The Political Economy of Defaultable Debt and Entitlements*

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Abstract

This study develops a two-period dynamic politico-economic model in which both government debt and entitlements may default. We examine how default costs influence policy choices and social welfare. In this model, debt shifts resources from future to present, whereas entitlements target the future allocation of resources. Therefore, both instruments allow a politically powerful group in the present to extract resources from the group that will be powerful in the future, thereby mediating intergenerational conflict. Our first main result is that higher debt-default costs have a non-monotonic effect on entitlement size. A similar non-monotonicity arises in how entitlement-default costs affect debt issuance, indicating that the two instruments are determined jointly and interdependently. Second, changing the default costs can generate Pareto improvements under certain conditions. When incentives to smooth private and public consumption are strong, raising default costs reduces future fiscal burdens and can improve the welfare of both current and future generations. The feasibility of such improvements depends on the levels of both debt- and entitlement-default costs. Overall, these results indicate that treating debt and entitlement policies separately is insufficient. Instead, an integrated approach for designing these two institutions is required.

Key words: Government debt; Entitlements; Default; Political economy.

JEL Classification: D72, E62, H60, H63

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1 Introduction

Concerns about fiscal sustainability in emerging market economies have intensified in recent years. In 2024, 51% of these economies recorded primary deficits exceeding the levels required to stabilize public debt, underscoring a heightened need for fiscal adjustment. Under current policies, the average public debt-to-GDP ratio of G20 emerging economies, which stood at 49.3% in 2016, is projected to increase to 91.9% by 2030 (IMF 2025) (see Figure 1).

Against this backdrop, entitlement-related expenditure has attracted increasing attention as a primary source of fiscal pressure. Entitlements are defined as "any spending program where expenditure is open-ended (usually transfer or grant payments) and where recipients must be paid or given transfers or grants if they meet certain criteria" (IMF 2025). Typical examples include public pension systems, public health insurance programs, and unemployment insurance.

Entitlements are sometimes referred to as "implicit government debt" because of their large scale and the difficulty in reducing them, making them a major determinant of fiscal sustainability. For example, Smetters (2004) and Kotlikoff (2006) show, both theoretically and empirically, that the institutional rigidity of entitlement programs reduces the flexibility of fiscal policies and amplifies long-term fiscal risks.

Several studies indicate that the expansion of entitlement spending poses a serious threat to fiscal sustainability in both advanced and emerging markets. For example, Eich et al. (2014) show that, as of 2010, public pension spending—a representative form of entitlement expenditure—accounted for over 20% of primary spending in several emerging economies, including Argentina, Brazil, Bulgaria, Chile, and Russia. As in advanced economies, demographic aging is progressing in emerging markets, and entitlement spending on programs such as public pensions and public health insurance is expected to increase further in the coming years, placing additional pressure on public finance (IMF 2025). Therefore, understanding the determinants of entitlement spending is essential to assess fiscal sustainability in emerging economies.

Recent work in political economy has made substantial progress in analyzing fiscal outcomes, particularly in distinguishing between discretionary and entitlement spending. Baron (1996) and Bowen et al. (2014), using dynamic bargaining models, show that entitlements can lead to a persistent expansion of public expenditures through a status quo effect. Azzimonti et al. (2023) demonstrate that rising income inequality strengthens the bargaining power of low-income groups and contributes to the long-run growth of entitlement spending. Bouton et al. (2020) show that entitlements can be strategically complementary to government debt, thereby expanding total government obligations. Furthermore, Piguillem and Riboni (2024) document that the stickiness of entitlement spending generates a non-linear relationship with debt accumulation.[1]

This literature has deepened our understanding of how entitlements shape fiscal obligations.

[1] See Section 2 for a more detailed discussion of related studies.

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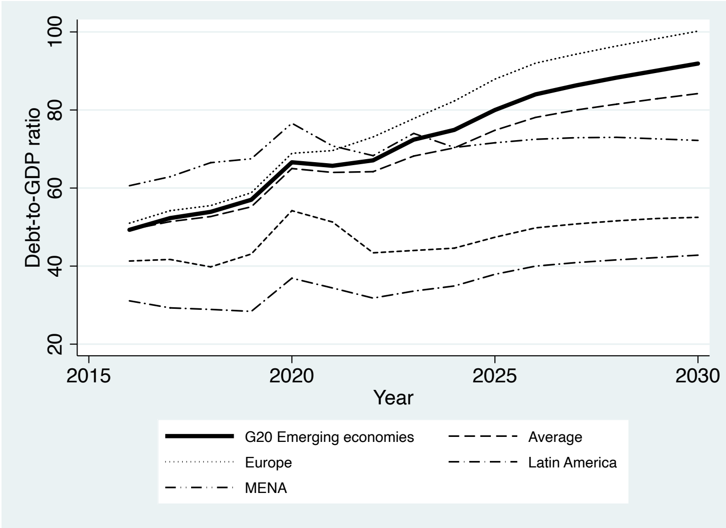

Figure 1: Emerging Market and Middle-Income Economies: General Government Gross Debt, 2016 – 2030

However, it omits a crucial dimension for analyzing fiscal obligations in emerging economies: the possibility of default on government debt and entitlements. Studies typically assume that such defaults do not occur. However, defaults on both government debt and entitlements are frequently observed in emerging market economies.

For example, Erce et al. (2024) report that between 1980 and 2018, there were 116 defaults on local-currency government debt, and 177 defaults on foreign-currency government debt, of which 87 and 118 cases, respectively, occurred in emerging market economies. Their analysis of these event data further indicates that the annual frequency of domestic defaults is 2.1% and that of external defaults is 3.0%, suggesting that the default risk is far from negligible.

Both government debt and entitlements have undergone de facto defaults through reforms of pension systems and related programs. For example, since the 1990s, countries such as the Czech Republic, Lithuania, and Georgia have raised their statutory retirement ages for public pensions (Holzmann and Hinz 2005). Bulgaria has implemented similar reforms since the early 2000s (IMF 2012). In Argentina, the indexation rule for pension benefits was revised in 2017, shifting from a wage- and revenue-linked formula to a new system based on a combination of the consumer price index and wage growth (Carrera and Angelaki 2021). These reforms were introduced to reduce entitlement spending and improve the viability of the pension system, and their effects can be interpreted as partial repudiations—or de facto defaults—of entitlement obligations.[2]

[2] In advanced economies, where population aging and longevity have progressed further, entitlement defaults have been observed even more frequently. In Japan, for instance, the statutory retirement age for public pensions has been raised multiple times since 2000 (Clements, Eich, et al. 2014). Several other advanced economies have also implemented significant pension reforms, including increases in retirement age (Italy and Spain), reductions in incentives for early retirement (Denmark and Italy), and cuts in pension benefits (Greece and Portugal) (IMF 2012).

As Bouton et al. (2020) point out, the relationship between entitlement spending and government debt can change substantially when the government has the option to default. In particular, while part of government debt represents repayment obligations to foreign creditors, entitlements represent commitments to specific domestic groups. These differences may affect the design of entitlement programs and government debt-issuance decisions in distinct ways. Incorporating these asymmetric effects of default across heterogeneous fiscal obligations—both theoretically and empirically—is crucial for deepening our understanding of fiscal outcomes. To the best of our knowledge, no political economy model integrates these two elements, and Bouton et al. (2020) are no exception.

The purpose of this study is to allow for default on both government debt and entitlements within the political economy framework for analyzing entitlements and to examine how the option to default shapes the government's debt-issuance decisions and the design of entitlement programs. More specifically, this study analyzes the relationship between the magnitude of the costs associated with default and the resulting size of government debt and entitlement spending. In particular, it investigates how changes in the costs incurred when the government defaults on either its debt or entitlement obligations influence the burden of debt repayment, the burden of entitlement commitments, and the combined level of overall fiscal obligations. This study also examines how the size of these costs affects the welfare of each generation in the economy. The model developed here builds on the framework of Bouton et al. (2020), but differs from their approach in a key respect: it explicitly introduces default on both government debt and entitlements as a feasible policy option.

The main components of the model developed in this study are as follows. We consider a two-period economy in which, in each period, the public-good provision and the allocation of private goods across the two groups are determined through a political process. Every period has a young and an old group, and political power is assumed to rest with the young.

In Period 1, the young group can use government debt to borrow resources from the future, and thereby enjoy higher private consumption. In addition, by choosing entitlement policies, they can predetermine the allocation of private goods that they will receive when they age in Period 2. Thus, both government debt and entitlements function as instruments through which the young in Period 1 extract resources from those in Period 2, who will hold political power in the future.

However, in the model, we assume that the young group holding political power in Period 2 can partially default on both government debt and entitlement by incurring a resource cost. The option to default affects the optimal choices of government debt and entitlements made by the young in Period 1 through distinct channels.

The first main finding of this study is that an increase in the cost of default on government debt has a non-monotonic effect on the size of entitlement. A higher debt-default cost reduces the fiscal burden of debt issuance by lowering the equilibrium size of the default, thereby allowing the Period-1 government to issue a larger amount of debt. However, as this effect interacts with future fiscal obligations and incentives for intertemporal smoothing, an increase in debt-default cost does not necessarily lead to an expansion of entitlements. Symmetric non-monotonicity arises from the effect of entitlement-default costs on debt issuance, indicating that default behavior under the two regimes is tightly interconnected.

Second, changes in the cost of default on government debt and entitlement can generate Pareto improvements under certain conditions. In particular, when the incentives to smooth private consumption and public-good provision are strong, raising default costs can simultaneously improve the welfare of all generations. Moreover, whether such improvements are attainable depends on the relative magnitudes of the two default costs, implying that it is theoretically insufficient to design the debt-default regime and entitlement regime independently. The analysis suggests that institutional reforms—such as strengthening fiscal rules or modifying the legal rigidity of social insurance programs—may serve as policy instruments for improving intergenerational welfare outcomes, offering a new perspective for the design of fiscal institutions.

The structure of this paper is organized as follows. Section 2 reviews the related literature in the field to which this study contributes and clarifies how this paper fits into the existing body of work. Section 3 presents the analytical model and formulates the political and economic environment, including the possibility of a default on government debt and entitlements. Section 4 defines the equilibrium concept used in this study, and derives the equilibrium outcomes. Section 5 presents a comparative statics analysis to examine how the equilibrium outcomes respond to changes in the costs of default on government debt and entitlements. Section 6 builds on these comparative static results to investigate how changes in default costs affect the welfare of different generations. Section 7 discusses the policy implications of the theoretical findings. Finally, Section 8 concludes the paper.

2 Related Literature

2.1 Political Economy of Entitlements

This paper contributes to the political economy literature on entitlements. Baron (1996) and Bowen et al. (2014) focus on public programs—such as entitlements and regulations—that remain in force unless new legislation is enacted and analyze the mechanisms through which such programs are chosen using dynamic political economy models. In these studies, the policies for each period are determined through political bargaining based on a take-it-or-leave-it budget offer. Consequently, the level of public-good provision implemented in the previous period functions as the endogenous status quo in subsequent negotiations. This structure provides the ruling party an incentive to set public spending above its static optimum, thereby generating the possibility of persistent and cumulative growth in public expenditure.

Azzimonti et al. (2023) aim to explain the long-run expansion of entitlement spending in the United States. They developed a dynamic political economy model in which two major parties—representing the interests of the rich and the poor, respectively—bargain over taxes, entitlement spending, and public-good provision. Their theoretical and quantitative analyses show that "unequal growth," characterized by rising income inequality, strengthens the bargaining power of the poor through the status quo mechanism. Consequently, entitlement spending increases over time.

Another strand of research focuses on the interaction between entitlement spending and government debt. A prominent early contribution that analyzes the strategic complementarity between the two using a political-economy framework is Bouton et al. (2020). They show that in the presence of capital market frictions, strengthening fiscal rules that restrict government borrowing can strategically increase the government's reliance on entitlement spending. As a result, "total government liabilities"—defined as the sum of government debt and entitlement spending—may expand, potentially leading to outcomes that are Pareto inferior for all parties involved.

Furthermore, Piguillem and Riboni (2024) analyze how the stickiness of entitlement spending affects the accumulation of government debt. In their model, the incumbent government is assumed to be required to maintain a fixed proportion of the previous period's spending level, and this constraint is formalized as "spending stickiness." Their analysis shows that the relationship between spending stickiness and debt accumulation is hump-shaped, implying that the effect of stickiness on debt dynamics varies substantially with its degree.

As noted above, existing political economy literature has primarily focused on identifying the mechanisms through which entitlement spending becomes excessively large and on examining its interaction with government debt. However, this literature typically assumes that neither government debt nor entitlements can be defaulted upon and therefore does not analyze how allowing for default on these obligations might affect the size of entitlements or the level of government debt. Building on this body of work, the present study takes a further step by introducing the option to default on both government debt and entitlements and by examining the theoretical implications of such default options for their interaction and overall fiscal obligations.

2.2 Political Economy of Sovereign Default

This paper also relates to the political economy literature on sovereign default. Theoretical research on government debt default has developed various model-based analyses aimed at identifying the mechanisms that give rise to sovereign risk, along with its macroeconomic consequences. The earliest contribution to the literature, Eaton and Gersovitz (1981) analyzes government borrowing and default decisions under debt contracts that allow for potential repudiation. Their framework provides a theoretical foundation for credit constraints in sovereign debt markets and serves as the basis for much of the subsequent quantitative analyses of sovereign defaults.

Since the 2000s, a dominant line of research in the sovereign default has employed DSGE models to quantitatively examine the relationship between sovereign default and business cycles in emerging market economies. For example, Aguiar and Gopinath (2006) introduce regime shocks to the trend growth rate of output and show that their framework can account for the countercyclical behavior of interest rates and the observed frequency of defaults in emerging economies. Arellano (2008) develops a DSGE model with endogenous default risk and demonstrates that high debt levels during recessions increase the incentive to default, consistent with empirical evidence. Furthermore, Mendoza and Yue (2012) present a general equilibrium model that jointly analyzes sovereign default and business-cycle dynamics, highlighting the financial amplification mechanisms that operate upon default and exacerbate macroeconomic fluctuations.

A substantial body of research on sovereign default has also focused on the lack of commitment inherent in international lending relationships. Cole and Kehoe (2000) formulate the concept of self-fulfilling debt crises within a general equilibrium framework and show that crises may involve multiple equilibrium regions—a no-crisis zone, a crisis zone, and a default-only zone. Their analysis is pioneering in demonstrating that crises can arise not only from fundamental economic factors but also from self-fulfilling changes in market expectations. In addition, Dovis (2019) shows that in a production economy with informational and commitment constraints, default and temporary exclusion from international financial markets emerge endogenously along the equilibrium path as outcomes of efficient risk sharing.

A growing body of research in the sovereign default literature has also focused on partial sovereign default, or "haircuts." For example, Adam and Grill (2017) show that even when the government can fully commit, deviating partially from its legal repayment obligations—that is, choosing a partial default—can be optimal under certain conditions. Moreover, Amador and Phelan (2021, 2023) introduce reputation as a central determinant of default decisions and develop a new theoretical framework that incorporates government type and market expectation formation. In addition, Arellano et al. (2023) identify a mechanism through which partial default in the present can trigger future default events.

Taken together, the political economy literature on sovereign default has evolved along two main lines: quantitative analyses based on DSGE models and theoretical studies emphasizing commitment problems and the determination of default size. This study is related to this literature in that it also considers sovereign default and adopts a framework in which the government endogenously chooses the size of its default on public debt. This study departs from the existing literature by introducing entitlement programs into the analysis and allows the government to choose to default not only on public debt, but also on entitlement obligations. By extending this framework, this study offers new theoretical insights into fiscal obligations and government policy choices.

3 Model

3.1 Households

This study considers an economy that lasts for two periods. In each period, there are two cohorts —the young and the old—each with a population size normalized to one and population growth assumed to be zero. The old cohort in Period 1 consists of initial old agents who do not make intertemporal decisions. Because the economy ends after Period 2, the young cohort in Period 2 also does not make forward-looking decisions. In contrast, the young cohort in Period 1 lives for two periods and chooses consumption and savings in Period 1. For clarity, the cohort that is young in Period 1 and old in Period 2 is referred to as Generation 1, whereas the cohort that is only young in Period 2 is referred to as Generation 2.

In each period, only the young supply labor inelastically and produce z_t $(t = 1, 2)$ units of the good.[3] The government levies a lump-sum tax τ_t $(t = 1, 2)$ on the young in each period and issues government debt d (government saving is also allowed). Government revenue consists of tax revenue and debt issuance and is used to finance public-good provision g_t $(t = 1, 2)$ and income transfers y_t^i $(t = 1, 2;\ i = y, o)$, which may differ across generations.

Generation 1, while young in Period 1, can set the size of the transfer that it will receive in Period 2 in advance by choosing $y_2^o = y^E$. We refer to this predetermined transfer as an "entitlement." This follows the formulation in Bouton et al. (2020); however, in contrast to their setting, the Period 2 government in our model can choose to default on part of the entitlement by incurring a resource cost, as detailed later.

Here, we follow Arellano (2008) and Bouton et al. (2020) and impose the following assumption:

Assumption 1. *Households face incomplete capital markets and therefore cannot engage in private saving or borrowing.*

If capital markets are complete and households can save and borrow freely under the same conditions as the government, Generation 1 can substitute private borrowing for public debt issuance in Period 1 and finance additional transfers in Period 2 by setting a larger entitlement in advance. In this case, government debt, entitlements, and private saving/borrowing would become mutually substitutable instruments.

To focus on how a government's ability to default on both public debt and entitlements affects its borrowing decisions and the design of entitlement programs, we follow Arellano (2008) and Bouton et al. (2020) by assuming incomplete capital markets. Under this assumption, the model

[3] In political economy studies of sovereign default such as Aguiar and Gopinath (2006) and Arellano (2008), income is modeled as a random variable in order to endogenize the probability of default. In contrast, because this study focuses on the size of the haircut at default rather than on default probabilities, income is treated as a deterministic exogenous variable.

becomes structurally equivalent to early political economy models of government debt, such as that of Alesina and Tabellini (1990). In particular, households use public debt as a substitute for private borrowing and entitlements as a substitute for private saving, which, in turn, affects the level of public-good provision chosen in each period.

Given the environment described above, the budget constraints for the old and the young in Period 1 are

$$c_1^o = y_1^o, \tag{1}$$

$$c_1^y = z_1 - \tau_1 + y_1^y. \tag{2}$$

Similarly, the budget constraints in Period 2 are

$$c_2^o = y_2^o, \tag{3}$$

$$c_2^y = z_2 - \tau_2 + y_2^y. \tag{4}$$

Preferences of households in each period are given by

$$u(c_t^i, g_t) = \frac{(c_t^i)^{1-\rho} - 1}{1-\rho} + \alpha \cdot \frac{(g_t)^{1-\rho} - 1}{1-\rho}, \quad \alpha > 0, \quad \rho \neq 1, \quad i \in \{y, o\}. \tag{5}$$

Here, ρ denotes the inverse of the elasticity of substitution. A larger value of ρ (a smaller value of $1/\rho$) implies a stronger incentive for households to smooth private and public-good consumption across periods.

3.2 Government

Political decision-making is assumed to be undertaken by the young generation in each period. Because the young also constitute the working population in this model, this assumption can be interpreted as implying that political decisions are made by workers during each period. Galasso and Profeta (2004) and Galasso (2008) estimate the age of the median voter using cross-country data on demographic structures and political participation. Their estimates indicate that even after accounting for the relatively high turnout rates among the elderly, the median age of voters in France, Italy, the United Kingdom, and the United States around 2000 lies in the forties. Therefore, this assumption is empirically plausible.

In Period 1, the government levies a lump-sum tax τ_1 on the young generation and issues d of one-period government debt (government saving is also permitted). The initial stock of government debt is assumed to be zero. Let q denote the government debt price. Thus, by issuing one unit of debt in Period 1, the government receives q units of the goods and faces a repayment obligation of one unit in Period 2. Therefore, the government's budget constraint in Period 1 is

$$g_1 + y_1^y + y_1^o = qd + \tau_1. \tag{6}$$

In Period 2, the government levies a lump-sum tax τ_2 on the young. As the economy ends in this period, the government cannot issue new public debt, and tax revenue constitutes its only source of income. The government is obligated to repay the public debt issued in Period 1 and finance the entitlement payments pre-specified in Period 1.

Here, the government is assumed to be able to default on a fraction $c^d \in [0, 1]$ of its outstanding public debt by incurring a cost $\chi^d(c^d, d)$. In other words, the Period 2 government may choose to partially default on public debt.[4] When a default occurs, the government is typically excluded from international financial markets for some time, and additional economic losses—such as productivity decline due to disruptions in trade—may also arise (Arellano 2008; Eaton and Gersovitz 1981). Although these channels are not modeled explicitly here, the function $\chi^d(c^d, d)$ can be interpreted as a reduced-form representation of such losses.[5]

Furthermore, this paper assumes that the government may also default on entitlements. Specifically, by incurring a cost $\chi^y(c^y, y^E)$, the government can default on a fraction $c^y \in [0, 1]$ of its entitlement obligation. This captures situations in which previously promised transfers—such as public pension benefits—are modified through measures such as raising the eligibility age or reducing the benefit level. Defaulting on predetermined entitlements generally entails transitional costs associated with institutional reform (Clements, Coady, et al. 2013). Additionally, entitlement defaults may heighten political instability and generate economic losses through reduced investment (Alesina and Perotti 1996) and lower productivity (Aisen and Veiga 2013). Although these elements are not explicitly modeled here, the function $\chi^y(c^y, y^E)$ can be interpreted as a reduced-form representation of such losses.

Under these assumptions, the budget constraint of the government in Period 2 is given by

$$g_2 + y_2^o + y_2^y + (1 - c^d)d + \chi^d(c^d, d) + \chi^y(c^y, y^E) = \tau_2, \tag{7}$$

$$y_2^o \geq (1 - c^y)y^E. \tag{8}$$

Constraint (8) represents the entitlement obligation. The young in Period 1 may pre-set the

[4] Such partial sovereign defaults or *haircuts* are analyzed, among others, in Adam and Grill (2017), Amador and Phelan (2021, 2023), and Arellano et al. (2023).

[5] Early seminal contributions to the sovereign default literature, including Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), and Arellano (2008), focus on binary default decisions in which the government either fully repays or fully defaults. In these models, default costs are captured through temporary exclusion from international financial markets. In contrast, the present paper emphasizes the endogenous choice of default size; accordingly, it adopts a specification in which default entails a continuous cost that depends on the extent of the default, rather than an access-exclusion penalty.

transfer they will receive in Period 2 at level y^E; however, if the government in Period 2 chooses to default on entitlements, the effective entitlement payment is reduced by $c^y y^E$.

Following Calvo (1988) and Adam and Grill (2017), this study assumes that default costs increase with the default size. That is, when the government chooses to partially default on public debt or entitlement benefits, the associated cost increases smoothly with the magnitude of the default. Specifically, the default cost of government debt, $\chi^d(c^d, d)$, and on entitlements, $\chi^y(c^y, y^E)$, are assumed to take the following forms:[6]

$$\chi^d(c^d, d) = \frac{\beta^d d}{2}(c^d)^2, \qquad \chi^y(c^y, y^E) = \frac{\beta^y y^E}{2}(c^y)^2, \qquad \beta^d > 0,\ \beta^y > 0. \tag{9}$$

The cost functions in (9) explicitly capture how the defaults on government debt and entitlements arise from distinct institutional settings and economic mechanisms. Parameter β^d governs the magnitude of the cost associated with a default on government debt. It reflects, in reduced form, several components of the sovereign default penalty: the duration and severity of credit market exclusion following default, the deterioration in future borrowing terms due to reputational losses vis-à-vis foreign investors, and the amplification of financial frictions that may induce capital flight. Accordingly, a larger value of β^d implies that the government faces stronger disincentives to default on public debt.

By contrast, β^y measures the magnitude of the cost associated with defaulting entitlements. In its reduced form, this parameter captures several components of the economic and political repercussions of entitlement default: social resistance to benefit cuts, administrative adjustment costs arising from program restructuring, heightened political instability, and broader economic and social disruptions stemming from adverse impacts on vulnerable households. Moreover, entitlement programs that enjoy stronger legal or institutional protection incur higher costs when a default occurs, which can be interpreted as corresponding to a relatively large value of β^y.

Because policy decisions in Period 2 are made by the young cohort in that period, the constraints associated with entitlements can never be slack. When the entitlement constraint binds, the government's budget constraint in Period 2 can be written as

$$g_2 + (1 - c^y)y^E + y_2^y + (1 - c^d)d + \chi^d(c^d, d) + \chi^y(c^y, y^E) = \tau_2. \tag{10}$$

3.3 International capital markets

The government is assumed to trade one-period bonds with international financial markets. Counterparties in these markets are characterized by three properties: (i) they are risk-neutral

[6] If a fixed cost of default were introduced, equilibria in which the optimal default size is zero could arise. For simplicity, such cases are not considered in this paper.

and perfectly competitive; (ii) they possess full information and can accurately anticipate the government's default decision in Period 2; and (iii) they can buy and sell risk-free bonds freely, yielding a gross interest rate R.

The magnitude of sovereign default directly affects the price of government debt (equivalent to the interest rate on government bonds). If the Period 2 government is expected to default on a fraction c^d of its outstanding debt, then an international creditor who purchases d units of government debt obtains an expected gross return of $(1-c^d)d/(qd)$. Given the three assumptions above, this return must equal the return on a risk-free bond. Hence, the following no-arbitrage condition must hold:

$$q = \frac{1-c^d}{R}. \tag{11}$$

This condition implies that the price of government debt, q, decreases as the default size c^d increases, reflecting a reduction in repayment. When no default occurs ($c^d = 0$), the debt price satisfies $q = 1/R$.

Finally, let β denote the household discount factor, and impose the following assumption:

Assumption 2. *R=β=1.*

Under this assumption, it is optimal for households to smooth consumption perfectly across periods. Hence, any deviation from consumption smoothing must arise from capital-market imperfections or political frictions rather than from intertemporal preferences.

4 Equilibrium analysis

The timing of the events in each period of the model can be summarized as follows: As the decisions of the government and households at each stage affect subsequent choices and equilibrium conditions, the problem must be solved by backward induction, as in standard dynamic general equilibrium models.

1. In Period 1, the government chooses $\{\tau_1, d, g_1, y_1^y, y_1^o, y^E\}$.
2. The consumption levels of the old and the young in Period 1, c_1^o and c_1^y, are determined.
3. Given $\{d, y^E\}$, the Period 2 government chooses default sizes $\{c^d, c^y\}$ and policy variables $\{\tau_2, g_2, y_2^y, y_2^o\}$.
4. The consumption levels of the old and the young in Period 2, c_2^o and c_2^y, are determined.

In what follows, we solve the dynamic optimization problem by backward induction, beginning with the default and policy choices of the Period 2 government and then deriving the optimal policies in Period 1.

4.1 Optimization Problems of the Period 2 Government and the Young

Because policy decisions in each period are made by the young, the problem of the Period 2 government and those of the young in Period 2 can be consolidated into a single optimization problem. The joint optimization problem in Period 2 is given by:

$$\max_{c_2^y, g_2} \frac{(c_2^y)^{1-\rho} - 1}{1-\rho} + \alpha \cdot \frac{(g_2)^{1-\rho} - 1}{1-\rho}, \tag{12}$$

$$\text{s.t.} \quad g_2 + (1 - c^y)y^E + c_2^y + (1 - c^d)d + \chi^d(c^d, d) + \chi^y(c^y, y^E) = z_2, \tag{13}$$

$$d,\ y^E,\ c^d,\ c^y \text{ given.}$$

Constraint (13) represents the Period 2 resource constraint obtained by combining households' budget constraints (3) and (4) with the government's budget constraints (7) and (8). Note that the default sizes of government debt and entitlement, $\{c^d, c^y\}$, are considered as given here.

The objective function in (12) corresponds to the utility of the young in Period 2. As the problems are consolidated, the choice variables are only $\{c_2^y, g_2\}$; once these are chosen, the implied values of $\{\tau_2, y_2^y\}$ are uniquely determined. Moreover, the entitlement constraint cannot be slack in the optimal allocation, implying that $y_2^o = (1 - c^y)y^E$ must hold.

Solving this optimization problem yields the following expressions for consumption and public-good provision in Period 2:

$$c_2^{B*} = \frac{1}{1 + \alpha^{1/\rho}} \left[z_2 - (1 - c^d)d - \chi^d(c^d, d) - (1 - c^y)y^E - \chi^y(c^y, y^E) \right], \tag{14}$$

$$g_2^* = \frac{\alpha^{1/\rho}}{1 + \alpha^{1/\rho}} \left[z_2 - (1 - c^d)d - \chi^d(c^d, d) - (1 - c^y)y^E - \chi^y(c^y, y^E) \right]. \tag{15}$$

In what follows, $\{d, y^E\}$ are assumed to lie within the range that ensures $c_2^{B*} > 0$ and $g_2^* > 0$. As shown below, these conditions are satisfied in equilibrium.

The government debt d and entitlement benefit y^E chosen in Period 1 affect the behavior of Period 2's government and young through two distinct channels. First, both d and y^E act as predetermined commitments that reduce the available fiscal resources of the Period 2 government. Consequently, they lower private consumption in Period 2 as well as the level of public-good provision. Second, given $\{d, y^E\}$, the default sizes $\{c^d, c^y\}$ are determined endogenously, which in turn determines the associated default costs $\{\chi^d(c^d, d),\ \chi^y(c^y, y^E)\}$. Larger default costs further reduce the government's available budget, thereby depressing the private consumption of the young in Period 2 and the provision of public goods.

By substituting (14) and (15) into (12), the value function of the Period 2 young can be written as follows:

$$V_2 = \frac{\left[\left(\frac{1}{1+\alpha^{1/\rho}}\right)^{1-\rho} + \alpha\left(\frac{\alpha^{1/\rho}}{1+\alpha^{1/\rho}}\right)^{1-\rho}\right]\left[z_2 - (1-c^d)d - \chi^d(c^d, d) - (1-c^y)y^E - \chi^y(c^y, y^E)\right]^{1-\rho} - (1+\alpha)}{1-\rho}. \tag{16}$$

Next, we determine the default sizes $\{c^d, c^y\}$ for government debt and entitlements. Assuming an interior solution, the first-order conditions of the optimization problem based on the value function (16) yield the following optimal default sizes:

$$c^{d*} = \frac{1}{\beta^d}, \qquad c^{y*} = \frac{1}{\beta^y}. \tag{17}$$

For the default sizes derived above to be interior solutions (i.e., $0 < c^{d*} < 1$ and $0 < c^{y*} < 1$), the following assumption is required:

Assumption 3. $\beta^d > 1$ *and* $\beta^y > 1$.

Under this assumption, the optimal default sizes satisfy $c^{d*} \in (0,1)$ and $c^{y*} \in (0,1)$, thus ensuring that partial defaults arise as interior solutions.

Next, we examine the net fiscal burden that remains in Period 2 when the Period 1 government issues public debt and/or sets entitlements. In the present model, a fraction of government debt and entitlement is subject to default. Since in Period 2 the government defaults only when doing so yields a higher payoff, the default always generates a positive net benefit for the government. Consequently, the amounts of public debt repayment and entitlement payments borne by the Period 2 government are strictly smaller than the total face value of the debt issued and the entitlement level chosen in Period 1.

We define the amount of public debt repayment that the Period 2 government effectively bears after default as the *net fiscal burden of public debt* (NFBD) and the amount of entitlement payments actually borne by the government as the *net fiscal burden of entitlement liabilities* (NFBE). These objects are given by

$$\Phi(c^{d*}, d) = (1-c^{d*}) \cdot d + \chi^d(c^{d*}, d) = \left(1 - \frac{c^{d*}}{2}\right) \cdot d, \tag{18}$$

$$\Psi(c^{y*}, y^E) = (1-c^{y*}) \cdot y^E + \chi^y(c^{y*}, y^E) = \left(1 - \frac{c^{y*}}{2}\right) \cdot y^E. \tag{19}$$

Here, $\Phi(c^{d*}, d)$ denotes the net fiscal burden of public debt and $\Psi(c^{y*}, y^E)$ denotes the net fiscal burden of entitlement liabilities. Given these definitions, the equilibrium level of public-good provision in Period 2 is

$$g_2^* = \frac{\alpha^{1/\rho}}{1+\alpha^{1/\rho}} \left[z_2 - \Phi(c^{d*}, d) - \Psi(c^{y*}, y^E) \right]. \tag{20}$$

As $c^{d*} \in (0,1)$ and $c^{y*} \in (0,1)$, NFBD is an increasing function of d; similarly, NFBE is an increasing function of y^E. Hence, equation (20) implies that the Period 2 level of public-good provision g_2 decreases when either d or y^E increases.

This result indicates that although the Period 1 young can raise their private consumption and public-good provision in Period 1 by issuing government debt and can increase their own private consumption in Period 2 by setting a higher entitlement level, both policy instruments generate a trade-off by lowering public-good provision in Period 2. The next subsection analyzes how the Period 1 government (the young), facing this tradeoff, chooses the optimal levels of government debt and entitlements.

4.2 Optimization Problems of the Period 1 Government and the Young

Because the policy decisions in each period are made by the young generation, the problems of the Period 1 government and that of Generation 1 can be consolidated into a single optimization problem. The Period 1 government chooses its policies while considering how the issuance of government debt and the pre-determined entitlement affect public-good provision and the default sizes $\{c^d, c^y\}$ chosen by the Period 2 government, as well as how these effects are reflected in the price of government debt in Period 1, $q(c^d)$.

Accordingly, the optimization problem for the Period 1 government and Generation 1 can be formulated as follows:

$$\max_{c_1^y, c_1^o, d, g_1, y^E} \; V_1 = \frac{(c_1^y)^{1-\rho} - 1}{1-\rho} + \alpha \cdot \frac{(g_1)^{1-\rho} - 1}{1-\rho} + \frac{(c_2^o)^{1-\rho} - 1}{1-\rho} + \alpha \cdot \frac{\left(g_2^*(d, y^E)\right)^{1-\rho} - 1}{1-\rho}, \tag{21}$$

$$\text{s.t. } c_1^y + c_1^o + g_1 = z_1 + q(c^{d*})d, \tag{22}$$

$$c_2^o = (1 - c^{y*})y^E, \tag{23}$$

$$q(c^{d*}) = 1 - c^{d*},$$

$$g_2^*(d, y^E) = \frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}} \cdot \left[z_2 - \Phi(c^{d*}, d) - \Psi(c^{y*}, y^E) \right]. \tag{24}$$

Equation (22) represents the Period 1 resource constraint, which is obtained by consolidating household budget constraints in Period 1 (1) and (2) with the government's budget constraint (6). Equation (21) represents the lifetime utility of Generation 1. As these components are integrated into a single optimization problem, the choice variables are $\{c_1^y, c_1^o, d, g_1, y^E\}$. Once these variables are determined, the corresponding values of $\{\tau_1, y_1^y\}$ are simultaneously pinned. Moreover, the constraints associated with entitlements can never be slack from the perspective of lifetime utility maximization. Consequently, in equilibrium, it must hold that $y_1^o = c_1^o = 0$.

The first-order conditions of the optimization problem are derived as follows:[7]

$$\frac{\partial V_1}{\partial g_1} = 0 \Leftrightarrow \; g_1 = \frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}} \cdot (z_1 + q(c^{d*})d), \tag{25}$$

$$\frac{\partial V_1}{\partial d} = 0 \Leftrightarrow \; \Big(z_1 + q(c^{d*})d - g_1\Big)^{-\rho} \cdot q(c^{d*}) + \alpha \cdot \big(g_2^*(d, y^E)\big)^{-\rho} \cdot \frac{\partial g_2^*(d, y^E)}{\partial d} = 0, \tag{26}$$

$$\frac{\partial V_1}{\partial y^E} = 0 \Leftrightarrow \; \big[(1-c^{y*})y^E\big]^{-\rho} \cdot (1-c^{y*}) + \alpha \cdot \big(g_2^*(d, y^E)\big)^{-\rho} \cdot \frac{\partial g_2^*(d, y^E)}{\partial y^E} = 0. \tag{27}$$

Government debt issuance and entitlements play distinct roles in the model. Government debt generates a trade-off between private consumption in Period 1 and public-good provision in Period 2. Thus, government debt is used to smooth consumption over time. In contrast, entitlements generate a trade-off between private consumption and public-good provision within Period 2. In other words, entitlements are used to smooth consumption across different types of goods rather than across periods.

The first term in equation (26) represents the marginal benefit of government debt issuance. An increase of one unit in government debt raises the resources available in Period 1 by $q(c^{d*})$, which in turn increases utility through higher private consumption in Period 1. The second term captures the marginal cost of government debt issuance: higher debt issuance reduces public-good provision in Period 2, thereby lowering utility in that period.

This relationship implies that government debt issuance generates a trade-off between private consumption of Generation 1 when young and public-good provision in Period 2 by reallocating resources intertemporally from Period 2 to Period 1. This effect is consistent with early contributions to the political economy of government debt, such as Persson and Svensson (1989) and Alesina and Tabellini (1990). Similar to these studies, government debt issuance in the present model can function as an institutional device that constrains the behavior of future governments when their preferences differ from those of the current government.

The first term in equation (27) represents the marginal benefit of setting the entitlement. Increasing entitlement by one unit raises the old-age private budget of Generation 1 by $1 - c^{y*}$, which in turn increases utility through higher consumption in Period 2. In contrast, the second term captures the marginal cost of setting entitlement: a higher entitlement reduces public-good provision in Period 2, thereby lowering utility in that period.

Rearranging the first-order conditions yields the levels of revenue from government debt issuance and from entitlements chosen by the Period 1 government (see Appendix A for detailed

[7] Note that the second-order conditions are also satisfied, since $\partial^2 g_2^*/\partial d^2 = 0$ and $\partial^2 g_2^*/\partial (y^E)^2 = 0$.

derivations).

$$q(c^{d*})d^* = \frac{\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot z_2 - \left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1}{A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}}, \tag{28}$$

$$(1-c^{y*})y^{E*} = \frac{\psi(c^{y*})^{-\frac{1}{\rho}}\cdot z_2+\phi(c^{d*})\cdot\psi(c^{y*})^{-\frac{1}{\rho}}\cdot z_1}{A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}}. \tag{29}$$

where

$$\phi(c^{d*}) = \frac{\Phi(c^{d*},d)}{q(c^{d*})d} = \frac{1-\frac{c^{d*}}{2}}{1-c^{d*}},\quad \psi(c^{y*}) = \frac{\Psi(c^{y*},y^E)}{(1-c^{y*})y^E} = \frac{1-\frac{c^{y*}}{2}}{1-c^{y*}},\quad A=\alpha^{\frac{1}{\rho}}\cdot\left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1}{\rho}}.$$

The term $\phi(c^{d*})$ measures the size of the NFBD generated per unit of government debt issuance revenue in Period 1. In what follows, we refer to this object as the *average fiscal burden of public debt* (AFBD). A higher value of $\phi(c^{d*})$ implies that each unit of debt issuance revenue in Period 1 entails a larger fiscal burden for the Period 2 government.

Similarly, $\psi(c^{y*})$ measures the size of the NFBE generated per unit of entitlement revenue in Period 2. This is referred to as the *average fiscal burden of entitlement liabilities* (AFBE). Both $\phi(c^{d*})$ and $\psi(c^{y*})$ are increasing functions of c^{d*} and c^{y*}, respectively. This property follows directly from equation (9), which implies that default costs convexly increase with the default size.

After default decisions are implemented, the total liabilities borne by the Period 2 government are given by

$$q(c^{d*})d^* + (1-c^{y*})y^{E*}.$$

In what follows, we refer to this sum as *total government liabilities.*

4.3 Crowd-out and Smoothing Effects

Two mechanisms primarily determine the equilibrium levels of government debt issuance and entitlement setting. First, even if the young generation in Period 1 leaves fiscal resources for Period 2, a portion of these resources is allocated to private consumption by the young in Period 2, so that not all remaining resources are used for public-good provision. As a result, the young in Period 1 have an incentive to expand total government liabilities, $(q(c^{d*})d^* + (1-c^{y*})y^{E*})$, to increase private consumption and public-good provision in Period 1 or private consumption in Period 2. This mechanism arises from the fact that resources carried over to the future period are partially crowded out by the private consumption of the young in Period

2. Following Bouton et al. (2020), we refer to this mechanism as the *crowd-out effect*.

Equation (20) shows that a one-unit reduction in the NFBD (or, analogously, the NFBE) left to the Period 2 government—achieved by lowering government debt issuance (or the level of entitlements)—raises public-good provision in Period 2, g_2^*, by only $\alpha^{1/\rho}/\left(1+\alpha^{1/\rho}\right)$ rather than by one unit. Accordingly, the magnitude of the crowd-out effect is given by $1-\left(\alpha^{1/\rho}/\left(1+\alpha^{1/\rho}\right)\right)$. When α is small, so that the preference weight on public-good consumption is low, the young in Period 2 allocate a larger share of the additional fiscal resources available in that period to their own private consumption. Consequently, a smaller fraction of these resources is devoted to public-good provision, and the crowd-out effect is stronger.

The second involves smoothing private and public consumption across periods. An increase in total government liabilities reduces the level of public-good provision in Period 2. Such a decline in public-good provision is undesirable for Generation 1, which values intertemporal consumption smoothing. Consequently, the young in Period 1 also have an incentive to restrain the expansion of total government liabilities to preserve public-good provision in Period 2. Following Bouton et al. (2020), we refer to this mechanism as the *smoothing effect*.

Noting that $\Phi(c^{d*}, d^*) = \phi(c^{d*})\, q(c^{d*})d^*$ and $\Psi(c^{y*}, y^{E*}) = \psi(c^{y*})\,(1-c^{y*})y^{E*}$, it follows from equation (24) that the following expression holds.

$$\left|\frac{\partial g_2^*(d, y^E)}{\partial\left[q(c^{d*})d\right]}\right| = \frac{\alpha^{1/\rho}}{1+\alpha^{1/\rho}}\cdot\phi(c^{d*}), \tag{30}$$

$$\left|\frac{\partial g_2^*(d, y^E)}{\partial\left[(1-c^{y*})y^E\right]}\right| = \frac{\alpha^{1/\rho}}{1+\alpha^{1/\rho}}\cdot\psi(c^{y*}), \tag{31}$$

The expression above shows how much public-good provision in Period 2, $g_2^*(d, y^E)$, decreases when government debt issuance revenue or entitlement revenue increases by one unit. The larger this effect, the greater the negative impact perceived by the young in Period 1, who dislike reductions in public-good provision in Period 2. In this case, the smoothing effect operates more strongly, leading to lower levels of government debt issuance and entitlements.

Equations (30) and (31) show that a larger AFBD (or AFBE) implies a stronger smoothing effect associated with government debt issuance (or entitlement setting). This is because the heavier fiscal burden arising from issuing government debt (or setting entitlements) leads to a larger reduction in public-good provision in Period 2.

The magnitudes of AFBD and AFBE depend on the default costs associated with government debt and entitlements as well as on the default sizes determined under those costs. Consequently, the strength of the smoothing effect is closely related to the default behavior. However, to the best of our knowledge, the existing literature does not feature a political economy model that incorporates both government debt and entitlements while allowing for endogenous default on each. As a result, it remains unclear how the presence of default shapes the smoothing effect, or how default costs and the resulting default sizes affect the equilibrium levels of government debt issuance and entitlement setting.

This study fills this gap by explicitly introducing default on both government debt and entitlements and analyzing the interaction between default behavior and the equilibrium levels of the respective policy instruments. In doing so, it theoretically clarifies how the presence of a default affects policy choices in Period 1 through the smoothing effect, thereby offering a novel perspective that is absent from existing political economy models.

From equations (18), (19), (28), and (29), the NFBD and NFBE are given by

$$\Phi(c^{d*}, d^*) = \frac{\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{1-\frac{1}{\rho}}\cdot z_2 - \left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot\phi(c^{d*})\cdot z_1}{A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}}, \tag{32}$$

$$\Psi(c^{y*}, y^{E*}) = \frac{\psi(c^{y*})^{1-\frac{1}{\rho}}\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]}{A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}}. \tag{33}$$

These expressions show that both the NFBD and NFBE depend on the default size of government debt, as well as on the default size of entitlements. That is, changes in the default size on either government debt or entitlements affect public-good provision in Period 2 through the crowd-out and smoothing effects. In response, the Period 1 government adjusts both government debt issuance and entitlement level to smooth utility across periods. Consequently, the NFBD and NFBE change simultaneously in equilibrium.

Moreover, for welfare analysis, the effect of changes in default costs on the welfare of the young in Period 2 depends on how the sum of the NFBD and NFBE varies. In what follows, we refer to the sum

$$\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*}) \tag{34}$$

as the *net fiscal burden of total government liabilities* (NFBT).

4.4 Allocation Elasticity to Fiscal Burden

From equations (26) and (27), the following relationships are obtained:

$$-\frac{\mathrm{d}\ln\left(\frac{c_1^*}{g_2^*}\right)}{\mathrm{d}\ln\phi(c^{d*})} = -\frac{\mathrm{d}\ln\left(\frac{c_1^*}{c_2^*}\right)}{\mathrm{d}\ln\phi(c^{d*})} = \frac{1}{\rho}, \qquad -\frac{\mathrm{d}\ln\left(\frac{c_2^*}{g_2^*}\right)}{\mathrm{d}\ln\psi(c^{y*})} = -\frac{\mathrm{d}\ln\left(\frac{c_2^*}{c_1^*}\right)}{\mathrm{d}\ln\psi(c^{y*})} = \frac{1}{\rho}. \tag{35}$$

Equation (35) provides a measure of how the ratio of private consumption to public-good provision in each period responds, in percentage terms, to a one-percent change in AFBD (or AFBE). In this study, we refer to these measures as the *allocation elasticity to debt burden* and *allocation elasticity to entitlement burden*, respectively. A larger value of these elasticities implies that the young in Period 1 adjust the ratio of private consumption to public-good provision more strongly in response to changes in AFBD or AFBE.

Moreover, equation (35) shows that $1/\rho$ corresponds to both the allocation elasticity to debt burden and the allocation elasticity to entitlement burden. Accordingly, a larger value of $1/\rho$ implies that the young in Period 1 have a weaker incentive to smooth private consumption and public-good provision across periods, and instead adjust these allocation ratios more flexibly in response to changes in fiscal burdens.

5 Comparative statics

This section examines how the magnitude of default costs on government debt, denoted by β^d, and that of default costs on entitlements, denoted by β^y, affect government debt issuance revenues, entitlement revenues, and social welfare.

We focus on the equilibria in which the level of government debt issuance is positive. To ensure that $d^* > 0$, we impose the following assumption:

Assumption 4. $z_1 < \dfrac{\left(1 + \alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{-\frac{1}{\rho}}}{A + \psi(c^{y*})^{\frac{\rho-1}{\rho}}} \cdot z_2 \equiv \overline{z}_1.$

If the income in Period 1 is sufficiently large relative to the income in Period 2, the young in Period 1 have an incentive to transfer resources from Period 1 to Period 2 through government saving. This behavior may prevent the existence of an equilibrium with a positive level of government debt issuance. Assumption 4 rules out this possibility by requiring that the income in Period 1 not be excessively large relative to the income in Period 2.

In what follows, we conduct comparative statics with respect to β^d and β^y: As equations (32) and (33) show, β^d affects $\{d^*, y^{E*}\}$ only through c^{d*}, whereas β^y affects them only through c^{y*}. Therefore, it is necessary to first derive explicitly the relationship between $\{c^{d*}, c^{y*}\}$ and $\{d^*, y^{E*}\}$.

5.1 Comparative Statics with Respect to Debt Default Costs

Here, we examine how changes in the parameter β^d affect government debt issuance revenues and entitlement revenues, as well as NFBD, NFBE, and NFBT in equilibrium.

5.1.1 Government Debt Issuance Revenues and Entitlement Revenues

We first examine how changes in government debt default cost β^d affect government debt issuance and entitlement revenues. The following proposition summarizes the results:

Proposition 1. *The following conclusions are drawn:*

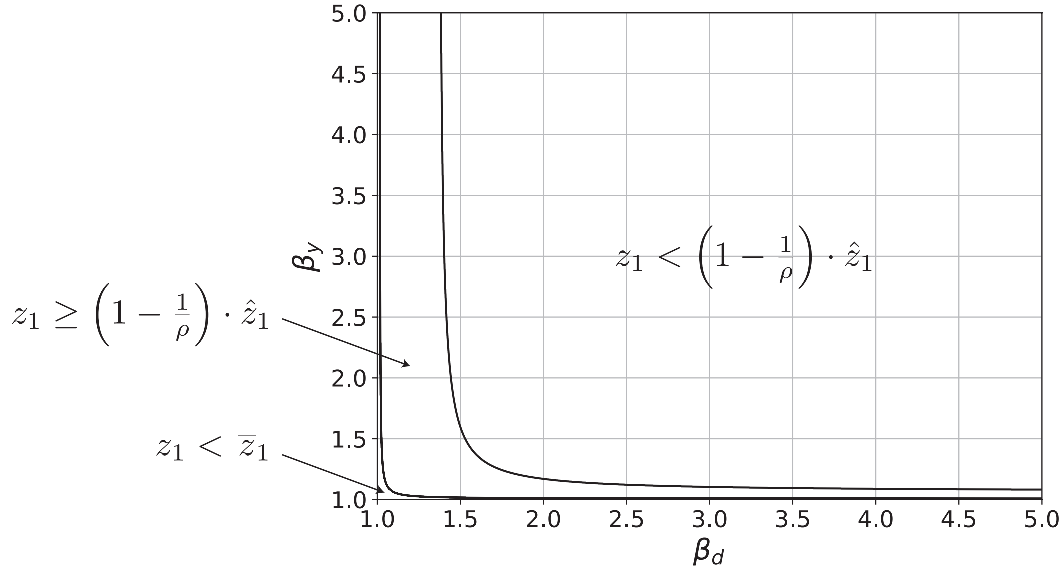

Figure 2: Combinations of $\{\beta_d, \beta_y\}$ for which $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ (or $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$) holds. Parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, and $z_2 = 1$.

(i) *Government debt issuance revenues are monotonically increasing in* β_d*.*

(ii) *When* $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$*, entitlement revenues are monotonically increasing in* β_d*, whereas when* $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$*, they are monotonically decreasing in* β_d *(and are constant at equality).*

where

$$\hat{z}_1 \equiv \frac{1 + \alpha^{\frac{1}{\rho}}}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}}\right] \cdot \phi(c^{d*})^{\frac{1}{\rho}} + \frac{1}{\rho} \cdot \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})} \cdot z_2. \tag{36}$$

(Proof) See Appendix B.

Note that $\hat{z}_1 < \bar{z}_1$ holds true. Hence, even under Assumption 4, both $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ and $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ may arise. However, as $z_1 \geq 0$, it necessarily follows that $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ when $\rho \leq 1$. Figure 2 illustrates the relationship between z_1 and $\left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ in the $\{\beta_d, \beta_y\}$-plane.[8]

An increase in β_d reduces the equilibrium default size of the government debt c^{d*}. Equation (11) implies that a smaller default size raises the price of government debt, thereby increasing the revenue obtained per unit of debt issuance. As a consequence, the fiscal burden per unit of government debt issuance revenue (AFBD) declines. As shown in equation (30), a reduction in AFBD weakens the smoothing effect and provides the Period 1 government with a stronger incentive to expand revenue financing through government debt issuance. Conse-

[8] From equation (36), $\hat{z}_1$ is increasing in β_d. Therefore, if inequality $z_1 < \left(1 - \frac{1}{\rho}\right) \hat{z}_1$ holds at a given level of β_d, it continues to hold for larger values of β_d.

quently, a higher β_d, which leads the Period 2 government to choose a smaller default size, increases the government debt issuance revenues in Period 1.

By contrast, the response of entitlement revenues to changes in β_d is non-monotonic. This non-monotonicity is closely related to the magnitude of the allocation elasticity to entitlement burden defined in equation (35). An increase in β_d lowers AFBD, $\phi(c^{d*})$, while simultaneously increasing government debt issuance revenue, $q(c^{d*})d^*$. Consequently, whether the NFBD—which represents the fiscal burden carried over to Period 2 and is given by $\Phi(c^{d*}, d^*) = \phi(c^{d*})q(c^{d*})d^*$ —increases or decreases depends on the extent to which government debt issuance revenues rise in response to the decline in AFBD.

First, equation (35) implies that a larger value of $1/\rho$ corresponds to a higher allocation elasticity to the debt burden such that government debt issuance revenues increase more strongly in response to a decline in AFBD. Consequently, the NFBD carried over to Period 2 rises, which in turn depresses the level of public-good provision in Period 2, g_2^*. To offset this reduction, Generation 1 reduces the level of entitlements, thereby lowering the NFBE carried over to Period 2.

Similarly, when Period 1 income z_1 is high, the Period 1 resource constraint is relaxed, leading the Period 1 government to place greater weight on securing fiscal resources in Period 2. Consequently, Generation 1 again adjusts the policy by reducing the level of entitlements to lower the NFBE left for Period 2.

Taken together, when the allocation elasticity to debt burden $1/\rho$ is large or Period 1 income z_1 is high, a decline in AFBD leads to a sufficiently large increase in government debt issuance revenues to raise NFBD carried over to Period 2. In response, Generation 1 reduces entitlement revenues in Period 2 to offset the implied decline in future public-good provision. As shown in Proposition 1(ii), it is precisely through this mechanism that an increase in β_d—and the associated reduction in the equilibrium default size—leads to a decline in entitlement revenue in Period 2 when $1/\rho$ or z_1 is sufficiently large. Conversely, the opposite logic applies when $1/\rho$ or z_1 are sufficiently small.

Figure 3 illustrates the responses of the AFBD, government debt issuance revenues, and entitlement revenues to an increase in β_d. While government debt issuance revenues, $q(c^{d*})d^*$, increase monotonically as the AFBD declines, entitlement revenues, $(1 - c^{y^*})y^*$, exhibit a non-monotonic response.

5.1.2 Net Fiscal Burden

Next, we examine how changes in government debt default cost, β^d, affect NFBD, NFBE, and NFBT. The following proposition is obtained:

Proposition 2. *The following conclusions are drawn:*

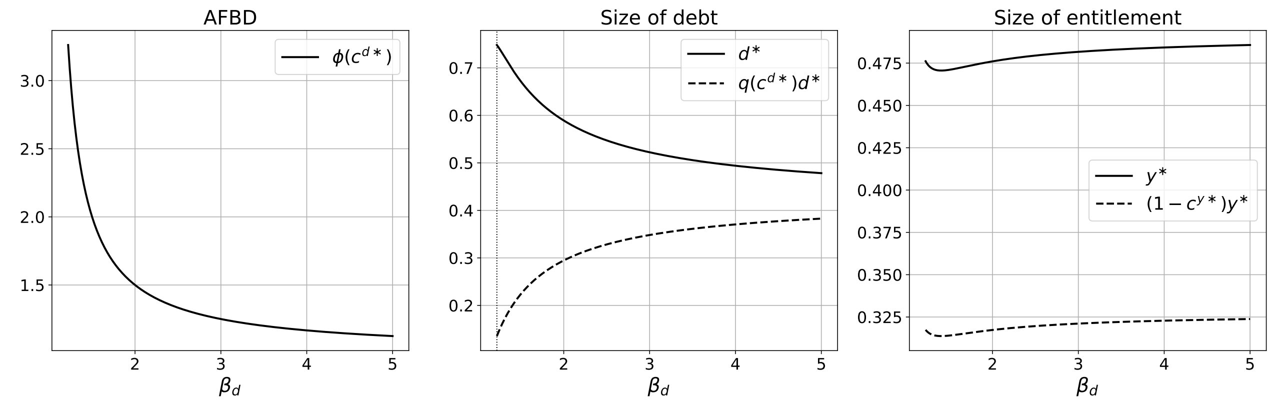

Figure 3: Comparative statics of AFBD, government debt issuance revenues, and entitlement revenues. Parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_y = 3$.

(i) *When* $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$*, NFBD, NFBE, and NFBT are monotonically decreasing, monotonically increasing, and monotonically decreasing in* β_d*, respectively.*

(ii) *When* $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$*, NFBD, NFBE, and NFBT are monotonically increasing, monotonically decreasing, and monotonically increasing in* β_d*, respectively (and are constant at equality).*

(Proof) See Appendix C.

Proposition 2 suggests that the effects of changes in government debt default cost on the NFBD, NFBE, and NFBT are not necessarily monotonic. First, an increase in government debt default cost, β_d, may either increase or decrease NFBD and NFBE. This result can be explained in the same manner as in Proposition 1.

Second, it is important to note that NFBT always moves in the same direction as NFBD. This is because NFBE responds to changes in β_d only indirectly through NFBD, whereas NFBD is directly linked to changes in the government debt default cost. Consequently, although NFBD and NFBE often move in opposite directions, the magnitude of the change is always larger for NFBD. Consequently, NFBT—defined as the sum of NFBD and NFBE—predominantly reflects the movement of NFBD and therefore always varies in the same direction as NFBD.

Figure 4 illustrates the responses of NFBD, NFBE, and NFBT to the changes in β_d. Both NFBD and NFBE vary non-monotonically in response to changes in β_d. Moreover, NFBD and NFBE move in opposite directions, whereas NFBT always moves in the same direction as NFBD.

5.2 Comparative Statics with Respect to Entitlement Default Costs

In this subsection, we examine how changes in the parameter β^y affect equilibrium government debt issuance revenues and entitlement revenues, as well as NFBD, NFBE, and NFBT.

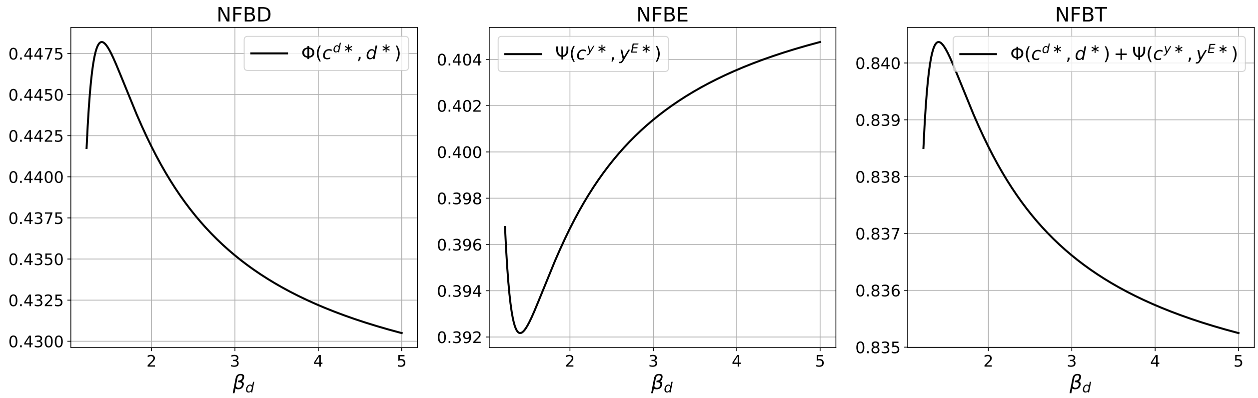

Figure 4: Comparative statics of NFBD, NFBE, and NFBT. The parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_y = 3$.

5.2.1 Government Debt Issuance Revenues and Entitlement Revenues

We first examine how changes in entitlement default costs, β^y, affect government debt issuance and entitlement revenues. The following proposition is obtained:

Proposition 3. *The following conclusions hold:*

(i) *Entitlement revenues are monotonically increasing in β_y.*

(ii) *When $1/\rho < 1$, government debt issuance revenues are monotonically increasing in β_y, whereas when $1/\rho \geq 1$, they are monotonically decreasing in β_y (and are constant at equality).*

(Proof) See Appendix D.

The mechanism through which an increase in the parameter β_y affects entitlement revenues and government debt issuance revenues is essentially the same as in the case of an increase in β_d.

First, a higher entitlement default cost reduces the equilibrium size of entitlement default. As a result, a larger fraction of the entitlement level set in period 1 is actually paid out in period 2. This increase in effective entitlement payouts lowers the average fiscal burden per unit of entitlement revenue (AFBE). As a decline in the AFBE weakens the smoothing effect, the first-period government has a stronger incentive to secure a larger entitlement revenue in the second period.

By contrast, whether government debt issuance revenues increase or decrease in response to an increase in β_y depends on the magnitude of the allocation elasticity to the entitlement burden. When $1/\rho$, which captures the allocation elasticity to the entitlement burden, is large (small), Generation 1 responds to the decline in AFBE, $\psi(c^{y*})$, associated with an increase in β_y by increasing the second-period entitlement revenue, $(1 - c^{y*})y^{E*}$, by a large (small) amount.

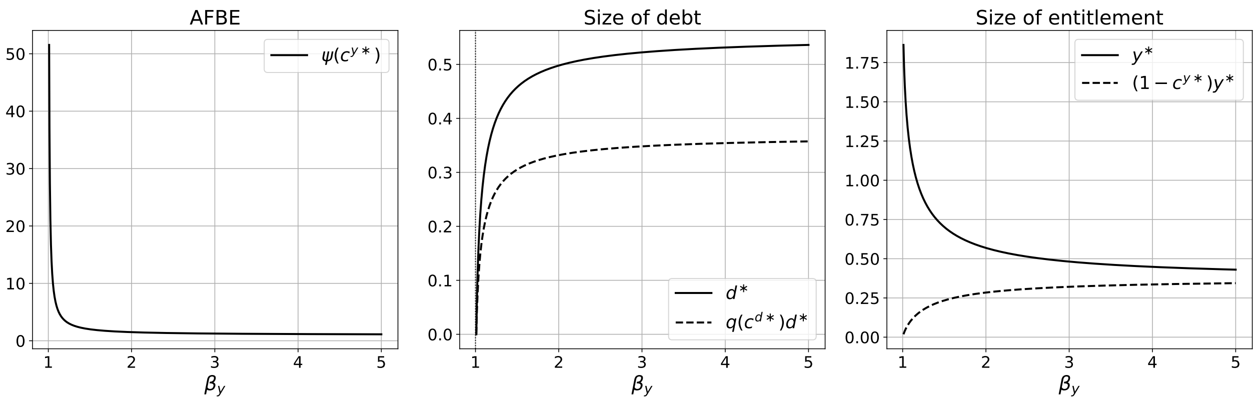

Figure 5: Comparative statics of AFBE, government debt issuance revenues, and entitlement revenues. The parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_d = 3$.

As a result, NFBE carried over to period 2 increases (decreases). An increase (decrease) in the NFBE reduces (increases) the second-period public good provision g_2^*. To offset this effect, Generation 1 adjusts its policy to reduce (increase) government debt issuance revenues, thereby lowering (raising) the NFBD left for Period 2.

Unlike Proposition 1, the level of z_1 does not affect the relevant cases because the key margin is the substitution between private consumption and public good provision at the same point in time. That is, the adjustment behavior is governed not by intertemporal allocation but by intra-temporal resource allocation in the second period, so the level of z_1 plays no role in the case distinction.

Figure 5 illustrates the responses of the AFBE, government debt issuance revenue, and entitlement revenue to an increase in β_y. This shows that entitlement revenues, $(1 - c^{y^*})y^*$, increase monotonically as AFBE declines. Moreover, in this numerical example, the condition $1/\rho < 1$ is satisfied; therefore, government debt issuance revenues, $q(c^{d*})d^*$, also increase monotonically in response to an increase in β_y.

5.2.2 Net Fiscal Burden

Next, we examine how changes in the entitlement default cost β^y affect NFBD, NFBE, and NFBT. The following proposition is obtained:

Proposition 4. *Then, the following results hold:*

(i) *When $1/\rho < 1$, NFBE, NFBD, and NFBT are monotonically decreasing, monotonically increasing, and monotonically decreasing in β_y, respectively.*

(ii) *When $1/\rho \geq 1$, NFBE, NFBD, and NFBT are monotonically increasing, monotonically decreasing, and monotonically increasing in β_y, respectively (and are constant at equality).*

(Proof) See Appendix E.

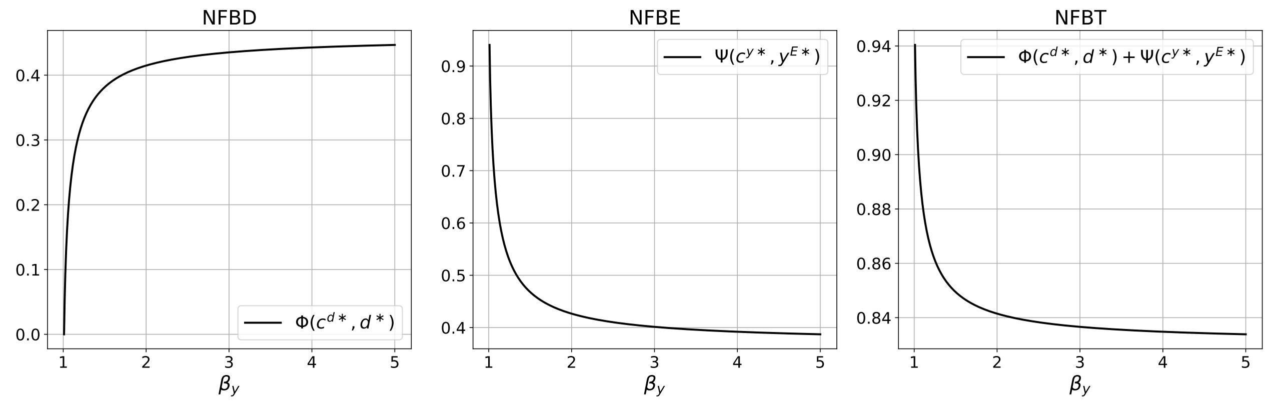

Figure 6: Comparative statics of NFBD, NFBE, and NFBT. The parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_d = 3$.

The implications of Proposition 4 are essentially the same as those of Proposition 2. First, an increase in the entitlement default cost does not necessarily move the NFBE in a single direction, which may lead to either an increase or a decrease. This is because an increase in β_y results in two opposing effects. On the one hand, it directly reduces AFBE by shrinking the size of entitlement default (the direct effect). On the other hand, the resulting decline in AFBE weakens the smoothing effect, which induces the first-period government to choose higher entitlement revenues, $(1 - c^{y*})y^{E*}$ (the indirect effect). When the allocation elasticity to the entitlement burden is high, that is, when $1/\rho$ is large, the indirect effect dominates the direct effect, resulting in an increase in the NFBE.

Second, changes in the NFBE always induce movements in the NFBD in the opposite direction. When the NFBE decreases (increases), the second-period public-good provision, g_2^*, increases (decreases). Consequently, from the perspective of utility smoothing, the first-period government has an incentive to expand (contract) government debt issuance to increase (decrease) first-period private consumption. For this reason, NFBD necessarily varies in a direction opposite to that of NFBE.

Finally, it is important to note that NFBT moves in the same direction as NFBE. This is because the NFBE is directly linked to changes in entitlement default costs, whereas the NFBD responds only indirectly through its adjustment to the NFBE. Consequently, the magnitude of the change is always larger for NFBE, and NFBT—defined as the sum of NFBE and NFBD—is therefore dominated by the movement of NFBE.

Figure 6 illustrates the responses of NFBD, NFBE, and NFBT to increases in β_y. In this numerical example, the condition $1/\rho < 1$ is satisfied; therefore, both the NFBE and NFBT decrease as β_y increases.

6 Welfare Analysis

This section analyzes how changes in the government debt default cost and entitlement default cost affect the welfare of the young in the first and second periods. The utility of the elderly in the first period is excluded from the analysis because it is independent of the levels of government debt issuance and entitlement chosen by the Period 1 government.

Our comparative statics analysis takes the levels of $\{\beta_d, \beta_y\}$ as given and focuses on how marginal changes in these parameters affect the welfare of each generation. In other words, rather than searching for the globally optimal cost levels that maximize welfare over the entire domain $\beta_d, \beta_y \in (1, \infty)$, we examine only the welfare effects of marginal adjustments on default costs in a given institutional environment. This approach is motivated not only by the technical difficulty of identifying globally optimal combinations of $\{\beta_d, \beta_y\}$ but also by institutional constraints; in practice, governments cannot freely manipulate government debt default costs or entitlement default costs. From this perspective, the approach adopted in the following analysis is empirically reasonable.

6.1 Welfare of Generation 2

From equations (16), (18), and (19), the equilibrium utility of Generation 2 can be expressed as

$$V_2^* = \frac{\left[\left(\frac{1}{1+\alpha^{\frac{1}{\rho}}}\right)^{1-\rho} + \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{1-\rho}\right] \left[z_2 - \Phi(c^{d*}, d^*) - \Psi(c^{y*}, y^{E*})\right]^{1-\rho} - (1+\alpha)}{1-\rho}. \tag{37}$$

Accordingly, changes in β_d or β_y affect the welfare of Generation 2 only through changes in NFBT, $\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*})$.

Using Propositions 2 and 4, the following lemma is obtained:

Lemma 1.

(i) *When $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$, the welfare of Generation 2 is monotonically increasing in β_d, whereas when $z_1 \geq \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$, it is monotonically decreasing in β_d (and is constant at equality).*

(ii) *When $1/\rho < 1$, the welfare of Generation 2 is monotonically increasing in β_y, whereas when $1/\rho \geq 1$, it is monotonically decreasing in β_y (and is constant at equality).*

Lemma 1 shows that the effects of changes in government debt default costs and entitlement default costs on Generation 2's welfare are non-monotonic. This non-monotonicity arises because, as shown in Propositions 2 and 4, an increase in default costs may either increase or decrease NFBT, depending on the magnitude of the allocation elasticity to the debt (entitlement) burden.

An important point to note is that an increase in default costs can improve the welfare of Generation 2, even though it restricts the degree of freedom of the default choices available to Generation 2 (the second-period government).

This occurs when the motive to smooth private consumption and public-good provision is strong, such that government debt issuance revenues respond only weakly to an increase in government debt default cost. This case corresponds to the relatively small values of $1/\rho$ and z_1. Under these conditions, the reduction in default size and the associated decline in AFBD dominate the increase in government debt issuance revenue, $q(c^{d*})d^*$.

As a result, NFBD and NFBT decrease, reducing the fiscal burden left to the second-period government and thereby improving the welfare of Generation 2. A similar mechanism applies to an increase in entitlement default cost.

6.2 Welfare of Generation 1

From equations (21) and (24), the equilibrium utility of the first-period government (Generation 1) can be written as

$$\begin{aligned} V_1^* =& \frac{\left[z_1 + (1 - c^{d*})d^* - g_1^*\right]^{1-\rho} - 1}{1-\rho} + \alpha \cdot \frac{(g_1^*)^{1-\rho} - 1}{1-\rho} + \frac{\left[(1 - c^{y*})y^{E*}\right]^{1-\rho} - 1}{1-\rho} \\ &+ \alpha \cdot \frac{\left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{1-\rho} \cdot \left[z_2 - \Phi(c^{d*}, d^*) - \Psi(c^{y*}, y^{E*})\right]^{1-\rho} - 1}{1-\rho}. \end{aligned} \tag{38}$$

Then, the following lemma holds.

Lemma 2. *The following conclusions are drawn:*

(i) *The welfare of Generation 1 is monotonically increasing in β_d.*

(ii) *The welfare of Generation 1 is monotonically increasing in β_y.*

(Proof) See Appendix F.

Lemma 2 shows that in contrast to Generation 2, the relationship between government debt default costs, entitlement default costs, and the welfare of Generation 1 is monotonic. Specifically, higher values of β_d or β_y lead to lower government debt and entitlement default sizes in the second period. This implies lower AFBD and AFBE, which creates an environment in which Generation 1 (the first-period government) can secure higher government debt issuance and entitlement revenues more easily. Because these revenue increases correspond to the transfer of resources from the second period to Generation 1, the welfare of Generation 1 improves monotonically.

6.3 Pareto Improvement

By combining Lemmas 1 and 2, we obtain the following proposition.

Proposition 5.

(i) *Suppose that* $z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1$ *holds. Then, an increase in* β_d *improves the welfare of both Generation 1 and Generation 2 and thus constitutes a Pareto improvement.*

(ii) *Suppose that* $\frac{1}{\rho} < 1$ *holds. Then, an increase in* β_y *improves the welfare of both Generation 1 and Generation 2 and thus constitutes a Pareto improvement.*

Proposition 5(i) suggests that under certain conditions, an increase in government debt default costs can lead to a Pareto improvement. Lemma 2 shows that, from the perspective of Generation 1, a higher government debt default cost β_d is always desirable. In contrast, as indicated by Lemma 1, the relationship between β_d and the welfare of Generation 2 is non-monotonic; thus, an increase in the government debt default cost does not necessarily improve the welfare of Generation 2.

When the government debt default cost β_d rises, the equilibrium size of government debt default c^{d*} shrinks, leading to a decline in AFBD. As a direct effect, this reduces the NFBD to the second-period government. However, at the same time, an increase in β_d raises the optimal level of government debt issuance revenue chosen by the first-period government, $q(c^{d*})d^*$, which works as an indirect effect that tends to increase NFBD.

When $1/\rho$ and z_1 are relatively small, Generation 1's incentive to smooth private consumption and public-good provision across periods is strong, and the increase in government debt issuance revenue is therefore limited. As a result, the reduction in NFBD and NFBT driven by the decline in AFBD becomes dominant, easing the fiscal burden left to the second-period government and thereby improving the welfare of Generation 2. Consequently, in this region of the parameter space, the welfare of both Generation 1 and Generation 2 increases, and a Pareto improvement is achieved. A similar mechanism also applies to the entitlement default cost β_y.

Figure 7 illustrates the responses of the second-period public-good provision and the welfare levels of each generation to an increase in β_d. A comparison with Figure 4 shows that the second-period public-good provision and welfare of Generation 2 move in opposite directions to the NFBT. By contrast, Figure 8 illustrates the responses of the second-period public good provision and welfare levels of each generation to an increase in β_y. As shown in Figure 6, the condition $1/\rho < 1$ holds in this numerical example, implying that the NFBT decreases as β_y increases. Consequently, the second-period public-good provision and the welfare of Generation 2 increase.

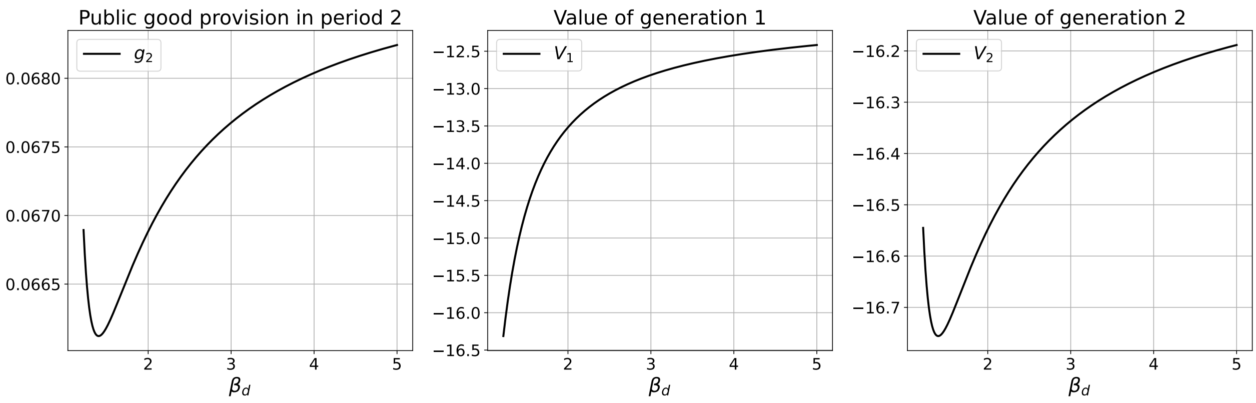

Figure 7: Comparative statics of second-period public good provision and the welfare levels of each generation. The parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_y = 3$.

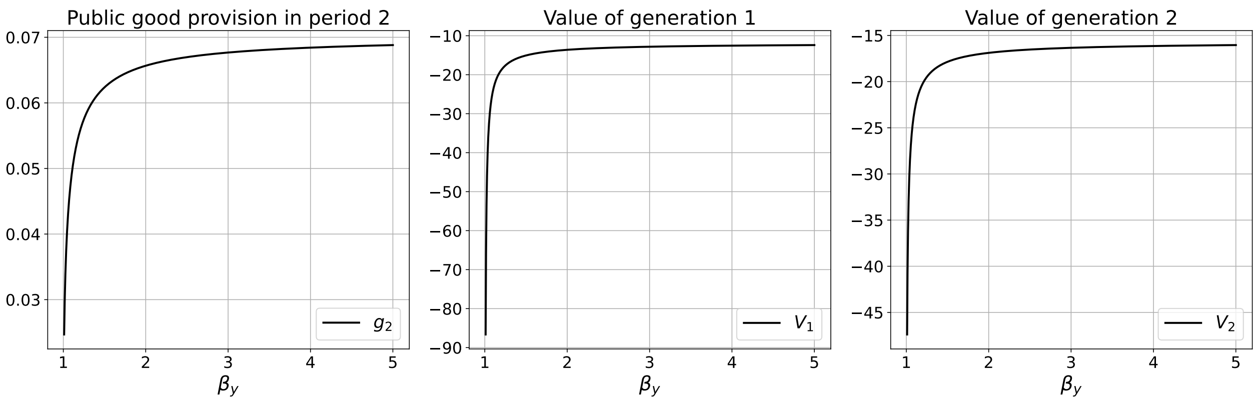

Figure 8: Comparative statics of second-period public good provision and the welfare levels of each generation. The parameter values are set to $\alpha = 0.5$, $\rho = 2$, $z_1 = 0.2$, $z_2 = 1$, and $\beta_d = 3$.

7 Policy implication

Proposition 5 provides important policy implications for the institutional design governing government debt default and entitlement default. As the proposition shows, when the default costs $\{\beta_d, \beta_y\}$ are taken as given, raise the costs of government debt default or entitlement default may lead to a Pareto improvement. Although government debt default costs and entitlement default costs are not parameters that governments can freely choose, some degree of adjustment is nevertheless possible through institutional design.

For example, strengthening domestic fiscal rules or participating in international fiscal discipline frameworks—such as those observed in EU countries—can effectively increase government debt default costs. Similarly, with respect to entitlements, enhancing the degree of legal protection for pension systems or income transfer programs can strengthen institutional commitment and thereby indirectly increase entitlement default costs.

The policy implications derived from Proposition 5 are important in two respects. First, whether an increase in government debt default costs or entitlement default costs leads to a Pareto improvement depends on the magnitude of the allocation elasticity to the debt burden and the allocation elasticity to the entitlement burden. Specifically, when the allocation elasticity to the debt (entitlement) burden is sufficiently small, an increase in the corresponding default cost reduces the size of government debt (entitlement) default and lowers the NFBD (NFBE) left to the second-period government. Consequently, the welfare of both Generation 1 and Generation 2 improves.

In this regard, this study contributes to the existing theoretical framework that incorporates government debt issuance and entitlements by explicitly modeling default behavior in both dimensions and evaluating their interdependence from the perspective of fiscal institutional design. By analyzing this interaction—which has been largely overlooked in previous literature—this paper provides new insights, showing that institutional adjustments to default costs can lead to welfare improvements for all generations.

Second, whether an increase in government debt default cost leads to a Pareto improvement depends on the relative levels of the government debt default cost, β_d, and entitlement default cost, β_y. This result indicates that designing institutions that govern government debt and entitlement default independently is theoretically insufficient. It also highlights the need to consider both regimes jointly in the fiscal institutional design, a perspective largely absent from the existing literature.

8 Conclusion

This study incorporates default on government debt and entitlements as an endogenous policy choice into a political economy framework and theoretically examines how such default behavior affects government debt issuance decisions and the design of entitlement systems. While several studies have conducted political economy analyses of the interaction between government debt and entitlements, this study is distinctive in explicitly modeling default behavior in both dimensions.

The main conclusions of this study are as follows: first, it shows that an increase in government debt default cost has a non-monotonic effect on the size of entitlements. The mechanism underlying this result is as follows. An increase in the government debt default cost reduces the equilibrium default size, which raises the price of government debt and thereby lowers the average fiscal burden per unit of government debt issuance revenues (AFBD). Through this channel, the smoothing effect is weakened, which in turn leads the first-period government to choose a higher level of government debt issuance revenue.

In contrast, the response of entitlement revenues to changes in government debt default cost is non-monotonic. When the allocation elasticity to the debt burden, $1/\rho$, is high, the young in Period 1 have weaker incentives to smooth private consumption and public-good provision across periods. Consequently, a decline in the AFBD induces the first-period government to increase government debt issuance revenues substantially. This, in turn, raises the government debt repayment burden in Period 2 (NFBD) and depresses second-period public-good provision. To offset this reduction in public-good provision, Generation 1 reduces the size of entitlements to lower the fiscal burden on the second-period government. When the allocation elasticity of the debt burden is low, the opposite logic applies. In addition, we show that changes in entitlement default costs exert a similar non-monotonic effect on government debt issuance revenue through an almost identical mechanism.

Second, this study shows that when the incentive to smooth the utility derived from private consumption and public-good provision across periods is sufficiently strong, an increase in government debt default costs or entitlement default costs can lead to a Pareto improvement. An important theoretical contribution of this study is to demonstrate explicitly that whether an increase in the government debt default cost results in a Pareto improvement depends on its level relative to the entitlement default cost.

These results suggest that raising the cost of government debt default—through the strengthening of domestic fiscal rules or participation in international fiscal discipline frameworks, such as those observed in EU countries—can serve as a policy instrument capable of achieving Pareto improvements. They further indicate that increasing the cost of entitlement default can play a similar role by reinforcing legal protection for pension systems and income transfer programs. The broader implication is that the conventional approach, which analyzes government debt default institutions and entitlement systems in isolation, is insufficient. By demonstrating the necessity of viewing these two systems as an interdependent institutional framework, this study offers a novel perspective that is not found in the existing literature.

Finally, the limitations of the present analysis and directions for future research are discussed. The first limitation is that the model is constructed within a deterministic framework and, therefore, does not endogenize the probability of default. In the existing political economy literature on sovereign default—such as Aguiar and Gopinath (2006) and Arellano (2008)—income is treated as a stochastic variable, allowing for an explicit analysis of how default probabilities vary over the business cycle or in response to exogenous shocks. In contrast, the present analysis takes income as a deterministic and exogenous variable and deliberately abstracts from the analysis of default probabilities, instead focusing on the size of the haircut in the event of default. Accordingly, the analysis provides a theoretical foundation for identifying political economy determinants, not of whether a default occurs but of its magnitude, conditional on occurrence.

One natural extension would be to treat second-period income z_2 as a stochastic variable and introduce a fixed cost of default, thereby allowing the default probabilities of government debt and entitlements to be endogenized. Examining how such an extension would alter the relationship between default costs and intergenerational welfare, as well as the implications for institutional design is a promising avenue for future research.

The second limitation is that because the analysis relies on a two-period model, the second generation—which determines the size of default—has no means of rolling over the fiscal burden associated with government debt or entitlements. Extending the framework to a multi-period setting would endow default decisions with a richer dynamic structure, including the possibility of postponement or debt restructuring, and could yield new insights into intergenerational incentive structures and comparative static results.

Both these considerations represent natural directions for extending the present framework, but they would require structural modifications that affect the core of the model. Accordingly, these issues should not be viewed as mere technical refinements; rather, they constitute research agendas capable of substantially broadening the theoretical implications of the analysis and are, therefore, left for future work.

Appendices

Appendix A. Derivation of equations (28) and (29)

Rearranging the first-order conditions yields the following expressions:

$$\left[z_2 - \Phi(c^{d*}, d) - \Psi(c^{y*}, y^E)\right] = \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1}{\rho}} \cdot \phi(c^{d*})^{\frac{1}{\rho}} \cdot \left(z_1 + q(c^{d*})d\right), \tag{A.1}$$

$$\left[z_2 - \Phi(c^{d*}, d) - \Psi(c^{y*}, y^E)\right] = \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}} \cdot \psi(c^{y*})^{\frac{1}{\rho}} \cdot (1-c^{y*})y^E. \tag{A.2}$$

Combining equations (A.1) and (A.2) yields

$$(1-c^{y*})\, y^E = \frac{1}{1+\alpha^{\frac{1}{\rho}}} \cdot \frac{\phi(c^{d*})^{\frac{1}{\rho}}}{\psi(c^{y*})^{\frac{1}{\rho}}} \cdot \left(z_1 + q(c^{d*})d\right). \tag{A.3}$$

Next, rearranging equation (A.2) and substituting equation (A.3) yields

$$\left[z_2 - \phi(c^{d*})q(c^{d*})d - \psi(c^{y*})(1-c^{y*})y^E\right] = \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}} \cdot \psi(c^{y*})^{\frac{1}{\rho}} \cdot (1-c^{y*})y^E$$

$$\Leftrightarrow\ z_2 - \phi(c^{d*})q(c^{d*})d = \left[\psi(c^{y*}) + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}} \cdot \psi(c^{y*})^{\frac{1}{\rho}}\right] \cdot (1-c^{y*})y^E$$

$$\Leftrightarrow\ z_2 - \phi(c^{d*})q(c^{d*})d = \left[\psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}\right] \cdot \frac{1}{1+\alpha^{\frac{1}{\rho}}} \cdot \phi(c^{d*})^{\frac{1}{\rho}} \cdot \left(z_1 + q(c^{d*})d\right)$$

$$\Leftrightarrow\ q(c^{d*})d = \frac{z_2 - \left[\psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}\right] \cdot \frac{1}{1+\alpha^{\frac{1}{\rho}}} \cdot \phi(c^{d*})^{\frac{1}{\rho}} \cdot z_1}{\phi(c^{d*}) + \left[\psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}\right] \cdot \frac{1}{1+\alpha^{\frac{1}{\rho}}} \cdot \phi(c^{d*})^{\frac{1}{\rho}}}$$

$$\Leftrightarrow\ q(c^{d*})d = \frac{\left(1+\alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{-\frac{1}{\rho}} \cdot z_2 - \left[\psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}\right] \cdot z_1}{\left(1+\alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{\frac{\rho-1}{\rho}} + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}}$$

Substituting this expression into equation (A.3) and simplifying yields

$$(1-c^{y*})y^E = \frac{\psi(c^{y*})^{-\frac{1}{\rho}}\cdot z_2 + \phi(c^{d*})\cdot\psi(c^{y*})^{-\frac{1}{\rho}}\cdot z_1}{\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{\frac{\rho-1}{\rho}} + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}}\cdot\left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1-\rho}{\rho}}}.$$

For notational convenience, define

$$A = \alpha^{\frac{1}{\rho}}\cdot\left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{\frac{1}{\rho}}.$$

Then equations (28) and (29) follow.

■

Appendix B. Proof of Proposition 1

B.1 Government debt issuance revenue

Note that $q(c^{d*}) = 1 - c^{d*}$. From (28), we obtain

$$\begin{aligned}
\frac{\partial q(c^{d*})d^*}{\partial c^{d*}} &= \frac{1}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad\times\left\{-\frac{1}{\rho}\cdot(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})\cdot z_2\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right. \\
&\quad\left.-\left[\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot z_2-\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1\right]\cdot\frac{\rho-1}{\rho}\cdot(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}}\phi'(c^{d*})\right\} \\
&= \frac{(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad\times\left\{-\frac{1}{\rho}\cdot z_2\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right. \\
&\quad\left.-\left[\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot z_2-\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1\right]\cdot\frac{\rho-1}{\rho}\cdot\phi(d^{d*})\right\} \\
&= \frac{(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad\times\left\{z_2\cdot\left[-\frac{1}{\rho}\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]-\frac{1}{\rho}\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}-\frac{\rho-1}{\rho}\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right. \\
&\quad\left.+\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1\cdot\frac{\rho-1}{\rho}\cdot\phi(d^{d*})\right\}
\end{aligned}$$

$$
\begin{aligned}
&= \frac{(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\qquad \times \left\{-\left[\frac{1}{\rho}\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\cdot z_2+\frac{\rho-1}{\rho}\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot\phi(d^{d*})\cdot z_1\right\} \\
&= -\frac{(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\qquad \times \left\{\frac{1}{\rho}\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]+\phi(c^{d*})\cdot\left[\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{-1}{\rho}}\cdot z_2-\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right.\right.\right. \\
&= -\frac{(1+\alpha^{\frac{1}{\rho}})\phi(d^{d*})^{-\frac{1}{\rho}-1}\phi'(c^{d*})\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2}\cdot\left\{\frac{1}{\rho}\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]+\phi(c^{d*})\cdot(\overline{z}_1-z_1)\right\} \\
&< 0.
\end{aligned}
$$

Noting that c^{d*} is decreasing in β_d yields the result in Proposition 1(i).

B.2 Entitlement revenue

From (29), we obtain

$$
\begin{aligned}
&\frac{\partial(1-c^{y*})y^{E*}}{\partial c^{d*}} \\
&\quad = -\frac{\phi'(c^{d*})\psi(c^{y*})^{-\frac{1}{\rho}}}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times\left\{\left(1-\frac{1}{\rho}\right)\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]-z_1\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right\}.
\end{aligned}
$$

Therefore,

$$
\frac{\partial(1-c^{y*})y^{E*}}{\partial c^{d*}}
\begin{cases}
< 0 & \text{when } \; z_1 < \left(1-\frac{1}{\rho}\right)\cdot\hat{z}_1, \\
\geq 0 & \text{otherwise.}
\end{cases}
$$

where

$$
\hat{z}_1 \equiv \frac{1+\alpha^{\frac{1}{\rho}}}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot\phi(c^{d*})^{\frac{1}{\rho}}+\frac{1}{\rho}\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})}\cdot z_2.
$$

Noting again that c^{d*} is decreasing in β_d yields the result in Proposition 1(ii).

$\blacksquare$

Appendix C. Proof of Proposition 2

C.1 Net fiscal burden of public debt (NFBD)

From equation (32), we obtain

$$
\begin{aligned}
&\frac{\partial \Phi(c^{d*}, d^*)}{\partial c^{d*}} \\
&\quad = \frac{\phi'(c^{d*})}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\qquad \times \Bigg\{ \left[\left(1-\frac{1}{\rho}\right)\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot z_2 - \left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1\right]\cdot\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] \\
&\qquad\qquad - \left(1-\frac{1}{\rho}\right)\cdot(1+\alpha^{\frac{1}{\rho}})\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot\left[\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{1-\frac{1}{\rho}}\cdot z_2 - \left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot\phi(c^{d*})\cdot z_1\right]\Bigg\} \\
&\quad = \frac{\phi'(c^{d*})}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\qquad \times \Bigg\{ \left(1-\frac{1}{\rho}\right)\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right] \\
&\qquad\qquad - \left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]\cdot z_1\cdot\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\Bigg\} \\
&\quad = \frac{\phi'(c^{d*})\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}\right]}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\qquad \times \Bigg\{ \left(1-\frac{1}{\rho}\right)\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\cdot\phi(c^{d*})^{-\frac{1}{\rho}}\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right] - z_1\cdot\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\Bigg\}.
\end{aligned} \tag{C.1}
$$

Therefore,

$$
\frac{\partial \Phi(c^{d*}, d^*)}{\partial c^{d*}} \begin{cases} > 0 & \text{when } \; z_1 < \left(1-\frac{1}{\rho}\right)\cdot\hat{z}_1, \\ \leq 0 & \text{otherwise.} \end{cases}
$$

Noting that c^{d*} is decreasing in β_d yields the result in Proposition 2.

C.2 Net fiscal burden of entitlement liabilities (NFBE)

From equation (33), we obtain

$$
\begin{aligned}
&\frac{\partial \Psi(c^{y*}, y^{E*})}{\partial c^{d*}} \\
&\quad = \frac{1}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{\phi'(c^{d*}) \cdot \psi(c^{y*})^{1-\frac{1}{\rho}} \cdot z_1 \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right. \\
&\qquad \left. -\psi(c^{y*})^{1-\frac{1}{\rho}} \cdot \left[z_2 + \phi(c^{d*}) \cdot z_1\right] \cdot \left(1 + \alpha^{\frac{1}{\rho}}\right) \cdot \frac{\rho - 1}{\rho} \cdot \phi(c^{d*})^{-\frac{1}{\rho}} \cdot \phi'(c^{d*})\right\} \\
&\quad = -\frac{\phi'(c^{d*}) \cdot \psi(c^{y*})^{1-\frac{1}{\rho}}}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{\left(1 - \frac{1}{\rho}\right) \cdot \left(1 + \alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{-\frac{1}{\rho}} \cdot \left[z_2 + \phi(c^{d*}) \cdot z_1\right] - z_1 \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right\}
\end{aligned} \tag{C.2}
$$

Therefore,

$$
\frac{\partial \Psi(c^{y*}, y^{E*})}{\partial c^{d*}} \begin{cases} < 0 & \text{when} \quad z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1, \\ \geq 0 & \text{otherwise.} \end{cases}
$$

Noting that c^{d*} is decreasing in β_d yields the result in Proposition 2.

C.3 Net fiscal burden of total government liabilities (NFBT)

From equations (C.1) and (C.2), we obtain

$$
\begin{aligned}
&\frac{\partial}{\partial c^{d*}}\left[\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*})\right] \\
&\quad = \frac{\phi'(c^{d*})A}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{\left(1 - \frac{1}{\rho}\right) \cdot \left(1 + \alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{-\frac{1}{\rho}} \cdot \left[z_2 + \phi(c^{d*}) \cdot z_1\right] - z_1 \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right\}.
\end{aligned} \tag{C.3}
$$

Therefore,

$$\frac{\partial}{\partial c^{d*}}\left[\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*})\right]\begin{cases} > 0 & \text{when} \quad z_1 < \left(1 - \frac{1}{\rho}\right) \cdot \hat{z}_1, \\ \leq 0 & \text{otherwise.} \end{cases}$$

Noting that c^{d*} is decreasing in β_d yields the result in Proposition 2.

■

Appendix D. Proof of Proposition 3

D.1 Entitlement revenue

Invoking the envelope theorem, equation (29) implies

$$\begin{aligned}
\frac{\partial\left[(1 - c^{y*})y^{E*}\right]}{\partial c^{y*}} &= \frac{1}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{-\frac{1}{\rho} \cdot \psi(c^{y*})^{-\frac{1}{\rho}-1} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right]\right. \\
&\quad \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] \\
&\quad \left. - \frac{\rho - 1}{\rho} \cdot \psi(c^{y*})^{-\frac{1}{\rho}} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right] \cdot \psi(c^{y*})^{-\frac{1}{\rho}}\right\} \\
&= \frac{\psi(c^{y*})^{-\frac{1}{\rho}-1} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right]}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{-\frac{1}{\rho} \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] - \frac{\rho - 1}{\rho} \cdot \psi(c^{y*})^{\frac{\rho-1}{\rho}}\right\} \\
&= -\frac{\psi(c^{y*})^{-\frac{1}{\rho}-1} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right]}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{\frac{1}{\rho} \cdot \left[A + \left(1 + \alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] + \psi(c^{y*})^{\frac{\rho-1}{\rho}}\right\} \\
&< 0.
\end{aligned}$$

Noting that c^{y*} is decreasing in β_y yields the result in Proposition 3(i).

D.2 Government debt issuance revenue

From equation (28), we obtain

$$\frac{\partial\left[q(c^{d*})d^*\right]}{\partial c^{y*}} = -\left(1-\frac{1}{\rho}\right)\frac{\psi(c^{y*})^{-\frac{1}{\rho}}\cdot\psi'(c^{y*})\cdot\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{-\frac{1}{\rho}}}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2}\cdot\left[z_2+\phi(c^{d*})z_1\right].$$

Hence,

$$\frac{\partial\left[q(c^{d*})d^*\right]}{\partial c^{y*}}\begin{cases}\geq 0 & \text{when } \frac{1}{\rho}\geq 1,\\ < 0 & \text{otherwise.}\end{cases}$$

Noting that c^{y*} is decreasing in β_y yields the result in Proposition 3(ii).

■

Appendix E. Proof of Proposition 4

E.1 Net fiscal burden of entitlement liabilities (NFBE)

$$\begin{aligned}
&\frac{\partial\Psi(c^{y*},y^{E*})}{\partial c^{y*}}\\
&=\frac{1}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2}\\
&\quad\times\left\{\frac{\rho-1}{\rho}\cdot\psi(c^{y*})^{-\frac{1}{\rho}}\cdot\psi'(c^{y*})\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]\cdot\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]\right.\\
&\qquad\left.-\frac{\rho-1}{\rho}\cdot\psi(c^{y*})^{-\frac{1}{\rho}}\cdot\psi'(c^{y*})\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]\cdot\psi(c^{y*})^{1-\frac{1}{\rho}}\right\}\\
&=\left(1-\frac{1}{\rho}\right)\cdot\frac{\psi(c^{y*})^{-\frac{1}{\rho}}\cdot\psi'(c^{y*})\cdot\left[z_2+\phi(c^{d*})\cdot z_1\right]}{\left[A+\psi(c^{y*})^{\frac{\rho-1}{\rho}}+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2}\cdot\left[A+\left(1+\alpha^{\frac{1}{\rho}}\right)\phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]. \qquad \text{(E.1)}
\end{aligned}$$

Therefore,

$$\frac{\partial\Psi(c^{y*},y^{E*})}{\partial c^{y*}}\begin{cases}\leq 0 & \text{when } \frac{1}{\rho}\geq 1,\\ > 0 & \text{otherwise.}\end{cases}$$

Noting that c^{y*} is decreasing in β_y yields the result in Proposition 4.

E.2 Net fiscal burden of public debt (NFBD)

$$
\begin{aligned}
&\frac{\partial \Phi(c^{d*}, d^*)}{\partial c^{y*}} \\
&\quad = \frac{1}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \\
&\quad \times \left\{ -\frac{\rho - 1}{\rho} \cdot \psi(c^{y*})^{-\frac{1}{\rho}} \cdot \psi'(c^{y*}) \cdot \phi(c^{d*}) \cdot z_1^A \cdot \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] \right. \\
&\qquad \left. - \frac{\rho - 1}{\rho} \cdot \psi(c^{y*})^{-\frac{1}{\rho}} \cdot \psi'(c^{y*}) \cdot \left[\left(1 + \alpha^{\frac{1}{\rho}}\right) \cdot \phi(c^{d*})^{1-\frac{1}{\rho}} \cdot z_2^B - \left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}}\right] \cdot \phi(c^{d*}) \cdot z_1^A\right] \right\} \\
&\quad = -\left(1 - \frac{1}{\rho}\right) \cdot \frac{\psi(c^{y*})^{-\frac{1}{\rho}} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right]}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} && \text{(E.2)} \\
&\quad \times \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}. && \text{(E.3)}
\end{aligned}
$$

Therefore,

$$
\frac{\partial \Phi(c^{d*}, d^*)}{\partial c^{y*}} \begin{cases} \geq 0 & \text{when } \frac{1}{\rho} \geq 1, \\ < 0 & \text{otherwise.} \end{cases}
$$

Noting that c^{y*} is decreasing in β_y yields the result in Proposition 4.

E.3 Net fiscal burden of total government liabilities (NFBT)

From equations (E.1) and (E.3), we obtain

$$
\begin{aligned}
&\frac{\partial}{\partial c^{y*}} \left[\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*})\right] \\
&\quad = \left(1 - \frac{1}{\rho}\right) \cdot \frac{\psi(c^{y*})^{-\frac{1}{\rho}} \cdot \psi'(c^{y*}) \cdot \left[z_2^B + \phi(c^{d*}) \cdot z_1^A\right]}{\left[A + \psi(c^{y*})^{\frac{\rho-1}{\rho}} + \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}\right]^2} \cdot \left[A + \left(1 + \alpha^{\frac{1}{\rho}}\right) \phi(c^{d*})^{\frac{\rho-1}{\rho}}\right] \cdot A. \\
& && \text{(E.4)}
\end{aligned}
$$

Therefore,

$$
\frac{\partial}{\partial c^{y*}} \left[\Phi(c^{d*}, d^*) + \Psi(c^{y*}, y^{E*})\right] \begin{cases} \geq 0 & \text{when } \frac{1}{\rho} \geq 1, \\ < 0 & \text{otherwise.} \end{cases} \tag{E.5}
$$

Noting that c^{y*} is decreasing in β_y yields the result in Proposition 4.

$\blacksquare$

Appendix F. Proof of Lemma 2

F.1 Changes in the government debt default cost

From equation (38), we obtain

$$\frac{\partial V_1^*}{\partial c^{d*}} = \left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} \cdot (-d^*) + \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{1-\rho} \cdot \left[z_2 - \Phi(c^{d*}, d^*) - \Psi(c^{y*}, y^{E*})\right]^{-\rho} \cdot \frac{d^*}{2}$$

$$= -\left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} \cdot d^* + \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} \cdot \frac{d^*}{2}$$

$$< -\left\{\left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho}\right\} \cdot d^*.$$

From the first-order condition (26), we have

$$0 = \left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} \cdot (1-c^{d*}) - \alpha \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(1 - \frac{c^{d*}}{2}\right)$$

$$< \left\{\left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho}\right\} \cdot \left(1 - \frac{c^{d*}}{2}\right).$$

It follows that, in equilibrium,

$$\left[z_1 + (1-c^{d*})d^* - g_1^*\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} > 0.$$

Under Assumption 4, we have $d^* > 0$. Therefore,

$$\frac{\partial V_1^*}{\partial c^{d*}} < 0. \tag{F.1}$$

F.2 Changes in the entitlement default cost

Invoking the envelope theorem, equation (38) implies

$$\frac{\partial V_1^*}{\partial c^{y*}} = \left[(1-c^{y*})y^{E*}\right]^{-\rho} \cdot \left(-y^{E*}\right) + \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right)^{1-\rho} \cdot \left[z_2 - \Phi(c^{d*}, d^*) - \Psi(c^{y*}, y^{E*})\right]^{-\rho} \cdot \frac{y^{E*}}{2}$$

$$= -\left[(1-c^{y*})y^{E*}\right]^{-\rho} \cdot y^{E*} + \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} \cdot \frac{y^{E*}}{2}$$
$$< -\left\{\left[(1-c^{y*})y^{E*}\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho}\right\} \cdot y^{E*}.$$

From the first-order condition (27), we obtain

$$0 = \left[(1-c^{y*})y^{E*}\right]^{-\rho} \cdot (1-c^{y*}) - \alpha \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(1 - \frac{c^{y*}}{2}\right)$$
$$< \left\{\left[(1-c^{y*})y^{E*}\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho}\right\} \cdot \left(1 - \frac{c^{y*}}{2}\right).$$

Thus, in equilibrium,

$$\left[(1-c^{y*})y^{E*}\right]^{-\rho} - \alpha \cdot \left(\frac{\alpha^{\frac{1}{\rho}}}{1+\alpha^{\frac{1}{\rho}}}\right) \cdot \left(g_2^*(d^*, y^{E*})\right)^{-\rho} > 0.$$

Therefore,

$$\frac{\partial V_1^*}{\partial c^{y*}} < 0. \tag{F.2}$$

■

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