zeta < \Psi \leq 1$), as soon as a pivotal mass of type a citizens decides to go to college.

This political asymmetry in favor of student debt relief is in place because the government (regardless of ρ) incurs (some) losses as soon as type a citizens with $y - T + \underline{w} \leq \beta_i < y$ go to college: If student debt relief is not offered, these citizens will not access credit and thus they will not be able to repay their outstanding debt $T - \underline{w}$ at $t = 2$. If student debt relief is offered, then again these graduates will not repay their student loan. In other words, as soon as type a citizens with $y - T + \underline{w} \leq \beta_i < y$ decide to go to college, at least a part of their tuition fees (i.e., $T - \underline{w}$) becomes a sunk cost. In turn, this means that student debt relief favors graduates more than it harms laborers, thus becoming the optimal strategy for politicians.

5 Extensions

We extent the analysis in three directions. First, we allow politicians to condition student debt relief on graduates' income at $t = 1$. Second, we explore a scenario where politicians can condition student debt relief not only on graduates' income at $t = 1$, but also on whether a graduate needs it to become incentive-compatible. We finally introduce a second policy that causes a redistribution in favor of laborers, and we study its interaction with student debt relief.

5.1 Income-Driven Repayment

In this subsection we consider a setup where politicians may choose to offer student debt relief based on income. This aims at capturing features of income-driven repayment plans that are currently being offered in the US. Let $\rho \in \{0, 1, 2\}$, where $\rho = 0$ means no student debt relief, $\rho = 1$ means student debt relief for all graduates, and $\rho = 2$ means that any outstanding student debt at the beginning of $t = 2$, i.e., once any salary income has been used for repaying student debt, is forgiven.

We focus again on cases with social mobility, i.e., where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. Since this specification means that a type b graduate is always able to repay her student debt by the end of $t = 1$, only type a graduates are eligible of student debt relief if $\rho = 2$. We then define

$$\gamma_i^1 = \begin{cases} 1 & \text{if } \rho = 1 \\ 0 & \text{otherwise,} \end{cases} \tag{17}$$

which denotes whether citizen i's outstanding student debt at the beginning of $t = 1$ is forgiven ($\gamma_i^1 = 1$), or not ($\gamma_i^1 = 0$), and

$$\gamma_i^2 = \begin{cases} 1 & \text{if } \rho = 2 \text{ and } \tau_i = 0 \\ 0 & \text{otherwise,} \end{cases} \tag{18}$$

which denotes whether citizen i's outstanding student debt at the beginning of $t = 2$ is forgiven ($\gamma_i^2 = 1$), or not ($\gamma_i^2 = 0$).

The laborers' incentive compatibility constraint (5) remains unchanged, whereas the graduates' incentive compatibility constraint (7) still holds, only replacing ρ with $\gamma_i^1 + \gamma_i^2$. Thus, we obtain that a type a graduate with private benefit β_i obtains a productive loan or fails to do so, according to

$$\{\xi_i\}_{i\in[0,\mu_a]} = \begin{cases} 1 & \begin{array}{l} \text{if } \beta_i < y - \max\{0, T - \underline{w}\} \text{ and } (\gamma_i^1 + \gamma_i^2) \in \{0,1\}, \\ \text{or } y - \max\{0, T - \underline{w}\} \leq \beta_i < y \text{ and } \gamma_i^1 + \gamma_i^2 = 1 \end{array} \\ 0 & \begin{array}{l} \text{if } y - \max\{0, T - \underline{w}\} \leq \beta_i < y \text{ and } \gamma_i^1 + \gamma_i^2 = 0, \\ \text{or } y \leq \beta_i \text{ and } (\gamma_i^1 + \gamma_i^2) \in \{0,1\}. \end{array} \end{cases} \tag{19}$$

Accordingly, a type b graduate with private benefit β_i obtains a productive loan or fails to do so, as follows:

$$\{\xi_i\}_{i\in(1-\mu_b,1]} = \begin{cases} 1 & \begin{array}{l} \text{if } \beta_i < y - \max\{0, T - \overline{w}\} \text{ and } (\gamma_i^1 + \gamma_i^2) \in \{0,1\}, \\ \text{or } y - \max\{0, T - \overline{w}\} \leq \beta_i < y \text{ and } \gamma_i^1 + \gamma_i^2 = 1 \end{array} \\ 0 & \begin{array}{l} \text{if } y - \max\{0, T - \overline{w}\} \leq \beta_i < y \text{ and } \gamma_i^1 + \gamma_i^2 = 0, \\ \text{or } y \leq \beta_i \text{ and } (\gamma_i^1 + \gamma_i^2) \in \{0,1\}. \end{array} \end{cases} \tag{20}$$

Accounting for that the salary at $t = 1$ of a type a (b) graduate does not suffice (suffices) for fully repaying her student debt in the specification under consideration (i.e., where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$), we write the payoff of citizen

i, as perceived at the beginning of $t = 1$, as follows:

$$\begin{aligned} c_i^1(\rho) =& (1-\pi_i)\left(\omega + \eta_i x\right) \\ & + \pi_i(1-\tau_i)\gamma_i^1 \underline{w} + \xi_i(y - (1-\gamma_i^1 - \gamma_i^2)T) \\ & + \pi_i \tau_i \left(\overline{w} - (1-\gamma_i^1)T + \xi_i y\right) \\ & + g(\rho), \end{aligned} \tag{21}$$

where η_i is given by Equation (6), ξ_i is given by Equations (19) and (20), and

$$g(\rho) = I - \phi T + \int_0^1 \pi_i \left(\tau_i(1-\gamma_i^1)T + (1-\tau_i)\left((1-\gamma_i^1-\gamma_i^2)T + \gamma_i^2 \underline{w}\right)\right) di. \tag{22}$$

Moreover, the consumption of citizen i, as perceived at the beginning of period $t = 0$ (i.e., at the time citizens choose π_i), is as follows:

$$c_i^0(\pi_i) = (1-\pi_i)\left(\omega + \eta_i x\right) + \pi_i\left(\mathbb{E}[w]_i + \mathbb{E}[y]_i\right) + \mathbb{E}[g], \tag{23}$$

where

$$\mathbb{E}[w]_i = (1-\tau_i)\underline{w} \sum_{j\in\{r,l\}} \Pr(\text{j wins})\gamma_i^1(\rho_j) + \tau_i \left(\overline{w} - T + T\sum_{j\in\{r,l\}} \Pr(\text{j wins})\gamma_i^1(\rho_j)\right) \tag{24}$$

is the expected income of citizen i from her salaried job as a graduate at $t = 1$,

$$\begin{aligned} \mathbb{E}[y]_i =& (1-\tau_i)\sum_{j\in\{r,l\}} \Pr(\text{j wins})\xi_i\left(y - (1-\gamma_i^1-\gamma_i^2)(T - \underline{w})\right) \\ & + \tau_i \sum_{j\in\{r,l\}} \Pr(\text{j wins})\xi_i(\gamma_i^1 + \gamma_i^2)y \end{aligned} \tag{25}$$

is the expected income of citizen i as a graduate at $t = 2$, and

$$\mathbb{E}[g] = \sum_{j \in \{r,l\}} \Pr(\text{j wins}) g(\rho_j), \tag{26}$$

with g being given by Equation (22), denotes the expected public good as perceived at the beginning of $t = 0$.

Let $\mathcal{G}^{\text{idr}}$ denote the sequential game with *income-driven repayment* where (i) at $t = 0$, every citizen $i \in [0, 1]$ sets π_i aiming at maximizing economic payoffs c_i^0 as determined by Equations (6), (17)–(20), and (22)–(26), and (ii) at $t = 1$, candidates, having observed $\{\pi_i\}_{i\in[0,1]}$, and knowing that citizen i's utility u_i is determined by Equations (2), (6), and (17)–(22), set ρ_r and ρ_l aiming at maximizing their probability of winning the election. An *equilibrium* of game $\mathcal{G}^{\text{idr}}$ refers to a tuple $(\{\pi_i^{\text{idr}^*}\}_{i\in[0,1]}, \rho_r^{\text{idr}^*}, \rho_l^{\text{idr}^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

Proposition 3. *Consider the game $\mathcal{G}^{\text{idr}}$ where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. Let*

$$\zeta^{\text{idr}} \equiv \frac{1}{1 + \dfrac{y}{(1-y)\mu_a(y - T + \underline{w})}} \in (0, 1). \tag{27}$$

- *For $\Psi \leq \zeta^{\text{idr}}$, then $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, $\{\pi_i^{\text{idr}^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{\text{idr}^*}, \rho_l^{\text{idr}^*}) = (0, 0)$.*

- *For $\zeta < \Psi \leq 1$, then either $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, $\{\pi_i^{\text{idr}^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{\text{idr}^*}, \rho_l^{\text{idr}^*}) = (0, 0)$, or $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{\text{idr}^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{\text{idr}^*}, \rho_l^{\text{idr}^*}) = (2, 2)$.*

- *For $1 < \Psi$, then $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{\text{idr}^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{\text{idr}^*}, \rho_l^{\text{idr}^*}) = (1, 1)$.*

The political asymmetry of student debt relief holds in game $\mathcal{G}^{\text{idr}}$ as in game $\mathcal{G}^{\text{wsm}}$: Student debt relief may be offered by politicians even when laborers are more homogeneous. We observe however two quantitative differences. First, $\{\rho_j\}_{j\in\{r,l\}} = 1$ when type a citizens with $y - T + \underline{w} \leq \beta_i < y$ go to college in game $\mathcal{G}^{\text{wsm}}$ with $\zeta < \Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 2$ when the same happens in game $\mathcal{G}^{\text{idr}}$ with $\zeta^{\text{idr}} < \Psi \leq 1$. Second, $\zeta^{\text{idr}} < \zeta$.

The first quantitative difference means that the possibility of income-driven repayments decreases the extent of student debt relief when offered despite graduates being less homogeneous. In particular, only type a graduates benefit from student debt relief when offered in game $\mathcal{G}^{\text{idr}}$ for $\zeta^{\text{idr}} < \Psi \leq 1$. As explained in the discussion that follows Proposition 2, student debt relief is offered despite graduates being less homogeneous because at least a part of student loan repayments is lost with certainty as soon as type a citizens with $y - T + \underline{w} \leq \beta_i < y$ decide to go to college. By choosing income-driven debt relief, politicians cover these citizens, while minimizing the extent of redistribution against laborers who are still more homogeneous as long as $\zeta^{\text{idr}} < \Psi \leq 1$.

This containment of redistribution against laborers explains the second quantitative difference. The harm to laborers is lower when type a citizens with $y - T + \underline{w} \leq \beta_i < y$ go to college in game $\mathcal{G}^{\text{idr}}$, as compared to when this happens in game $\mathcal{G}^{\text{wsm}}$. As a result, this pivotal mass of citizens can prompt politicians to inflict this harm to laborers as soon as $\zeta^{\text{idr}} < \Psi$, i.e., including values of graduates' homogeneity relative to laborers' (as measured by Ψ) that are lower than the threshold ζ. That is, being able to contain the extent of student debt relief, politicians offer it (and citizens prompt it) more often.

5.2 Income-and-Incentive-Driven Repayment

Politicians were allowed to contain student debt relief only to type a citizens in the preceding subsection. They were still unable to condition student debt relief on a citizen's individual incentive-incompatibility. The reason is that we have assumed so far that politicians, and the government that is run by politicians, knows the distribution of β_i, but not the materialized value for every citizen i. In this subsection we explore the (less realistic, but analytically interesting) possibility for student debt relief that is both income- and incentive-driven.

Let $\rho = 2$ mean that any outstanding student debt at the beginning of $t = 2$, i.e., once any salary income has been used for repaying student debt, is forgiven *only for those citizens whose incentive-compatibility depends on student debt relief.* We let $\rho = 0$ and $\rho = 1$ have the same meaning as in the preceding analysis. Moreover, to ensure the possibility of social mobility, we still focus on cases where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$.

This setup is fully described by Equations (17) and (19)-(26), plus

$$\gamma_i^2 = \begin{cases} 1 & \text{if } \rho = 2,\ \tau_i = 0 \text{ and } y - T + \underline{w} \leq \beta_i < y \\ 0 & \text{otherwise ,} \end{cases} \tag{28}$$

which replaces Equation (18).

Let $\mathcal{G}^{\text{iidr}}$ denote the sequential game with *income-and-incentive-driven repayment* where (i) at $t = 0$, every citizen $i \in [0, 1]$ sets π_i aiming at maximizing economic payoffs c_i^0 as determined by Equations (6), (17), (19)–(20), (22)–(26), and (28) and (ii) at $t = 1$, candidate $j \in \{r, l\}$, having observed $\{\pi_i\}_{i\in[0,1]}$, and knowing that citizen i's utility u_i is determined by Equations (2), (6), (17), (19)–(22) and (28), set $\rho_j \in \{0, 1, 2\}$ aiming at maximizing their probability of winning the election. An *equilibrium* of game $\mathcal{G}^{\text{iidr}}$ refers to a tuple $(\{\pi_i^{\text{iidr}^*}\}_{i\in[0,1]}, \rho_r^{\text{iidr}^*}, \rho_l^{\text{iidr}^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

Proposition 4. *Consider the game $\mathcal{G}^{\text{iidr}}$ where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$.*

- *For $\Psi \leq 1$, then either $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} =$*

0, $\{\pi_i^{\text{iidr}^*}\}_{i\in(1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{iidr}^*}, \rho_l^{\text{idr}^*}) = (0,0)$, *or* $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},y)} = 1$, $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{\text{iidr}^*}\}_{i\in(1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{iidr}^*}, \rho_l^{\text{iidr}^*}) = (2,2)$.

- *For* $1 < \Psi$, *then* $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{\text{iidr}^*}\}_{i\in(1-\mu_b,1]} = 1$ *and* $(\rho_r^{\text{iidr}^*}, \rho_l^{\text{iidr}^*}) = (1,1)$.

Politicians make use of the possibility to offer student debt relief only to those citizen whose (i) salary income at $t = 1$ does not allow them to fully repay their student loan, and (ii) incentive compatibility depends on student debt relief. This strategy is chosen by politicians as long as laborers are more homogeneous than graduates, subject to $\{\pi_i^{\text{idr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},y)} = 1$ due to the strategic complementarities that are explained in the discussion that follows Proposition 2. That is, being able to offer even more contained student debt relief, they do so over an even wider range in game $\mathcal{G}^{\text{iidr}}$ (as compared to game $\mathcal{G}^{\text{idr}}$).

Moreover, the possibility of an income-and-incentive-driven repayment gives rise to an allocation that does not appear in the preceding analysis. Specifically, when $\Psi < 1$, there is an where $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = 0$, and $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},y)} = 1$. This means that type a citizens who are incentive-compatible as graduates without student debt relief choose to work without a college degree, whereas type a citizens who are incentive-compatible as graduates only with student debt relief go to college. Notwithstanding questions of fairness, such an allocation improves aggregate welfare in that it takes place only when a type a citizen is more productive without a college degree (i.e., when $z = 0$). At the same time, this means that when $z = 0$, a welfare loss as a result of $\{\pi_i^{\text{iidr}^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},y)} = 1$ only hinges on how strategic complementarities of a pivotal mass of type a citizens play out in equilibrium.

5.3 Interaction with a Laborer Subsidy

We return to our baseline setup where politicians either forgive student debt for all graduates, or for none. In this setup we introduce a second policy tool that causes a redistribution running in the opposite direction compared to student debt relief. In particular, laborers may receive a stipend $s > 0$ from the government. The value of stipend s is fixed and publicly known at the beginning of time. But whether, or not, the stipend s is eventually offered depends on a government decision. Let $\sigma_j = 0$ mean that candidate $j \in \{r, l\}$ offers no stipend if elected, and $\sigma_j = 1$ mean that candidate $j \in \{r, l\}$ offers the stipend s to every laborer if elected.

To keep the possibility of social mobility open, we assume that $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. To avoid undue technical complications, we also assume that s takes a strictly positive yet infinitesimal value.[7] Under this specification, the consumption of citizen i, as perceived at the beginning of $t = 1$ (right before the election), reads

$$\begin{aligned} c_i^1(\rho, \sigma) =& (1 - \pi_i)\left(\omega + \eta_i x + \sigma s\right) \\ &+ \pi_i (1 - \tau_i)\left(\max\{0, \underline{w} - (1 - \rho)T\} + \xi_i\left(y - \max\{0, (1 - \rho)T - \underline{w}\}\right)\right) \\ &+ \pi_i \tau_i \left(\overline{w} - (1 - \rho)T + \xi_i\left(y - \max\{0, (1 - \rho)T - \overline{w}\}\right)\right) \\ &+ g(\rho, \sigma), \end{aligned} \tag{29}$$

where η_i is given by Equation (6), ξ_i is given by Equations (8) and (9), and

$$g = I - \phi T + (1 - \rho) \int_0^1 \pi_i\left(\tau_i \min\{T, \overline{w} + \xi_i y\} + (1 - \tau_i)\min\{T, \underline{w} + \xi_i y\}\right) di - \sigma s \lambda \tag{30}$$

is the public good that is offered to everyone upon the collection of any student loan repayments and the payment of any stipends.

[7] Our analysis remains unchanged with a less strict constraint on s.

Moreover, the (expected) payoffs as perceived at the beginning of time $t = 0$ now read

$$c_i^0(\pi_i) = (1 - \pi_i)\left(\omega + \eta_i x + \mathbb{E}[s]\right) + \pi_i\left(\mathbb{E}[w]_i + \mathbb{E}[y]_i\right) + \mathbb{E}[g], \tag{31}$$

where $\mathbb{E}[w]_i$ and $\mathbb{E}[y]_i$ are given by Equations (11) and (12), respectively,

$$\mathbb{E}[s] = s \sum_{j \in \{r,l\}} \Pr(\text{j wins})\sigma_j, \tag{32}$$

is the expected income from stipends, and

$$\mathbb{E}[g] = \sum_{j \in \{r,l\}} \Pr(\text{j wins}) g(\rho_j, \sigma_j), \tag{33}$$

with g being given by Equation (30), is the expected public good.

Let Γ denote the sequential game where (i) at $t = 0$, every citizen $i \in [0, 1]$ sets π_i aiming at maximizing economic payoffs as determined by Equations (6), (8), (9), and (30)–(33), and (ii) at $t = 1$, candidate $j \in \{r, l\}$, having observed $\{\pi_i\}_{i\ \in[0,1]}$, and knowing that citizen i's utility is determined by Equations (2), (6), (8), (9), (29) and (30), set $\rho_j \in \{0, 1\}$ aiming at maximizing the probability of winning the election. An *equilibrium* of game Γ refers to a tuple $(\{\pi_i^{s^*}\}_{i\in[0,1]}, \rho_r^{s^*}, \rho_l^{s^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

Proposition 5. *Consider the game Γ where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, and s takes a strictly positive, yet infinitesimal value.*

- *For $\Psi \leq \zeta$, then $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, $\{\pi_i^{s^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{s^*}, \sigma_r^{s^*}), (\rho_l^{s^*}, \sigma_l^{s^*}) = (0, 1), (0, 1)$.*

- *For $\zeta < \Psi \leq 1$, then either $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = z$, $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, $\{\pi_i^{s^*}\}_{i\in(1-\mu_b,1]} = 1$ and $(\rho_r^{s^*}, \sigma_r^{s^*}), (\rho_l^{s^*}, \sigma_l^{s^*}) = (0, 1), (0, 1)$, or $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} =$*

1, $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{s^*}\}_{i\in(1-\mu_b,1]} = 1$ *and* $(\rho_r^{s^*}, \sigma_r^{s^*}), (\rho_l^{s^*}, \sigma_l^{s^*}) = (1,1), (1,1)$.

- *For* $1 < \Psi$, *then* $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i^{s^*}\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, $\{\pi_i^{s^*}\}_{i\in(1-\mu_b,1]} = 1$ *and* $(\rho_r^{s^*}, \sigma_r^{s^*}), (\rho_l^{s^*}, \sigma_l^{s^*}) = (1,0), (1,0)$.

Student debt relief and a laborer subsidy are strategic substitutes from the perspective of politicians for sufficiently small, and sufficiently large values of Ψ. When laborers are sufficiently more homogeneous than graduates, i.e., $\Psi < \zeta$, politicians subsidize them and offer no student debt relief. On the contrary, when graduates are more homogeneous than graduates, i.e., $1 < \Psi$, politicians offer a student debt relief and they refrain from subsidizing laborers.

The political asymmetry in favor of student debt relief appears in game Γ as well: Student debt relied may be offered as long as laborers are not too much more homogeneous than graduates, for $\zeta < \Psi \leq 1$. Over this intermediate range however, student debt relief and a laborer subsidy are strategic complements from the perspective of politicians: They do offer a student debt relief (for the reasons explained in the discussion that follow Proposition 2), but they keep subsidizing laborers who are still more homogeneous than graduates.

We finally consider a setup where politicians' stance on the laborers' subsidy is fixed and divergent.[8] Let Γ^{fs} denote the sequential game with $\sigma_r = 0$ and $\sigma_l = 1$ being fixed (and publicly known) where (i) at $t = 0$, every citizen $i \in [0,1]$ sets π_i aiming at maximizing economic payoffs as determined by Equations (6), (8), (9), and (30)–(33), and (ii) at $t = 1$, candidate $j \in \{r, l\}$, having observed $\{\pi_i\}_{i\,\in[0,1]}$, and knowing that citizen i's utility is determined by Equations (2), (6), (8), (9), (29) and (30), set $\rho_j \in \{0,1\}$ aiming at maximizing the probability of winning the election. An *equilibrium* of game Γ^{fs} refers to a tuple $(\{\pi_i^{\text{fs}^*}\}_{i\in[0,1]}, \rho_r^{\text{fs}^*}, \rho_l^{\text{fs}^*})$ that constitutes a subgame perfect Nash equilibrium in pure strategies.

[8]The equilibrium in case of fized and convergent stance on σ is the same as in Section 4.

Proposition 6. *Consider the game* Γ *where* $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ *and* $x + \omega < y < 1$.

- *For* $\Psi \leq \zeta$, *then* $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})} = z$, $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w}, 1]} = 0$, $\{\pi_i^{\text{fs}^*}\}_{i \in (1-\mu_b, 1]} = 1$ *and* $(\rho_r^{\text{fs}^*}; \sigma_r^{\text{fs}^*}) = (0, 0)$ *and* $(\rho_r^{\text{fs}^*}; \sigma_l^{\text{fs}^*}) = (0; 1)$.

- *For* $\zeta < \Psi \leq 1$, *then either* $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})} = z$, $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w}, 1]} = 0$, $\{\pi_i^{\text{fs}^*}\}_{i \in (1-\mu_b, 1]} = 1$ *and* $(\rho_r^{\text{fs}^*}; \sigma_r^{\text{fs}^*}) = (0, 0)$ *and* $(\rho_r^{\text{fs}^*}; \sigma_l^{\text{fs}^*}) = (0; 1)$, *or* $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y)} = 1$, $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y, 1]} = 0$, $\{\pi_i^{\text{fs}^*}\}_{i \in (1-\mu_b, 1]} = 1$ *and* $(\rho_r^{\text{fs}^*}; \sigma_r^{\text{fs}^*}) = (1; 0)$ *and* $(\rho_r^{\text{fs}^*}; \sigma_l^{\text{fs}^*}) = (1; 1)$.

- *For* $1 < \Psi$, *then* $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y)} = 1$, $\{\pi_i^{\text{fs}^*}\}_{i \in [0,\mu_a] \cap \beta_i \in [y, 1]} = 0$, $\{\pi_i^{\text{fs}^*}\}_{i \in (1-\mu_b, 1]} = 1$ *and* $(\rho_r^{\text{fs}^*}; \sigma_r^{\text{fs}^*}) = (1; 0)$ *and* $(\rho_r^{\text{fs}^*}; \sigma_l^{\text{fs}^*}) = (1; 1)$.

The structure of the political equilibrium of student debt relied remains the same. Thus, whether student debt relief is a strategic substitute or complement of the laborer subsidy depends on politicians' fixed stance on the latter. For $\Psi < \zeta$, candidate l, substitutes student debt relief with the fixed (and advantageous) stance in favor of the subsidy to the more homogeneous laborers. But candidate r complements the fixed (and disadvantageous) stance against a laborer subsidy by opposing student debt relief as well. On the contrary, for $\zeta < \Psi$, candidate l, complements the fixed (and now disadvantageous) stance in favor of the subsidy to laborers who are now not homogeneous enough. At the same time, student debt relief works as a substitute to the laborer subsidy that candidate r opposes anyway.

6 Conclusion

While politicians tend to favor the most homogeneous group in a probabilistic voting setup, we identify conditions under which politicians forgive student debt even when non-college laborers are more homogeneous than college graduates. This political asymmetry in favor of student debt relief gives rise to a double equilibrium that is driven by strategic complementarities among a pivotal mass of citizens: When laborers are not sufficiently more homogeneous than graduates, either this pivotal mass banks on student debt relief, thus going to college, and forcing politicians to forgive student debt, or they reject college, thus preempting politicians from forgiving student debt. Income-driven repayments make politicians forgive fewer students' debt but under a wider range of parameters. Finally, student debt relief and a redistribution in favor of laborers act as strategic (political) substitutes when laborers are sufficiently more homogeneous than graduates (by rejecting student debt relief and subsidizing laborers), as well as when graduates are more homogeneous than laborers (by forgiving student debt and rejecting a laborer subsidy). Politicians use them however as political complements when laborers are not sufficiently more homogeneous than graduates by forgiving student debt and subsidizing laborers.

Appendix

Proof of Proposition 1

We have restricted our focus to cases where $\underline{w} < \omega < \overline{w} - T$ and $x = y < 1$. Under this specification, as explained in Footnote 5, $\{\pi_i\}_{i\in[0,1]} = \tau_i$ is the solution that maximizes every individual citizen's payoff, as perceived at the beginning of $t = 0$. This solution means that $\lambda = \mu_a$ and $\phi = \mu_b$.

We proceed to characterize candidates' decision (ρ_r, ρ_l) in equilibrium. Because candidates face a symmetrical problem, we know that a solution where candidates choose a different policy cannot be sustained in equilibrium. Therefore, in equilibrium candidates set either $(\rho_r, \rho_l) = (0, 0)$, or $(\rho_r, \rho_l) = (1, 1)$. We characterize the equilibrium conditions for each of these two solutions, in turn.

Solution $(\rho_r, \rho_l) = (0, 0)$:

Because candidates face a symmetrical problem, the condition

$$\Pr(\text{r wins}; (0, 0)) = 0.5 \geq \Pr(\text{r wins}; (1, 0)) \tag{34}$$

is necessary and sufficient for the solution $(\rho_r, \rho_l) = (0, 0)$ to be an equilibrium. Towards characterizing condition (34), we write the vote share of candidate r when $(\rho_r, \rho_l) = (1, 0)$, denoted by $v_r(1, 0)$. Substituting for $(\rho_r, \rho_l) = (1, 0)$ into Equations (1)–(3), (6), (8), and (9), we obtain

$$v_r(1, 0) = (0.5 - \psi_g(B + \mu_b T - T))\, \mu_b + (0.5 - \psi_l(B + \mu_b T))\, \mu_a. \tag{35}$$

In turn, we obtain that the probability that r wins the election when $(\rho_r, \rho_l) = (1, 0)$, i.e., that $v_r(1, 0) > 0.5$, reads

$$\Pr(\text{r wins}; (1, 0)) = 0.5 + \chi \left(-\mu_b T + \frac{\psi_g \mu_b T}{\mu_a \psi_l + \mu_b \psi_g} \right). \tag{36}$$

Substituting for Equation (36) into condition (34), we conclude that $(\rho_r, \rho_l) = (0, 0)$ is an equilibrium if and only if

$$\Psi \leq 1. \tag{37}$$

Solution $(\rho_r, \rho_l) = (1, 1)$:

Because candidates face a symmetrical problem, the condition

$$\Pr(\text{r wins}; (1, 1)) = 0.5 \geq \Pr(\text{r wins}; (0, 1)) \tag{38}$$

is necessary and sufficient for the solution $(\rho_r, \rho_l) = (1, 1)$ to be an equilibrium. Taking

Equation (36) into account, we obtain that

$$\Pr(\text{r wins}; (0,1)) = 0.5 - \chi\left(-\mu_b T + \frac{\psi_g \mu_b T}{\mu_a \psi_l + \mu_b \psi_g}\right). \tag{39}$$

Substituting for Equation (39) into condition (38), we conclude that $(\rho_r, \rho_l) = (1,1)$ is an equilibrium if and only if

$$1 < \Psi. \tag{40}$$

This completes the proof. $\square$

Proof of Proposition 2

We consider cases where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. Under this specification all type b citizens go to college. Moreover, it is straightforward that every type a citizen with $y \leq \beta_i$ decides to work without a college degree (because these citizens feature $\xi_i = 0$ for every $\rho \in \{0,1\}$ as known from Equation (8)). The decision of type a citizens with $\beta_i < y$ at $t = 0$ is not trivial, and we characterize it by solving backward. We use the following notation: The variable $\mu_a' \equiv \int_0^{y-(T-\underline{w})} (1-\tau_i)\pi_i d\beta_i$ is the mass of type a graduates who are incentive-compatible regardless of ρ, and the variable $\mu_a'' = \int_{y-(T-\underline{w}\}}^{y} (1-\tau_i)\pi_i d\beta_i$ is the mass of type a graduates who are incentive-compatible only if $\rho = 1$. It holds, by definition, that $\phi + \lambda = (\mu_b + \mu_a' + \mu_a'') + (\mu_a - \mu_a' - \mu_a'') = 1$.

Candidate problem

Solving backwards, we first characterize candidates' decision (ρ_r, ρ_l) in equilibrium for given $\{\pi_i\}_{i\in[0,1]}$. Following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0,0)$ we obtain that in game $\mathcal{G}^{\text{wsm}}$, where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$

and $x+\omega<y<1$, the vote share of candidate r if $(\rho_r,\rho_l)=(1,0)$ reads

$$\begin{aligned} v(1,0) = &\left(0.5-\psi_g(B+\phi T-\mu_a''(T-\underline{w})-T)\right)(\mu_b+\mu_a') \\ &+\left(0.5-\psi_g(B+\phi T-\mu_a''(T-\underline{w})-(y+\underline{w}))\right)\mu_a'' \\ &+\left(0.5-\psi_l(B+\phi T-\mu_a''(T-\underline{w}))\right)\lambda, \end{aligned} \tag{41}$$

and the probability that r wins the election when $(\rho_r,\rho_l)=(1,0)$ reads

$$\begin{aligned} &\Pr(\text{r wins};(1,0)) = 0.5 \\ &+\chi\left(-\phi T+\mu_a''(T-\underline{w})+\frac{\psi_g\left((\mu_b+\mu_a')T+\mu_a''(y+\underline{w})\right)}{\lambda\psi_l+\phi\psi_g}\right). \end{aligned} \tag{42}$$

Thus, $(\rho_r,\rho_l)=(0,0)$ is an equilibrium if and only if

$$\Psi \leq \frac{1}{1+\dfrac{\mu_a'' y}{\lambda\left((\mu_b+\mu_a')T+\mu_a''\underline{w}\right)}}. \tag{43}$$

Moreover, following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r,\rho_l)=(1,1)$, we obtain that $(\rho_r,\rho_l)=(1,1)$ is an equilibrium if and only if

$$\frac{1}{1+\dfrac{\mu_a'' y}{\lambda\left((\mu_b+\mu_a')T+\mu_a''\underline{w}\right)}} < \Psi. \tag{44}$$

Citizen problem

As explained in the first paragraph of this proof, it follows directly from specifying $-y<\underline{w}-T<0<\omega<\overline{w}-T$ and $x+\omega<y<1$ that $\{\pi_i=1\}_{i\in(1-\mu_b,1]}$, and that $\{\pi_i=0\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]}$. It remains to characterize $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$.

We note that any type a graduate who is incentive compatible obtains the same individual income regardless of β_i. Therefore, if among type a citizens with $\beta_i<y-T+\underline{w}$

some choose $\pi_i = 0$ and some choose $\pi_i = 1$, either the former or the latter will be better off by deviating from their decision. We thus conclude that $\mu'_a \in \{0, y - T + \underline{w}\}$. The same reasoning can be extended to type a citizens with $y - T + \underline{w} \leq \beta_i < y$ to conclude that $\mu''_a \in \{0, T - \underline{w}\}$.

Finally, the reasoning of the previous paragraph suffices to know that there is no equilibrium with $\mu'_a = 0$ and $\mu''_a = T - \underline{w}$. If citizens with $y - T + \underline{w} \leq \beta_i < y$ choose $\pi_i = 1$ (thus becoming policy-dependent graduates), then citizens with $\beta_i < y - T + \underline{w}$ (who are incentive-compatible regardless of ρ) must choose $\pi_i = 1$. Otherwise, either the former or the latter will be better off by deviating from their decision.

From the three previous paragraphs we obtain that a solution holds in equilibrium only if

(i) $\{\pi_i = 0\}_{i \in [0,\mu_a]}$ and $\{\pi_i = 1\}_{i \in (1-\mu_b,1]}$ (which implies $\mu'_a = \mu''_a = 0$, $\phi = \mu_b$ and $\lambda = \mu_a$), or

(ii) $\{\pi_i = 1\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})}$, $\{\pi_i = 0\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w},1]}$, and $\{\pi_i = 1\}_{i \in (1-\mu_b,1]}$ (which implies $\mu'_a = y - T + \underline{w}$, $\mu''_a = 0$, $\phi = \mu_b + \mu'_a$ and $\lambda = \mu_a - \mu'_a$), or

(iii) $\{\pi_i = 1\}_{i \in [0,\mu_a] \cap \beta_i \in [0,y)}$, $\{\pi_i = 0\}_{i \in [0,\mu_a] \cap \beta_i \in [y,1]}$, and $\{\pi_i = 1\}_{i \in (1-\mu_b,1]}$ (which implies $\mu'_a = y - T + \underline{w}$, $\mu''_a = T - \underline{w}$, $\phi = \mu_b + \mu'_a + \mu''_a$ and $\lambda = \mu_a - \mu'_a - \mu''_a$).

Accounting for the above three possible solutions, along with the above described solution to candidates' problem (substituting in particular into (43) and (44)), we obtain that a solution to game $\mathcal{G}^{\text{wsm}}$ must take one of the following forms:

A. $\{\pi_i = 0\}_{i \in [0,\mu_a]}$ and $\{\pi_i = 1\}_{i \in (1-\mu_b,1]}$, and $\{\rho_j\}_{j \in \{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j \in \{r,l\}} = 1$ for $1 < \Psi$.

B. $\{\pi_i = 1\}_{i \in [0,\mu_a] \cap \beta_i \in [0, y-T+\underline{w})}$, $\{\pi_i = 0\}_{i \in [0,\mu_a] \cap \beta_i \in [y-T+\underline{w},1]}$, and $\{\pi_i = 1\}_{i \in (1-\mu_b,1]}$, and $\{\rho_j\}_{j \in \{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j \in \{r,l\}} = 1$ for $1 < \Psi$.

C. $\{\pi_i = 1\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$, $\{\pi_i = 0\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]}$, and $\{\pi_i = 1\}_{i\in(1-\mu_b,1]}$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq \zeta$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $\zeta < \Psi$, where ζ is defined by (16).

We next note that an individual citizen has mass zero, and thus an individual citizen's deviation cannot change $\{\rho_j\}_{j\in\{r,l\}}$ as described in each of the above three solutions. We next identify under which conditions a citizen cannot be better off by deviating from each of the above three solutions.

Solution A. $\{\pi_i = 0\}_{i\in[0,\mu_a]}$ and $\{\pi_i = 1\}_{i\in(1-\mu_b,1]}$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$:

For $\Psi \leq 1$, among type a citizens, only those with $\beta_i < y - T + \underline{w}$ will be incentive compatible as graduates at $t = 2$. Moreover, every incentive compatible type a graduate will receive an individual income (cumulatively at $t = 1$ and $t = 2$) equal to $y - T + \underline{w}$. It follows that solution (A) is an equilibrium if $z = 0$, where z is defined by Equation (15). If $z = 1$, then solution (A) is not an equilibrium because a type a citizen with $\beta_i < y - T + \underline{w}$ would be better off by choosing to go to college.

For $1 < \Psi$, among type a citizens, only those with $\beta_i < y$ will be incentive compatible as graduates at $t = 2$. Moreover, every incentive compatible type a graduate will receive an individual income (cumulatively at $t = 1$ and $t = 2$) equal to $y + \underline{w}$. It follows that solution (A) is not an equilibrium for $1 < \Psi$ in game $\mathcal{G}^{\text{wsm}}$ where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, because a type a citizen with $\beta_i < y$ would be better off by choosing to go to college.

Solution B. $\{\pi_i = 1\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})}$, $\{\pi_i = 0\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]}$, and $\{\pi_i = 1\}_{i\in(1-\mu_b,1]}$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$:

The above reasoning under solution (A) suffices to conclude that solution (B) is an equilibrium only if $z = 1$ and $\Psi \leq 1$.

Solution C. $\{\pi_i = 1\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$, $\{\pi_i = 0\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]}$, and $\{\pi_i = 1\}_{i\in(1-\mu_b,1]}$, and

$\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq \zeta$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $\zeta < \Psi$:

For $\Psi \leq \zeta$, among type a citizens, only those with $\beta_i < y - T + \underline{w}$ will be incentive compatible as graduates at $t = 2$. Moreover, every incentive compatible type a graduate will receive an individual income (cumulatively at $t = 1$ and $t = 2$) equal to $y - T + \underline{w}$. It follows that this cannot be an equilibrium because (at least) a citizen with $y - T + \underline{w} \leq \beta_i < y$ would be better off by choosing to work without a college degree.

For $\zeta < \Psi$, among type a citizens, only those with $\beta_i < y$ will be incentive compatible at $t = 2$. Moreover, every incentive compatible graduate will receive an individual income (cumulatively at $t = 1$ and $t = 2$) equal to $y + \underline{w}$. It follows that this is an equilibrium in game $\mathcal{G}^{\text{wsm}}$ where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. $\square$

Proof of Proposition 3

We consider cases where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. Under this specification, as explained in the first paragraph of the proof of Proposition 2, $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$ and $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$. We use again the variables μ'_a and μ''_a as defined in the first paragraph of the proof of Proposition 2 while solving backwards to characterize the non-trivial decisions $\{\pi_i = 0\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$.

Candidate problem

We first characterize candidates' decision (ρ_r, ρ_l) in equilibrium for given $\{\pi_i\}_{i\in[0,1]}$. Because candidates face a symmetrical problem, we know that a solution where candidates choose a different policy cannot be sustained in equilibrium. Therefore, in equilibrium candidates set either $(\rho_r, \rho_l) = (0, 0)$, or $(\rho_r, \rho_l) = (1, 1)$, or $(\rho_r, \rho_l) = (2, 2)$. We characterize the equilibrium conditions for each of these three solutions, in turn.

Solution $(\rho_r, \rho_l) = (0, 0)$:

Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (0, 0)) = 0.5 \geq$

Pr(r wins; (1, 0)), which is equivalent to condition (43) as known from the candidate problem in the proof of Proposition 2, along with

$$\Pr(\text{r wins}; (0,0)) = 0.5 \geq \Pr(\text{r wins}; (2,0)), \tag{45}$$

are necessary and sufficient conditions for $(\rho_r, \rho_l) = (0, 0)$ to be an equilibrium. Following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, only now considering Equations (2), (6), and (17)–(22) instead of Equations (1)–(3), (6), (8), and (9), we obtain that in game $\mathcal{G}^{\text{idr}}$, where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, the vote share of candidate r if $(\rho_r, \rho_l) = (2, 0)$ reads

$$\begin{aligned} v(2,0) = &\left(0.5 - \psi_g(B + \mu_a'(T - \underline{w}))\right)\mu_b \\ &+ \left(0.5 - \psi_g(B + \mu_a'(T - \underline{w}) - (T - \underline{w}))\right)\mu_a' \\ &+ \left(0.5 - \psi_g(B + \mu_a'(T - \underline{w}) - y)\right)\mu_a'' \\ &+ \left(0.5 - \psi_l(B + \mu_a'(T - \underline{w}))\right)\lambda, \end{aligned} \tag{46}$$

and the probability that r wins the election when $(\rho_r, \rho_l) = (2, 0)$ reads

$$\Pr(\text{r wins}; (2,0)) = 0.5 + \chi\left(-\mu_a'(T - \underline{w}) + \psi_g \frac{\mu_a'(T - \underline{w}) + \mu_a'' y}{\lambda\psi_l + \phi\psi_g}\right). \tag{47}$$

We then obtain that condition (45) is satisfied for every

$$\Psi < \frac{1}{1 + \dfrac{\mu_a'' y}{\lambda\mu_a'(T - \underline{w})}}. \tag{48}$$

Taking into account that the right-hand side of (43) is larger than the right-hand side of (48), we conclude that (48) is a necessary and sufficient condition for $(\rho_r, \rho_l) = (0, 0)$ to be an equilibrium.

Solution $(\rho_r, \rho_l) = (1, 1)$:

Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (1, 1)) = 0.5 \geq \Pr(\text{r wins}; (0, 1))$, which is equivalent to condition (44) as known from the candidate problem in the proof of Proposition 2, along with

$$\Pr(\text{r wins}; (1, 1)) = 0.5 \geq \Pr(\text{r wins}; (2, 1)), \tag{49}$$

are necessary and sufficient conditions for $(\rho_r, \rho_l) = (1, 1)$ to be an equilibrium. Following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, only now considering Equations (2), (6), and (17)–(22) instead of Equations (1)–(3), (6), (8), and (9), we obtain that in game $\mathcal{G}^{\text{idr}}$, where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, the vote share of candidate r if $(\rho_r, \rho_l) = (2, 1)$ reads

$$\begin{aligned} v(2,1) = &(0.5 - \psi_g(B - \phi T + (\mu_a' + \mu_a'')(T - \underline{w}) + T))\, \mu_b \\ &+ (0.5 - \psi_g(B - \phi T + (\mu_a' + \mu_a'')(T - \underline{w}) + \underline{w}))\, (\mu_a' + \mu_a'') \\ &+ (0.5 - \psi_l(B - \phi T + (\mu_a' + \mu_a'')(T - \underline{w})))\, \lambda, \end{aligned} \tag{50}$$

and the probability that r wins the election when $(\rho_r, \rho_l) = (2, 1)$ reads

$$\Pr(\text{r wins}; (2, 1)) = 0.5 + \chi \left(\phi T - (\mu_a' + \mu_a'')(T - \underline{w}) - \psi_g \frac{\mu_b T + (\mu_a' + \mu_a'')\underline{w}}{\lambda \psi_l + \phi \psi_g} \right). \tag{51}$$

We then obtain that condition (45) is satisfied for every

$$1 < \Psi. \tag{52}$$

Taking into account that the left-hand side of (44) is lower than the left-hand side of (52), we conclude that (52) is a necessary and sufficient condition for $(\rho_r, \rho_l) = (1, 1)$ to be an equilibrium.

Solution $(\rho_r, \rho_l) = (2, 2)$:

Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (2,2)) = 0.5 \geq \Pr(\text{r wins}; (0,2))$, which is equivalent to

$$\frac{1}{1 + \frac{\mu_a'' y}{\lambda \mu_a' (T - \underline{w})}} < \Psi, \tag{53}$$

as inferred from condition (48), along with the condition $\Pr(\text{r wins}; (2,2)) = 0.5 \geq \Pr(\text{r wins}; (1,2))$, which is equivalent to

$$\Psi < 1, \tag{54}$$

as inferred from condition (52), we conclude that the condition

$$\frac{1}{1 + \frac{\mu_a'' y}{\lambda \mu_a' (T - \underline{w})}} < \Psi < 1 \tag{55}$$

is necessary and sufficient for $(\rho_r, \rho_l) = (2, 2)$ to be an equilibrium.

Citizen problem

From the reasoning in the first four paragraphs under citizen problem in the proof of Proposition 2, and accounting for the above described solution to candidates' problem (substituting in particular into conditions (48), (52) and (55)), we obtain that a solution to game $\mathcal{G}^{\text{idr}}$ must take one of the following forms:

A. $\{\pi_i\}_{i \in [0, \mu_a]} = 0$ and $\{\pi_i\}_{i \in (1-\mu_b, 1]} = 1$, and $\{\rho_j\}_{j \in \{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j \in \{r,l\}} = 1$ for $1 < \Psi$.

B. $\{\pi_i\}_{i \in [0, \mu_a] \cap \beta_i \in [0, y - T + \underline{w})} = 1$, $\{\pi_i\}_{i \in [0, \mu_a] \cap \beta_i \in [y - T + \underline{w}, 1]} = 0$, and $\{\pi_i\}_{i \in (1-\mu_b, 1]} = 1$, and $\{\rho_j\}_{j \in \{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j \in \{r,l\}} = 1$ for $1 < \Psi$.

C. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq \zeta^{\text{idr}}$, $\{\rho_j\}_{j\in\{r,l\}} = 2$ for $\zeta^{\text{idr}} < \Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$, where ζ^{idr} is defined by (27).

Following the same reasoning as in the citizen problem in the proof of Proposition 1, we find that solution (A) is an equilibrium only if $z = 0$ and $\Psi < 1$, solution (B) is an equilibrium only if $z = 1$ and $\Psi < 1$, and solution (C) is an equilibrium only if $\zeta^{\text{idr}} < \Psi$. $\square$

Proof of Proposition 4

We consider cases where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$. Under this specification, as explained in the first paragraph of the proof of Proposition 2, $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$ and $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$. We use again the variables μ_a' and μ_a'' as defined in the first paragraph of the proof of Proposition 2 while solving backwards to characterize the non-trivial decisions $\{\pi_i = 0\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$.

Candidate problem

We first characterize candidates' decision (ρ_r, ρ_l) in equilibrium for given $\{\pi_i\}_{i\in[0,1]}$. Because candidates face a symmetrical problem, we know that a solution where candidates choose a different policy cannot be sustained in equilibrium. Therefore, in equilibrium candidates set either $(\rho_r, \rho_l) = (0, 0)$, or $(\rho_r, \rho_l) = (1, 1)$, or $(\rho_r, \rho_l) = (2, 2)$. We characterize the equilibrium conditions for each of these three solutions, in turn.

Solution $(\rho_r, \rho_l) = (0, 0)$:

Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (0, 0)) = 0.5 \geq \Pr(\text{r wins}; (1, 0))$, which is equivalent to condition (43) as known from the candidate problem in the proof of Proposition 2, along with

$$\Pr(\text{r wins}; (0,0)) = 0.5 \geq \Pr(\text{r wins}; (2,0)), \tag{56}$$

are necessary and sufficient conditions for $(\rho_r, \rho_l) = (0,0)$ to be an equilibrium. Following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0,0)$, only now considering Equations (2), (6), and (17), (21)–(22) and (28) instead of Equations (1)–(3), (6), (8), and (9), we obtain that in game $\mathcal{G}^{\text{iidr}}$, where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, the vote share of candidate r if $(\rho_r, \rho_l) = (2,0)$ reads

$$\begin{aligned} v(2,0) = &(0.5 - \psi_g B)\,(\mu_b + \mu_a') \\ &+ (0.5 - \psi_g (B - y))\,\mu_a'' \\ &+ (0.5 - \psi_l B)\,\lambda, \end{aligned} \tag{57}$$

and the probability that r wins the election when $(\rho_r, \rho_l) = (2,0)$ reads

$$\Pr(\text{r wins}; (2,0)) = 0.5 + \chi\psi_g \frac{\mu_a'' y}{\lambda\psi_l + \phi\psi_g}. \tag{58}$$

We thus conclude that $(\rho_r, \rho_l) = (0,0)$ is a strictly dominated strategy for $\mu_a'' > 0$, whereas $(\rho_r, \rho_l) = (0,0)$ is an equilibrium for every $\Psi \leq 1$ and $\mu_a'' = 0$.

Solution $(\rho_r, \rho_l) = (1,1)$:
Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (1,1)) = 0.5 \geq \Pr(\text{r wins}; (0,1))$, which is equivalent to condition (44) as known from the candidate problem in the proof of Proposition 2, along with

$$\Pr(\text{r wins}; (1,1)) = 0.5 \geq \Pr(\text{r wins}; (2,1)), \tag{59}$$

are necessary and sufficient conditions for $(\rho_r, \rho_l) = (1, 1)$ to be an equilibrium. Following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, only now considering Equations (2), (6), and (17), (21)–(22) and (28) instead of Equations (1)–(3), (6), (8), and (9), we obtain that in game $\mathcal{G}^{\text{iidr}}$, where $-y < \underline{w} - T < 0 < \omega < \overline{w} - T$ and $x + \omega < y < 1$, the vote share of candidate r if $(\rho_r, \rho_l) = (2, 1)$ reads

$$\begin{aligned} v(2,1) = &\left(0.5 - \psi_g(B - \phi T + \mu_a''(T - \underline{w}) + T)\right)(\mu_b + \mu_a') \\ &+ \left(0.5 - \psi_g(B - \phi T + \mu_a''(T - \underline{w}) + \underline{w})\right)\mu_a'' \\ &+ \left(0.5 - \psi_l(B - \phi T + \mu_a''(T - \underline{w}))\right)\lambda, \end{aligned} \tag{60}$$

and the probability that r wins the election when $(\rho_r, \rho_l) = (2, 1)$ reads

$$\Pr(\text{r wins}; (2,1)) = 0.5 + \chi\left(\phi T - \mu_a''(T - \underline{w}) - \psi_g \frac{(\mu_b + \mu_a')T + \mu_a''\underline{w}}{\lambda\psi_l + \phi\psi_g}\right). \tag{61}$$

We then obtain that condition (59) is satisfied for every

$$1 < \Psi. \tag{62}$$

Taking into account that the left-hand side of (44) is lower than the left-hand side of (62), we conclude that (62) is a necessary and sufficient condition for $(\rho_r, \rho_l) = (1, 1)$ to be an equilibrium.

Solution $(\rho_r, \rho_l) = (2, 2)$:

Because candidates face a symmetrical problem, the condition $\Pr(\text{r wins}; (2,2)) = 0.5 \geq \Pr(\text{r wins}; (0,2))$, which is satisfied for every $\mu_a'' \geq 0$ as inferred from Equation (61), along with the condition $\Pr(\text{r wins}; (2,2)) = 0.5 \geq \Pr(\text{r wins}; (1,2))$, which is equivalent to

$$\Psi < 1, \tag{63}$$

as inferred from condition (52), we conclude that $(\rho_r, \rho_l) = (2, 2)$ is an equilibrium for every $\Psi \leq 1$ and $\mu_a'' > 0$.

Citizen problem

From the reasoning in the first four paragraphs under citizen problem in the proof of Proposition 2, and accounting for the above described solution to candidates' problem, we obtain that a solution to game $\mathcal{G}^{\text{iidr}}$ must take one of the following forms:

A. $\{\pi_i\}_{i\in[0,\mu_a]} = 0$ and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

B. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

C. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 2$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

D. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},y)} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap(\beta_i\in[0,y-T+\underline{w})\cup\beta_i\in[y,1])} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 2$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

Following the same reasoning as in the citizen problem in the proof of Proposition 2, we find that solution (A) is an equilibrium only if $z = 0$ and $\Psi < 1$, solution (B) is an equilibrium only if $z = 1$ and $\Psi < 1$, solution (C) is an equilibrium only if $z = 1$ and $\Psi < 1$, or $1 < \Psi$, and solution (D) is an equilibrium only if $z = 0$ and $\Psi < 1$. $\square$

Proof of Proposition 5

We consider cases where $-y < \underline{w} - T < 0 < \omega + \sigma < \overline{w} - T$ and $x + \omega + \sigma < y < 1$. Following analogous reasoning as in the first paragraph of the proof of Proposition 2, we know that under this specification $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\pi_i\}_{i\in[0,\mu_a]\cap y\leq\beta_i} = 0$. We use again the variables μ_a' and μ_a'' as defined in the first paragraph of the proof of Proposition 2 while solving backwards to characterize the non-trivial decisions $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$.

Candidate problem

Because candidates face a symmetrical problem, we know that any solution other than $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,0),(0,0)))$, or $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,1),(0,1)))$, or $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((1,0),(1,0)))$, or $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((1,1),(1,1)))$ cannot hold in equilibrium.

Solution $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,0),(0,0)))$:

Because candidates face a symmetrical problem, and following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r,\rho_l) = (0,0)$, we obtain that the conditions

$$\begin{aligned}&\Pr(\text{r wins};(0,0),(0,0)) = 0.5 \geq \Pr(\text{r wins};(1,0),(0,0))\\&= 0.5+\chi\left(\mu_a''(T-\underline{w})-\phi T+\psi_g\frac{T(\mu_b+\mu_a')+(y+\underline{w})\mu_a''}{\lambda\psi_l+\phi\psi_g}\right)\end{aligned} \tag{64}$$

$$\begin{aligned}&\Pr(\text{r wins};(0,0),(0,0)) = 0.5 \geq \Pr(\text{r wins};(0,1),(0,0))\\&= 0.5+\chi\left(-s\lambda+\psi_l\frac{s\lambda}{\phi\psi_g+\lambda\psi_l}\right)\end{aligned} \tag{65}$$

$$\begin{aligned}&\Pr(\text{r wins};(0,0),(0,0)) = 0.5 \geq \Pr(\text{r wins};(1,1),(0,0))\\&= 0.5+\chi\left(\mu_a''(T-\underline{w})-\phi T-s\lambda+\frac{\psi_g\left(T(\mu_b+\mu_a')+(y+\underline{w})\mu'')a\right)+\psi_l s\lambda}{\lambda\psi_l+\phi\psi_g}\right)\end{aligned} \tag{66}$$

are necessary and sufficient for the solution $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,0),(0,0)))$ to be an equilibrium. Because (64) and (65) are equivalent to

$$1 < \Psi < \frac{1}{1+\dfrac{\mu_a''y}{\lambda\left(T(\mu_b+\mu_a')+\mu_a''\underline{w}-\phi s\right)}}, \tag{67}$$

and since the two inequalities cannot hold simultaneously, we conclude that $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,0),(0,0)))$ cannot hold in equilibrium.

Solution $((\rho_r,\sigma_r),(\rho_l,\sigma_l)) = ((0,1),(0,1)))$:

Because candidates face a symmetrical problem, and following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, we obtain that the conditions

$$\begin{aligned}
&\Pr(\text{r wins}; (0,1), (0,1)) = 0.5 \geq \Pr(\text{r wins}; (0,0), (0,1)) \\
&= 0.5 - \chi\left(-s\lambda + \psi_l \frac{s\lambda}{\phi\psi_g + \lambda\psi_l}\right)
\end{aligned} \tag{68}$$

$$\begin{aligned}
&\Pr(\text{r wins}; (0,1), (0,1)) = 0.5 \geq \Pr(\text{r wins}; (1,1), (0,1)) \\
&= 0.5 + \chi\left(\mu_a''(T - \underline{w}) - \phi T + \psi_g \frac{T(\mu_b + \mu_a') + (y + \underline{w})\mu_a''}{\lambda\psi_l + \phi\psi_g}\right)
\end{aligned} \tag{69}$$

$$\begin{aligned}
&\Pr(\text{r wins}; (0,1), (0,1)) = 0.5 \geq \Pr(\text{r wins}; (1,0), (0,1)) \\
&= 0.5 + \chi\left(\mu_a''(T - \underline{w}) - \phi T + s\lambda + \frac{\psi_g\left(T(\mu_b + \mu_a') + (y + \underline{w})\mu_a''\right) - \psi_l s\lambda}{\lambda\psi_l + \phi\psi_g}\right)
\end{aligned} \tag{70}$$

are necessary and sufficient for the solution $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((0,1), (0,1)))$ to be an equilibrium. Solving (68)–(70) with respect to Ψ, we obtain that $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((0,1), (0,1)))$ is an equilibrium if and only if

$$\Psi < \frac{1}{1 + \frac{\mu_a'' y}{\lambda\left(T(\mu_b + \mu_a') + \mu_a''\underline{w}\right)}}. \tag{71}$$

Solution $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1,0), (1,0)))$:

Because candidates face a symmetrical problem, and following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, we obtain that the conditions

$$\begin{aligned} &\Pr(\text{r wins}; (1,0),(1,0)) = 0.5 \geq \Pr(\text{r wins}; (0,0),(1,0)) \\ &= 0.5 - \chi\left(\mu_a''(T - \underline{w}) - \phi T + \psi_g \frac{T(\mu_b + \mu_a') + (y + \underline{w})\mu'')a}{\lambda\psi_l + \phi\psi_g}\right) \end{aligned} \tag{72}$$

$$\begin{aligned} &\Pr(\text{r wins}; (1,0),(1,0)) = 0.5 \geq \Pr(\text{r wins}; (1,1),(1,0)) \\ &0.5 + \chi\left(-s\lambda + \frac{s\lambda\psi_l}{\phi\psi_g + \lambda\psi_l}\right) \end{aligned} \tag{73}$$

$$\begin{aligned} &\Pr(\text{r wins}; (1,0),(1,0)) = 0.5 \geq \Pr(\text{r wins}; (0,1),(1,0)) \\ &= 0.5 - \chi\left(\mu_a''(T - \underline{w}) - \phi T + s\lambda + \frac{\psi_g\left(T(\mu_b + \mu_a') + (y + \underline{w})\mu_a''\right) - \psi_l s\lambda}{\lambda\psi_l + \phi\psi_g}\right) \end{aligned} \tag{74}$$

are necessary and sufficient for the solution $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1, 0), (1, 0)))$ to be an equilibrium. Solving (72)–(74) with respect to Ψ, we obtain that $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1, 0), (1, 0)))$ is an equilibrium if and only if

$$1 < \Psi. \tag{75}$$

Solution $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1, 1), (1, 1)))$:

Because candidates face a symmetrical problem, and following analogous steps as in the proof of Proposition 1 under the solution $(\rho_r, \rho_l) = (0, 0)$, we obtain that the conditions

$$\begin{aligned}
&\Pr(\text{r wins}; (1,1),(1,1)) = 0.5 \geq \Pr(\text{r wins}; (0,1),(1,1)) \\
&= 0.5 - \chi\left(\mu_a''(T-\underline{w}) - \phi T + \psi_g \frac{T(\mu_b+\mu_a') + (y+\underline{w})\mu_a''}{\lambda\psi_l + \phi\psi_g}\right)
\end{aligned} \tag{76}$$

$$\begin{aligned}
&\Pr(\text{r wins}; (1,1),(1,1)) = 0.5 \geq \Pr(\text{r wins}; (1,0),(1,1)) \\
&0.5 - \chi\left(-s\lambda + \frac{s\lambda\psi_l}{\phi\psi_g + \lambda\psi_l}\right)
\end{aligned} \tag{77}$$

$$\begin{aligned}
&\Pr(\text{r wins}; (1,1),(1,1)) = 0.5 \geq \Pr(\text{r wins}; (0,0),(1,1)) \\
&= 0.5 - \chi\left(\mu_a''(T-\underline{w}) - \phi T - s\lambda + \frac{\psi_g\left(T(\mu_b+\mu_a') + (y+\underline{w})\mu'')a\right) + \psi_l s\lambda}{\lambda\psi_l + \phi\psi_g}\right)
\end{aligned} \tag{78}$$

are necessary and sufficient for the solution $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1,0),(1,0)))$ to be an equilibrium. Solving (76)–(78) with respect to Ψ, we obtain that $((\rho_r, \sigma_r), (\rho_l, \sigma_l)) = ((1,1),(1,1)))$ is an equilibrium if and only if

$$\frac{1}{1 + \dfrac{\mu_a'' y}{\lambda\left(T(\mu_b+\mu_a') + \mu_a''\underline{w}\right)}} < \Psi < 1. \tag{79}$$

Citizen problem

From the reasoning in the first four paragraphs under citizen problem in the proof of Proposition 2, and accounting for the above described solution to candidates' problem, we obtain that a solution to game Γ must take one of the following forms:

A. $\{\pi_i\}_{i\in[0,\mu_a]} = 0$ and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} = (0,1)$ for $\Psi \leq 1$, whereas $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} = (1,0)$ for $1 < \Psi$.

B. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} = (0,1)$ for $\Psi \leq 1$, whereas $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} = (1,0)$ for $1 < \Psi$.

C. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} =$

$(0,1)$ for $\Psi \leq \zeta^{\mathrm{s}}$, $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} = (1,1)$ for $\zeta^{\mathrm{s}} < \Psi \leq 1$, whereas $\{(\rho_j, \sigma_j)\}_{j\in\{r,l\}} =$ $(1,0)$ for $1 < \Psi$.

Following the same reasoning as in the citizen problem in the proof of Proposition 2, we find that solution (A) is an equilibrium only if $z = 0$ and $\Psi < 1$, solution (B) is an equilibrium only if $z = 1$ and $\Psi < 1$, solution (C) is an equilibrium only if $\zeta < \Psi$. $\square$

Proof of Proposition 6

We consider cases where $-y < \underline{w} - T < 0 < \omega + \sigma < \overline{w} - T$ and $x + \omega + \sigma < y < 1$. Following analogous reasoning as in the first paragraph of the proof of Proposition 2, we know that under this specification $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\pi_i\}_{i\in[0,\mu_a]\cap y\leq\beta_i} = 0$. We use again the variables μ_a' and μ_a'' as defined in the first paragraph of the proof of Proposition 2 while solving backwards to characterize the non-trivial decisions $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)}$.

Candidate problem

We characterize candidates' decision $((\rho_r; 0), (\rho_l; 1))$ in equilibrium for given $\{\pi_i\}_{i\in[0,1]}$. There are four possible solutions: $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (1; 1)))$, $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (0; 1)))$, $((\rho_r; 0), (\rho_l; 1)) = ((1; 0), (1; 1)))$, $((\rho_r; 0), (\rho_l; 1)) = ((1; 0), (0; 1)))$. We characterize the equilibrium conditions for each of these four solutions, in turn. We will use the variables μ_a', μ_a'' as defined under the candidate problem in the proof of Proposition 2.

Solution $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (1; 1))$:

For the solution $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (1; 1)))$ to be an equilibrium, the following is necessary and sufficient:

$$\Pr(\text{r wins}; ((0; 0), (1; 1))) \geq \Pr(\text{r wins}; ((1; 0), (1; 1))) = \tag{80}$$

$$\Pr(\text{l wins}; ((0; 0), (1; 1))) \geq \Pr(\text{l wins}; ((0; 0), (0; 1))). \tag{81}$$

Solving with respect to Ψ, using (78), (77), and (68), we conclude that $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (1; 1))$ cannot hold in equilibrium because that would require

$$\frac{1}{1 + \frac{\mu_a'' y}{\lambda\left(T(\mu_b + \mu_a') + \mu_a'' \underline{w}\right)}} < \Psi < \frac{1}{1 + \frac{\mu_a'' y}{\lambda\left(T(\mu_b + \mu_a') + \mu_a'' \underline{w}\right)}}. \tag{82}$$

Solution $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (0; 1))$:

For the solution $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (0; 1)))$ to be an equilibrium, the following is necessary and sufficient:

$$\Pr(\text{r wins}; ((0; 0), (0; 1))) \geq \Pr(\text{r wins}; ((1; 0), (0; 1))) \tag{83}$$

$$\Pr(\text{l wins}; ((0; 0), (0; 1))) \geq \Pr(\text{l wins}; ((0; 0), (1; 1))) \tag{84}$$

Solving with respect to Ψ, using (68), (70), and (78), we conclude that $((\rho_r; 0), (\rho_l; 1)) = ((0; 0), (0; 1))$ is an equilibrium if and only if

$$\Psi < \frac{1}{1 + \frac{\mu_a'' y}{\lambda\left(T(\mu_b + \mu_a') + \mu_a'' \underline{w}\right)}}. \tag{85}$$

Solution $((\rho_r; 0), (\rho_l; 1)) = ((1; 0), (1; 1))$:

For the solution $((\rho_r; 0), (\rho_l; 1)) = ((1; 0), (1; 1)))$ to be an equilibrium, the following is necessary and sufficient:

$$\Pr(\text{r wins}; ((1; 0), (1; 1))) \geq \Pr(\text{r wins}; ((0; 0), (1; 1))) \tag{86}$$

$$\Pr(\text{l wins}; ((1; 0), (1; 1))) \geq \Pr(\text{l wins}; ((1; 0), (0; 1))). \tag{87}$$

Solving with respect to Ψ, using (77), (78), and (70), we conclude that $((\rho_r; 0), (\rho_l; 1)) =$

$((1;0),(1;1))$ is an equilibrium if and only if

$$\frac{1}{1+\frac{\mu_a''y}{\lambda\left(T(\mu_b+\mu_a')+\mu_a''\underline{w}\right)}} < \Psi. \tag{88}$$

Solution $((\rho_r;0),(\rho_l;1)) = ((1;0),(0;1))$:

For the solution $((\rho_r;0),(\rho_l;1)) = ((1;0),(0;1)))$ to be an equilibrium, the following is necessary and sufficient:

$$\Pr(\text{r wins}; ((1;0),(0;1))) \geq \Pr(\text{r wins}; ((0;0),(0;1))) \tag{89}$$

$$\Pr(\text{l wins}; ((1;0),(0;1))) \geq \Pr(\text{l wins}; ((1;0),(1;1))) \tag{90}$$

Solving with respect to Ψ, using (70), (68), and (77), we conclude that $((\rho_r;0),(\rho_l;1)) = ((1;0),(0;1))$ cannot be an equilibrium because that would require

$$\frac{1}{1+\frac{\mu_a''y}{\lambda\left(T(\mu_b+\mu_a')+\mu_a''\underline{w}\right)}} < \Psi < \frac{1}{1+\frac{\mu_a''y}{\lambda\left(T(\mu_b+\mu_a')+\mu_a''\underline{w}\right)}}. \tag{91}$$

Citizen problem

From the reasoning in the first four paragraphs under citizen problem in the proof of Proposition 2, and accounting for the above described solution to candidates' problem, we obtain that a solution to game Γ^{fs} must take one of the following forms:

A. $\{\pi_i\}_{i\in[0,\mu_a]} = 0$ and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

B. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y-T+\underline{w})} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y-T+\underline{w},1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} = 0$ for $\Psi \leq 1$, whereas $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $1 < \Psi$.

C. $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[0,y)} = 1$, $\{\pi_i\}_{i\in[0,\mu_a]\cap\beta_i\in[y,1]} = 0$, and $\{\pi_i\}_{i\in(1-\mu_b,1]} = 1$, and $\{\rho_j\}_{j\in\{r,l\}} =$

0 for $\Psi \leq \zeta$, $\{\rho_j\}_{j\in\{r,l\}} = 1$ for $\zeta^{\mathrm{s}} < \Psi$.

Following the same reasoning as in the citizen problem in the proof of Proposition 2, we find that solution (A) is an equilibrium only if $z = 0$ and $\Psi < 1$, solution (B) is an equilibrium only if $z = 1$ and $\Psi < 1$, solution (C) is an equilibrium only if $\zeta < \Psi$. □

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