

Deficits, Gifts, and Bequests

Daniel Barczyk

Economics Department, McGill University

Leacock building, Room 321b

855 Sherbrooke Street West

Montreal H3A 2T7, Canada

daniel.barczyk@mcgill.ca

1-514-398-4400 ext.09057

THIS VERSION: NOVEMBER 2012

Abstract

What is the response of aggregate consumption to a deficit-financed tax cut? It is well-known that intergenerational transfers are key to answer this question. I address this issue by studying a heterogeneous-agents overlapping-generations economy with imperfect altruism. The model generates richer and more realistic transfer behavior than a dynastic or an overlapping-generations economy. The model is calibrated to match aggregate data on inter-vivos transfers. I find that the response of aggregate consumption to a deficit-financed tax cut is quantitatively more similar to the overlapping-generations economy's, welfare implications, however, tend to be closer to the dynastic economy's.

Keywords: Ricardian equivalence, intergenerational transfers, deficits, altruism.

JEL Codes: D64, H31, H62.

* This paper is based on chapter 3 of my PhD dissertation at New York University. I thank Jess Benhabib, Mark Gertler, Matthias Kredler, Tom Sargent, and Gianluca Violante for valuable guidance and discussions. I would like to thank Andy Abel, Francisco Alvarez-Cuadrado, Matthias Lux, Virgiliu Midrigan, and Markus Poschke for useful comments and discussions. I have also benefited from comments of seminar participants at the Rotman School of Management, the Stern School of Business, the Wharton School of Business, Cornell University, McGill University, Penn State University, Ryerson University, Université de Montréal, Wilfried Laurier University, and from participants at various conferences. All errors are mine.

1 Introduction

In a seminal paper, Barro (1974) shows that intergenerational transfers motivated by altruism can undo government transfers.¹ As a consequence, a mere change in the timing of taxes, holding government expenditure constant, leaves aggregate consumption unaffected. Two standard workhorse models in macroeconomics implicitly have opposite and equally extreme views on altruism: in the dynastic model, households in the dynasty (e.g. young and old households) are perfectly altruistic – a household cares about the other as much as about itself; in the overlapping-generations (OLG) economy, altruism in the spirit of Barro is absent.² Given these two polar opposites, it seems desirable to study a model which lies between these two.

One could think of two possible directions to take. First, one could explain the occurrence of transfers by motives other than Barro-type altruism, such as “warm glow”, i.e. joy of giving. Andreoni (1989) and Abel & Bernheim (1991), for example, go this route in exploring aspects of fiscal policy. Second, one can stay with Barro’s type of altruism to explain intentional transfers and, in contrast to the standard workhorse models, allow for more plausible degrees of altruism. This paper follows the latter approach by modelling a framework with imperfect altruism (IA); households do care about each other, but not as much as about themselves.

Allowing for a more plausible degree of altruism is important because the prevalence of intergenerational transfers depends on it. In turn, how much aggregate consumption changes in response to a deficit-financed tax cut depends on the prevalence of these transfers. An artificially high intensity of altruism leads to an incidence of intergenerational transfers larger than is observed in the data. Thus, relying on such a model may under-predict the response in aggregate consumption to a deficit-financed tax cut. On the other hand, models that exclude altruism, rule out Barro’s mechanism a priori, and so may over-predict consumption changes due to changes in the timing

¹More precisely, Barro requires *universally operative transfer motives*: equilibrium transfers are an interior solution for all current and future generations. Barro (1989) argues, that gifts are a crucial form of intergenerational transfers in addition to bequests. In terms of terminology, I will use gifts and inter-vivos transfers interchangeably. The Latin phrase *inter vivos* means “between the living”, and so such a transfer refers to one made during one’s lifetime.

²Laitner (1992), Heathcote (2005), and Fuster et al. (2007), for example, study redistributive fiscal policy using the dynastic framework; Diamond (1965), Auerbach & Kotlikoff (1987) and Kitao (2010) use the OLG framework.

of taxes. Additionally, a key strength of the IA model vis-à-vis the dynastic and OLG economies is, that it generates richer and more realistic transfer behavior.

In the IA model, just as in the data, transfers flow between households of *certain* families depending on the intra-family wealth and income distribution. Thus, in contrast to an OLG economy with an ad hoc transfer function, such as warm glow, the incidence of transfers depends on the economic well-being of the recipient. Indeed, this is the crucial element that underlies Barro's mechanism. Also, micro-level data suggests that the incidence of inter-vivos transfers depends on the recipient's economic circumstances. For example, McGarry & Schoeni (1995,1997) and Berry (2008) find that transfers are more likely to flow when the donor's income is large relative to the recipient's income as well as increasing in both the donor's wealth and income and decreasing in the recipient's income. The IA economy is consistent with these features of the data.

In a dynastic economy, households within a family act to equalize consumption between each other; Altonji et al. (1992) strongly reject this implication. According to Cox (1990), Cox & Jappelli (1990), and McGarry (1999) inter-vivos transfers are especially likely to occur when the recipient is liquidity constrained while these are indeterminate in a dynastic economy. In contrast, the equilibrium of the IA economy features a stark prediction on when inter-vivos transfers occur, namely, they flow only when the recipient is borrowing constrained.

The IA framework nests an OLG and a dynastic economy. The former arises when altruism is absent and so I refer to it as the no-altruism (NA) economy. In the latter, a household cares about the other household in the dynasty as much as about itself; this economy is referred to as the perfect-altruism (PA) economy. All economies are calibrated to match the same wealth-to-GNP ratio and the same fraction of wealth-poor households. In order to obtain reasonable values for the altruism parameters, the IA economy is also calibrated to match U.S. data on aggregate inter-vivos transfers based on the Survey of Consumer Finances.³

I study deficit-financed tax cuts in the following environment. The economy is

³The data on aggregate inter-vivos transfers is taken from Gale & Scholz (1994). Nishiyama (2002) also utilizes these data for calibrating the degree of altruism of the old generation and studies the U.S. wealth distribution in a four-period OLG economy. In contrast to Nishiyama, I calibrate the degrees of altruism for both the old and the young generation in an OLG economy with infinitely-many periods. Furthermore, the model generates endogenously the timing of transfers that Nishiyama assumes.

populated by a large number of young and old heterogeneous households. A young and an old household make up a family. The economy is open and changes in national savings due to changes in the timing of taxes are assumed to be small enough to leave the world interest rate unaffected. Households face an idiosyncratic stochastic endowment process; old households are subject to a mortality hazard. Markets to insure against idiosyncratic risks are absent. Agents choose consumption, savings in a riskless asset – subject to a no-borrowing constraint – and a non-negative gift to the other agent. Individuals do not have the ability to commit to a sequence of gifts. Bequests are accidental in the sense that wealth left over after the old household in the dynasty dies is transferred to the young household. The government finances a constant stream of expenditure using lump-sum taxes and debt.

I follow Heathcote (2005) and measure deviations from Ricardian equivalence (RE) by calculating changes in aggregate consumption relative to changes in the tax rate; Heathcote refers to this measure as the “propensity to consume of income tax” (PCT). For the IA economy, I find that during the tax-cut regime, the PCT is on average about 12-35 cents out of a \$1 tax cut. The lower bound corresponds to a relatively short and the upper bound to a relatively long deficit-financed tax cut. In contrast, the average PCTs’ ranges are 9-32 cents for the NA economy and 8-24 cents for the PA economy.

In terms of the PCT, the IA economy is more similar to the NA economy. An obvious reason for this is that the calibrated degrees of altruism are far from perfect since measured aggregate transfers are just not large enough for the calibration to produce substantial magnitudes of altruism. As a result, IA consumption policies resemble NA consumption policies over a large part of the state space.

Furthermore, part of the relatively large size of the PCT is accounted for by the fact that the fraction of borrowing-constrained households is largest in the IA economy. This is because in the equilibrium of this economy, there is an incentive to become constrained, as transfers only flow when the recipient is constrained. This incentive is absent from the other two economies. The reason why all three economies are calibrated to match a realistic fraction of wealth-poor households is to ensure that the fraction of borrowing-constrained households is not vastly different across the three economies as to become the main driving force for the differences across the economies.

Finally, and at first sight surprisingly, the PTC in the IA economy is even larger

than in the NA economy. Initially, one would have expected the PCT of the IA economy to lie somewhere between those of the NA and PA economies, moving closer to, but being strictly below, the NA economy for weaker degrees of altruism. This is not the case, however, since imperfect altruism and lack of commitment fundamentally alter the nature of the model: taken together they imply strategic considerations in the consumption-savings decision. A household that is either a current recipient of transfers or expects to receive transfers in the future if he remains poor enough, faces a disincentive to save out of the higher disposable income during the tax-cut regime; it anticipates that in the future, when taxes increase, he will be “bailed out” with higher private transfers. As a result, the household increases consumption by more than he would if he could not count on a transfer. This type of moral hazard is absent in the PA and NA economies, in which savings increase at an earlier point in time.

This same relationship does not hold, however, for ex-ante welfare implications. That is, the ex-ante welfare gains from deficit-financed tax cuts in the IA economy are not larger than in the NA economy. Instead, they lie between those of the NA and the PA economies and tend to be somewhat closer to those from the PA economy. The reason for this is that deficits crowd out gifts. Since consumption policies for transfer recipients in the IA economy differ substantially from the ones in the NA economy, welfare effects of poor households differ dramatically across the two economies. Inter-vivos transfers, which are free, are replaced with deficits, which must be repaid. Recipients of private transfers have high marginal utility of consumption and disproportionately impact the welfare calculations. Thus, ex-ante welfare gains in the IA economy are reduced vis-à-vis the NA economy.

Computing an IA model, in which generations overlap for multiple time periods and there is a lack of commitment, is not a trivial task. In this regard, this paper builds on Barczyk & Kredler (2012a) and Barczyk & Kredler (2012b). These authors study a dynamic Markovian game of two infinitely-lived altruistic agents without commitment. In the former paper, the authors provide a theoretical characterization of possible equilibria, which points to one stable equilibrium in which transfers only flow when the recipient is borrowing constrained. Their latter paper is more computational in nature; it studies the transfers-when-constrained equilibrium and provides a numerical algorithm. As such, it is the basic building block for the IA economy studied here.

In terms of studying deviations from RE with incomplete markets this paper is

principally related to Heathcote (2005) and Laitner (1992). Both of these papers employ a dynastic framework.⁴ The consequences of redistributive fiscal policies when markets are incomplete, altruism is imperfect but commitment is present are studied in Altig & Davis (1988, 1992, 1993). Both the dynastic assumption as well as commitment imply that these models have no predictions on the wealth positions of the different generations. In addition, there are no predictions on the timing of transfers between these generations.

Laitner (1988) studies an OLG economy in which altruism is imperfect, commitment is absent, and there is heterogeneity in lifetime earnings ability. He shows that transfer motives fail to be universally operative in this environment but does not analyze its quantitative importance. Furthermore, and importantly, this paper allows generations to overlap for multiple time periods, while Laitner's generations overlap for only one period. This opens up the study of a transition period, which is the main focus of the paper, along with the study of long-run steady-states.⁵

The remainder of the paper proceeds as follows. Section 2 provides the physical environment, the equilibrium definition, and a description of the incentives households face. The calibration of the economy is discussed in section 3. Section 4 presents the main results. Section 5 concludes.

2 Model Framework

2.1 The Environment

The economy is a small open endowment economy. Time t is continuous. A household in the economy faces two life-cycle stages, $s \in \{1, 2\}$. When $s = 1$ the household is in the young life-cycle stage and when $s = 2$ it is in the old life-cycle stage. At each point in time there is a large (measure one) number of young households and a large (measure one) number of old households. A young and an old household make up a family. An old household faces a mortality hazard given by a Poisson

⁴This modelling approach has the advantage that the generations' problems can be pooled and solved as a joint-maximization problem. So perfect altruism leads to a significant simplification.

⁵Abel (1987), who theoretically studies the operativeness of the gift and bequest motives, calls on future research to study the transition path in heterogeneous economies in his concluding remarks. In his conclusion, Laitner (1988) suggests an expansion of the model to many-period lives as being a key issue.

rate, δ . When the old household dies, the young household becomes an old household, and a new young household enters the economy; in this way, a new family is formed.⁶

Households face an idiosyncratic labor income process but do not face aggregate uncertainty. At each point in time, a household obtains an exogenous endowment, y^s , according to a Poisson rate, ξ , and transitions, $y^s \in \{y_1, y_2, y_3\}$, where $y_1 < y_2 < y_3$. The initial income realization of a new young household follows a three-state Markov chain. I use π_{ij} to denote the probability that he obtains the income realization j , given that the old household in the family has the income realization i . Furthermore, the new young household obtains an initial wealth endowment that is proportional to his income realization, $m \cdot y_j^1$, where m is the factor of proportionality.⁷ Finally, when an old household dies, any wealth it has left is automatically bequeathed to the young household.

The market arrangement is as in standard incomplete-markets models. There is a single asset that pays a time-invariant rate of interest, r . A household can hold a non-negative amount, $w^s \geq 0$, of the asset. Markets to insure against idiosyncratic risks are absent.

Government consumption is constant, $\{G\}$. It is financed through a proportional lump-sum tax, ϕ_t , and through deficits, $dD/dt \equiv \dot{D}_t$, where D stands for government debt. The flow version of the government budget constraint is given by

$$\dot{D}_t = rD_t + G - \phi_t Y, \quad \text{given } D_0 = D, \quad (1)$$

where Y is the (time-invariant) aggregate gross endowment.

At each point in time, households choose a consumption rate, $c^s \geq 0$, and a non-negative transfer rate, $g^s \geq 0$, (g stands for “gift”). These choices then imply the

⁶The way I model the life cycle has the advantage of introducing few new parameters; there is only one hazard rate and age is not a state variable. This comes at the cost of the model not being able to capture more realistic life-cycle savings behavior. There are two possibilities of introducing a more realistic life cycle. One would be to model a finite life cycle with time-varying mortality, which comes at the cost of an increased computational burden. The other would be to maintain stochastic transitions of life-cycle stages but to add more of them. What is not feasible – at least in this model – is to have more than two altruistically-linked households overlap.

⁷This endowment acts as a modelling short-cut to account for initial wealth observed in the data while not modelling the origination of this wealth; more on this in section 3.

following savings rate

$$\dot{w}^s = rw^s + y^s + g^{s'} - c^s - g^s, \quad s \in \{1, 2\}. \quad (2)$$

The life-cycle stage s' is the one of the other household in the family.

There are two important qualifications to equation (2). First, it describes the law of motion of wealth while households remain in their current life-cycle stage. That is, it does not describe a discrete change in the wealth level, which occurs if a household receives a bequest. Second, when $w^s = 0$ feasibility has to be enforced in the following way

$$c^s + g^s \leq y^s + g^{s'}, \quad s \in \{1, 2\}.$$

That is, a household cannot spend more than it receives.

A household's flow utility is given by

$$U^s(c^s, c^{s'}) = u(c^s) + \alpha^s u(c^{s'}), \quad \alpha^s \in [0, 1], \quad s \in \{1, 2\},$$

where α^s is the degree of altruism for a household in life-cycle stage s . The preferences of a household are represented by

$$E_0 \int_0^\tau \underbrace{e^{-\rho t} U^s(c_t^s, c_t^{s'}) dt}_{\text{life-cycle stage } s} + \underbrace{[1 - I_{s=2}(1 - \alpha^2)] e^{-\rho \tau} V^e(Z_\tau, y^1)}_{\text{continuation value}}, \quad s \in \{1, 2\},$$

where $I_{s=2}$ is an indicator variable. It is equal to zero for a young household, $s = 1$, and is equal to one for an old household, $s = 2$. Life-time utility is decomposed into what accrues over the current life-cycle stage, s , and what accrues afterwards (continuation value). Note that the continuation value of an old household is the same as one for a young household, except that V^e is multiplied by α^2 .⁸

The integration starts with the current date (here, time 0) and ends with the random time of death of the old household, τ . The latter follows an exponential distribution.⁹ The discount rate is denoted by ρ . The variable Z_τ denotes the level of wealth the currently-young household would own given the death of the old house-

⁸It is important to emphasize that while this function can be interpreted as a “bequest motive,” it should not be confused with an ad hoc bequest function as, for example, in the case of warm-glow altruism. For example, when $\alpha^2 = 1$, then the preferences are simply the one of an infinitely-lived household.

⁹That is $F(t) = Pr(\tau < t) = 1 - e^{-\delta t}$, where δ is the mortality hazard alluded to above.

hold. That is, it is the sum of his own life-cycle savings and the (non-negative) wealth left behind by the old household.

In order to define the function V^e , let $V^2(w^1, w^2, y^1, y^2)$ be the value of an old household with wealth w^2 and income y^2 , along with his young household's wealth w^1 and income y^1 . Then,

$$V^e(Z, y_i^1) = \sum_j \pi_{ij} V^2(m \cdot y_j^1, Z, y_j^1, y_i^2).$$

V^e is therefore the expected value of a currently-young household, whose family has wealth Z and current income realization y_i^1 , becoming an old household.

The PA model is obtained when setting $\alpha^1 = 1 = \alpha^2$ and the NA model when $\alpha^1 = 0 = \alpha^2$.

2.2 Equilibrium Definition

When altruism is imperfect and commitment is absent, strategic considerations in the consumption-savings decisions arise. In order to deal with this implication, the concept of a Markov-perfect equilibrium is used. A Markov strategy is a pair of non-negative functions $\{c^1(t, x), g^1(t, x)\}$ for a young household and a pair of non-negative functions $\{c^2(t, x), g^2(t, x)\}$ for an old household. The payoff-relevant state includes time, t , and $x = (w^1, w^2, y^1, y^2)$, where w^1 is the young's household wealth, w^2 is the old's household wealth, y^1 is the young's household income, and y^2 is the old's household income.

When the other player's strategy is Markov, the best-response problem of each player is a dynamic-programming problem and best responses will be Markov as well. Let $V^s(t, x)$ be the value for a household in life-cycle stage s and state (t, x) . Given the strategy $\{c^{s'}(t, x), g^{s'}(t, x)\}$ of the other household in the family, $V^s(t, x)$ and its partial derivatives satisfy the following partial differential equation

$$\begin{aligned} \rho V^s = \max_{c^s \geq 0, g^s \geq 0} \{ & U^s(c^s, c^{s'}) + \dot{w}^{s'} V_{w^{s'}}^s + \dot{w}^s V_{w^s}^s + \\ & + \xi(V^s(\hat{y}^s, \cdot) - V^s) + \xi(V^s(\hat{y}^{s'}, \cdot) - V^s) + \\ & + \delta([1 - I_{s=2}(1 - \alpha^2)])V^e - V^s\}, \end{aligned} \quad (3)$$

$$\text{where } V^e = \sum_j \pi_{ij} V^2.$$

This equation is known as the Hamilton-Jacobi-Bellman equation (HJB). Subscripts denote partial derivatives (e.g. $V_{w^s}^s = \partial V^s / \partial w^s$), and for better readability, the dependence of the value function and the policies on (t, x) is suppressed. The interpretation of equation (3) is deferred to subsection 2.3.

A Markov-perfect equilibrium is given by a set of functions for young households, $\{c^1(\cdot), g^1(\cdot), V^1(\cdot)\}$, a set of functions for old households, $\{c^2(\cdot), g^2(\cdot), V^2(\cdot)\}$, and distributions of households over the state-space, $\{\lambda_t\}$, such that, given the world interest rate, r , the government policy rules, $\{\phi_t, D_t, G\}$, and an initial distribution, λ_0 , the following restrictions hold:

1. Given $\{c^2(\cdot), g^2(\cdot)\}$, $\{c^1(\cdot), g^1(\cdot), V^1(\cdot)\}$ solves (3) for $s = 1$, subject to feasibility.
2. Given $\{c^1(\cdot), g^1(\cdot)\}$, $\{c^2(\cdot), g^2(\cdot), V^2(\cdot)\}$ solves (3) for $s = 2$, subject to feasibility.
3. The government budget constraint – equation (1) – holds.
4. The probability measure, λ , follows the law of motion induced by $\{c^1(\cdot), g^1(\cdot), c^2(\cdot), g^2(\cdot)\}$.

As is well-known, a Markov-perfect equilibrium is subgame perfect.

2.3 Best Responses

We now turn our attention to the interpretation of equation (3). To this end, we write out the savings rates, given by equation (2), for $s = 1$ and $s = 2$, and group terms according to whether or not they directly factor into the household's current choices:

$$\begin{aligned}
\rho V^s = & \alpha^s u(c^{s'}) + \left(r w^{s'} + y^{s'} - c^{s'} - g^{s'} \right) V_{w^{s'}}^s + (r w^s + y^s + g^s) V_{w^s}^s + \quad (4) \\
& + \xi \underbrace{(V^s(\hat{y}^s, \cdot) - V^s)}_{\text{jump in } y^s} + \xi \underbrace{(V^s(\hat{y}^{s'}, \cdot) - V^s)}_{\text{jump in } y^{s'}} + \\
& + \delta \underbrace{([1 - I_{s=2}(1 - \alpha^2)] V^e - V^s)}_{\text{jump in } s} + \\
& + \max_{g^s \geq 0} \{ g^s (\underbrace{V_{w^{s'}}^s - V_{w^s}^s}_{\equiv \mu^s: \text{transfer motive}}) \} + \max_{c^s \geq 0} \{ u(c^s) - c^s V_{w^s}^s \}, \quad s \in \{1, 2\}.
\end{aligned}$$

The left-hand side of equation (4) is the flow value of the household's optimal program. In order for the allocation to be optimal, this value must equal the value of the right-hand side. The last line on the right-hand side collects the terms which are relevant for the household's current choices. All the other terms are predetermined given the current state.

A household's value is affected by its own income uncertainty as well as by the income uncertainty faced by its related household. In the HJB, this manifests itself through two jump-terms; the former through the term "jump in y^s " and the latter through the term "jump in $y^{s'}$ ". These jump-terms measure the differences from current values for the household if either its own income jumps or its counterpart's income jumps. The current values are denoted y^s and $y^{s'}$, respectively, and the jump terms are denoted $\hat{y}^s$ and $\hat{y}^{s'}$.

A household also faces the uncertainty of a change in the life-cycle stage; the term "jump in s " accounts for the effect this uncertainty has on the household's value. For a household in $s = 1$ this term becomes $\delta(V^e - V^1)$. A young household becomes an old household at the Poisson rate δ . Conditional on this event, he obtains the value V^e and loses the value V^1 . For a household in $s = 2$, the term becomes $\delta(\alpha^2 V^e - V^2)$. An old household faces the mortality hazard δ . Conditional on his death, the old household loses V^2 , but its current well-being is still affected by how well-off the young household will be, $\alpha^2 V^e$.

The last line collects the household's current choices. The first-order condition for consumption is given by

$$u_c(c^s) = V_{w^s}^s.$$

The equation states that the marginal utility of current consumption is equal to the marginal value of saving. An important feature is that current actions of the other player do not have to be explicitly contemplated by the decision maker. Thus, over a short amount of time best-response functions are constants and optimal consumption can be obtained, as in a standard consumption-savings problem, without having to compute best responses for each action of the other player.¹⁰

The term "transfer motive", μ^s , measures the marginal benefit to a donor of trans-

¹⁰This feature of the decision problem is a crucial simplification of continuous time with respect to discrete time. The technical reasons are that second-order effects vanish as time becomes continuous and that flow utility $u(c^s) + \alpha^s u(c^{s'})$ is separable in c^s and $c^{s'}$. For a more extensive discussion on the advantages of continuous time refer to section 2 in Barczyk & Kredler (2012a).

ferring an additional unit of resources to the recipient. In any equilibrium, the transfer motive has to be non-negative. A positive transfer motive induces a mass-point transfer, which takes place in zero time, and renders it zero.

Whenever the transfer motive is strictly negative transfers will be set to zero. When the transfer motive is zero, the household is (locally) indifferent with regard to the intra-family wealth distribution so that any transfer flow is consistent with optimality. In the PA economy the transfer motive holds with equality. Households of the same family are indifferent (locally and globally) with regards to the intra-family wealth distribution and transfers are indeterminate.

In the equilibrium it will turn out that inter-vivos transfers only flow when the recipient is borrowing constrained. In that region of the state space transfer motives take on a different form – they resemble those in the static transfer model. Suppose, for example, that the young household is constrained, the old household is unconstrained, and transfers are zero:

$$u_c(y^1) > V_{w^1}^1, \quad V_{w^2}^2 = u_c(c^2), \quad \text{and} \quad g^2 = 0.$$

Since transfers are zero, it must be the case that

$$u_c(c^2) > \alpha^2 u_c(y^1).$$

Otherwise, the old household would choose a positive amount of transfers in order to equalize her c^2 - and g^2 -margins

$$V_{w^2}^2 = u_c(c^2) = \alpha^2 u_c(y^1 + g^2).$$

This shows that the old household can “dictate” the young household’s consumption, i.e. $c^1 = y^1 + g^2$. Although the constrained case is actually more intricate than presented here, this simple example conveys the intuition well.¹¹

¹¹For a complete analysis of the constrained case, refer to sections 3.2 (one household is broke) and A.3 (both households are broke) in Barczyk & Kredler (2012b). These sections also form the basis for the computation of inter-vivos transfers in the numerical algorithm.

2.4 Strategic Considerations and Savings Incentives

The Euler equations reveal the various savings incentives that households face and how policies of the other player influence decision making. In addition, contrasting the Euler equations for the IA economy with those from the PA and NA economies highlights key differences in the savings incentives among these economies.

In order to obtain the Euler equation of a household in life-cycle stage s , take the derivative of HJB (4) with respect to w^s

$$\begin{aligned} \mathcal{A}u_c(c^s) = & \underbrace{(\rho - r)u_c(c^s)}_{\text{representative household}} - \underbrace{\delta\{[1 - I_{s=2}(1 - \alpha^2)]V_Z^e - u_c(c^s)\}}_{\text{jump in } s} + \quad (5) \\ & + \underbrace{[V_{w^{s'}}^s - \alpha^s u_c(c^{s'})]c_{w^s}^{s'}}_{\text{altruistic-strategic distortion}} + \underbrace{\mu^s g_{w^s}^{s'}}_{\text{transfer-induced incentive}}. \end{aligned}$$

The operator $\mathcal{A}$ is defined as the “expected time derivative”.¹² The terms $c_{w^s}^{s'}$ and $g_{w^s}^{s'}$ denote the partial derivatives of the consumption policy and of the transfer policy for the counterpart household in life-cycle stage s' , respectively, with respect to the wealth of the household in life-cycle stage s . These measure how the other player’s consumption and transfer react to an increase in the household’s wealth. Note that the term transfer-induced incentive also includes $-\mu^s g_{w^s}^s$; if $g_{w^s}^s > 0$, then $\mu^s = 0$ and the term vanishes. Thus, in order to highlight this term, it is assumed that $\mu^s < 0$.

When dividing both sides of the Euler equation by $u_c(c^s)$, the terms on the right-hand side determine the expected growth rate of marginal utility. If a household marginally increases wealth, then there is the standard trade-off between lower current consumption and higher future consumption, as shown by the term “representative household”. But, there are additional effects, the most important ones contained in the term referred to in the equation as “altruistic-strategic distortion”.

When the household has a higher level of wealth, the consumption of the other player reacts by $c_{w^s}^{s'}$. Suppose that $c_{w^s}^{s'} > 0$.¹³ As a consequence, there is a marginal

¹²The operator $\mathcal{A}$ (the *infinitesimal generator*) is defined for a differentiable function $f(x)$ as

$$\begin{aligned} \mathcal{A}f(x_t) &\equiv \lim_{\Delta t \rightarrow 0} \frac{1}{\Delta t} E_t[f(x_{t+\Delta t}) - f(x_t)] \\ &= f_{w^s} \dot{w}_t^s + f_{w^{s'}} \dot{w}_t^{s'} + \xi[f(\hat{y}^s, \cdot) - f(y^s, \cdot)] + \xi[f(\hat{y}^{s'}, \cdot) - f(y^{s'}, \cdot)]. \end{aligned}$$

¹³This is reasonable since a higher level of wealth for one household implies that transfers are more

benefit of $\alpha^s u_c(c^{s'})$ which stems from the consumption of the other player. This provides an incentive to save, and so $\alpha^s u_c(c^{s'})$ enters the Euler equation with the same sign as does the interest rate. An increase in consumption of the other player, however, means that he will have fewer resources. Thus, the increase in consumption by the other player comes at a cost of $V_{w^{s'}}^s$. The term values what would happen if the equilibrium path was left and another equilibrium path, in which the other player has $c_{w^s}^{s'}$ less wealth, was entered into. A disincentive to save results, and so the term enters the Euler equation with the same sign as does the discount rate.

The term referred to as “transfer-induced incentive” in the equation involves the transfer motive, μ^s , and the reaction in the transfer function of the other player to an increase in the level of wealth, $g_{w^s}^{s'}$. The transfer motive is negative since the household currently does not provide transfers (otherwise this term would be simply zero). As long as the other household does not provide any transfers, $g_{w^s}^{s'} = 0$, and this term vanishes. If it is assumed that $g_{w^s}^{s'} > 0$ – that is, the other player rewards thrift by providing an increasing schedule in savings of the other – then this term provides an incentive to save, just as the donor intended to, and it enters the equation with the same sign as does the interest rate.

The Euler equation for the NA economy is obtained by substituting $\alpha^1 = 0 = \alpha^2$ in the Euler equation (5). The payoff relevant state for an old household does not include resources from the young household in the family, and so the last line vanishes. For the old household, the term “jump in s ” simply becomes $\delta u_c(c^s)$, and it can be seen that the Euler equation is just as in Yaari (1965) – that is, uncertain lifetimes increase the discount rate ρ by the mortality hazard δ :

$$\mathcal{A}u_c(c^2) = (\rho + \delta - r)u_c(c^2).$$

Since, in the event of death, the young household receives an accidental bequest, the old household’s wealth continues to be a payoff relevant state for the young household. The young household’s Euler equation becomes:

$$\mathcal{A}u_c(c^1) = (\rho - r)u_c(c^1) - \delta[V_Z^e - u_c(c^1)].$$

For the PA economy, $\alpha^1 = 1 = \alpha^2$. The two individual household problems

likely and larger and the likelihood that the other household has to provide transfers in the future is reduced.

can then be pooled into a single joint-maximization problem. The dynasty's payoff relevant state variables are given by their joint level of wealth $W_t = w_t^1 + w_t^2$ and the joint level of the income realizations $Y_t = y^1 + y^2$. Thus, consumption and saving decisions depend only on total family resources, but not on how they are distributed. Furthermore, $V_{w^1}^2 = V_{w^2}^2 = V_{w^1}^1 = u'(c^1)$, and so there are neither altruistic-strategic distortions nor transfer-induced incentives. The Euler equation thus becomes

$$\mathcal{A}u_c(c) = (\rho - r)u_c(c) - \delta[V_Z^e - u_c(c)].$$

A final remark concerns the issue of commitment. With commitment it would be the case that $c_{w^s}^{s'} = 0 = g_{w^s}^{s'}$ and the behavior of the economy would lie “in-between” the PA and the NA economies. Without commitment, however, the nature of the model fundamentally alters. For the PA and the NA economies, and in the case of commitment, the Euler equations are ordinary-differential equations, that do not take into account what would happen off the equilibrium path. In the IA economy, the Euler equations are partial-differential equations, signifying that off-equilibrium information enters.

3 Calibration

The key parameters for the IA economy are the discount rate, ρ , and young and old households' degrees of altruism, α^1 and α^2 , respectively. For the NA and PA economies, the key parameter is the discount rate, ρ . The discount rate is jointly identified by the wealth-to-GNP ratio and the fraction of wealth-poor households. The degrees of altruism are primarily pinned down by young and old generations' aggregate transfer-to-wealth ratios. Before a discussion of the calibration of these parameters in more detail occurs, the parameters common to the three economies, summarized by table 1, are discussed.

3.1 Parameters common across economies

The life-cycle stages young and old correspond approximately to ages 25-50 and to ages 50-75, respectively. The expected duration of a life-cycle stage is therefore 25 years, implying a value of 4% for the mortality hazard δ .

The labor income process follows a three-state Markov chain. It is calibrated to the U.S. income distribution for households of ages 25-65. An income realization

can be low, medium, or high. When a household is in a low or in a high income state, it can only switch to the medium level. Furthermore, the household's income can jump up or down with equal likelihood. From the middle income state, income can switch to the high or the low levels with equal probability. Thus, only one rate parameter, ξ , needs to be calibrated for the income process. It is chosen in order to match a persistence parameter for the labor income process of 0.9.¹⁴

The probability that a young household enters the economy with income realization j , given that the old household has income realization i , is denoted by π_{ij} . Analogous to the labor income process, if the parent household is in a low or in a high income state, a young household is equally likely to enter the economy with a medium level of income. If the parent household is in the medium income state, the new young household will enter the economy with a low or a high level of earnings with equal probability. Again, only one parameter needs to be calibrated. This parameter is chosen in order to match an inter-generational correlation of labor income coefficient of 0.4.

The initial wealth endowment of a new young household is proportional to his income realization. This short-cut allows the model to account for the initial wealth observed in the data for households aged 25 to 30 (see, for example, Budria-Rodriguez et al. (2002)), without speculating on the origination of this initial wealth; a small level of initial wealth also helps to ensure that not too many young households are borrowing constrained. In the calibration, the factor of proportionality m equals 1.

The per-period utility function is given by

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma},$$

where γ is the coefficient of relative risk aversion. It is identical for both old and young households with a coefficient of relative risk aversion equal to 2.

The interest rate r is assumed to be 4%.

3.2 Parameters specific to economies

Table 2 shows the values of the calibration targets. For the IA economy, the

¹⁴The income for an old household consists of a weighted average of the realization of the labor income process and its corresponding social security income. The latter is computed as the replacement rate multiplied by income, where the replacement rates are taken from Mitchell & Phillips (2006). The weights capture the average duration an old household spends earning labor income and social security.

Table 1: Common parameters

Parameter	γ	r	δ	ξ	π	m
Value	2	4%	4%	10%	0.36	1

Parameters and their values that the three economies have in common. γ is the coefficient of relative risk aversion, r is the interest rate, δ is the mortality hazard, ξ is the earnings hazard, π is the earnings-heritability probability, and m is the factor of proportionality, which, together with the income realization, determine the initial wealth endowment of a new young household.

parameters $\{\rho, \alpha^1, \alpha^2\}$ are chosen in order to match four calibration targets, i.e. the calibration is over-identified: a wealth-to-GNP ratio of 3.4, a fraction of 20% of households without wealth, a transfer-to-wealth ratio for the young generation of 0.03%, and a transfer-to-wealth ratio for the old generation of 0.32%. For both the NA and PA economies, the discount rate ρ is calibrated by matching a wealth-to-GNP ratio of 3.4 and a fraction of 20% of households without wealth.

Table 2: Calibration targets

Target	NA	IA	PA
W/Y	3.4	3.4	3.4
W poor	20%	20%	20%
Tr/W (young)	n/a	0.03%	n/a
Tr/W (old)	n/a	0.32%	n/a

Calibration targets and their values for the three economies. W/Y is the wealth-to-GNP ratio, W poor is the fraction of households without wealth, and Tr/W is the transfer-to-wealth ratio.

The value of 20% of households without wealth is based on Jappelli (1990), who reports that in the 1983 Survey of Consumers Finances (SCF), 12.5% of households have a request for credit rejected and a further 6.5% does not apply for it, expecting to be rejected. Gale & Scholz (1994) document data on intended intergenerational transfers using the 1983-86 SCF. Intended transfers are defined to include financial

support given to other households, trust accumulations, and life insurance payments to children. Bequests are excluded since they are not necessarily intentional. The *annual* flow of intended transfers as a percentage of aggregate net worth is 0.53%¹⁵ and is made up of 0.35% of support given to adult family members, 0.12% of trusts, and 0.05% of life insurance. The 0.35% of support given to adult family members as a percentage of aggregate net worth is the most appropriate counterpart in the data to the flow of annual gifts as a percentage of aggregate net worth generated by the IA economy.¹⁶ Furthermore, the authors report that this ratio consists of 0.32% of support given to young households and of 0.03% of support given to old households. The young and the old generations' transfer-to-wealth ratios are primarily responsible for the identification of their respective degrees of altruism.

The wealth-to-GNP ratio would clearly be enough to identify the discount rate, and as such, the calibration of the parameters in the three economies is over-identified. The inclusion of the fraction of wealth-poor households in the calibration helps, however, to ensure a realistic fraction of borrowing-constrained households and a more meaningful comparison across the three economies. After all, wealth-poor households will be a key driving force behind the response in aggregate consumption to a deficit-financed tax cut.

The parameters are chosen to minimize the equally weighted sum of squared differences between the moments generated by the model and the data. Table 3 summarizes the calibrated key parameters.

Table 3: Key parameters

Parameter	NA	IA	PA
ρ	3.15%	3%	5.14%
α^1	0	0.12	1
α^2	0	0.28	1

¹⁵This number appears to be very small, since it is an annual flow. Converting this flow into a stock, Gale & Scholz (1994) argue that intended transfers are the source of at least 20% of aggregate net worth.

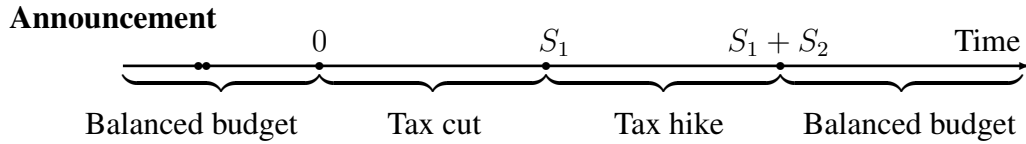
¹⁶In section A.1, I will change these values from the stated values here to account for likely under-reporting in the SCF data. The calibration will be redone in order to check the robustness of the results (the SCF only reports support given if its value is at least \$3000). Qualitatively the results do not change after redoing the calibration.

The discount rate, ρ , is largest in the PA economy, since in the IA and NA economies the effective discount rate also takes into account the mortality hazard, δ . For the IA and NA economies, the discount rates are relatively similar, with values of 3% and 3.15%, respectively.

The calibrated magnitudes of altruism are imperfect and asymmetric. The value for the young household's altruism parameter is $\alpha^1 = 0.12$ and the one for the old household is $\alpha^2 = 0.28$. This asymmetry is driven by the fact that the transfers observed in the data from the old generation to the young generation are larger than those from the young generation to the old generation. Altruism is far from perfect since observed aggregate transfers are just not large enough to justify sizable magnitudes of altruism.¹⁷

4 Results

The following time line illustrates the timing of taxes for a generic deficit-financed tax cut:



Initially, the economy is assumed to be in the stationary equilibrium. In this equilibrium, lump-sum taxes finance the entire expenditure stream, $\{G\}$. The deficit-financed tax cut is announced prior to its implementation at time 0. The time of the announcement is indicated by the two dots. The tax cut lasts for S_1 years, during which time deficits pay for the shortfall in government revenues. The tax hike implemented afterwards is such that the debt accumulated over-and-above its steady-state value is paid off over the following S_2 years. Finally, the tax rate returns to its steady-state value indefinitely.

¹⁷The interpretation of the magnitude of the degree of altruism depends on the value of the coefficient of relative risk aversion; see section A.3 in the appendix for more details.

4.1 Stationary Equilibrium

The stationary equilibrium has three key features.¹⁸ Firstly, a donor delays inter-vivos transfers until the recipient is borrowing constrained. Secondly, the consumption path of a gift recipient jumps downward when entering a transfer region. Thirdly, consumption policies become increasingly similar to those in the NA economy in regions where the intra-family wealth distribution is more balanced.

4.1.1 Gifts when constrained

The donor is faced with incentives to delay transfers until the recipient is borrowing constrained. Conversely, as long as the wealth of both households in a family are positive, $w^1 > 0$ and $w^2 > 0$, each household's transfer motive in the HJB (4) is negative, $\mu^1 < 0$ and $\mu^2 < 0$. Each household has a larger marginal value with respect to its own savings than with the other household's savings. This is obviously also the case for the NA economy but not for the PA economy, in which households are indifferent with respect to the intra-family wealth distribution, valuing only the size of family resources, and not how these resources are distributed across the two households.

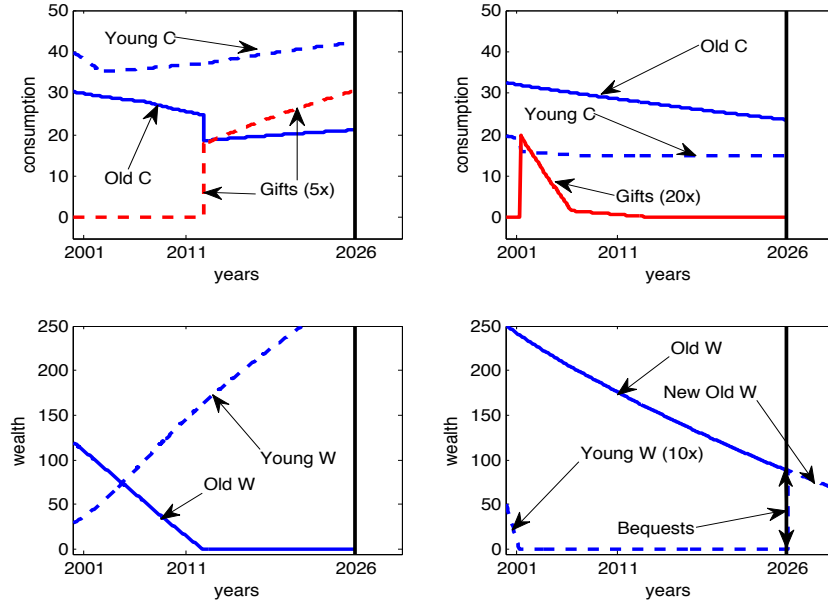
The economic intuition of why transfers in the IA economy are delayed is as follows. An imperfect altruist does not fully internalize the effect its consumption behavior has on family resources. Thus, an “early” transfer would be consumed at a faster rate than is in the donor's interest. When a household is borrowing constrained, however, the donor has control over the recipient's consumption behavior – in fact, the donor household uses transfers in order to temporarily implement his preferred allocation.

Figure (1) demonstrates feasible transfer behavior in the IA economy; it is much richer than what either the NA or PA economy can produce. Two families are endowed with different levels of initial wealth and earning streams. The left-hand side top and bottom graphs belong to one family and the right-hand side ones to the other family. The top panel displays histories for consumption and gifts, while the bottom panel displays histories for wealth and bequests. The dashed lines refer to the young households and the solid lines refer to the old households. In both families, the old

¹⁸This equilibrium is qualitatively as in Barczyk & Kredler (2012b). They study this type of equilibrium in an economy with two infinitely-lived altruistic agents in detail and provide a numerical algorithm. Here, a rather brief discussion behind the key features is provided.

household dies in the year 2026 (demarcated by vertical solid lines).

Figure 1: A history of two families.



The top panel displays the histories for consumption and gifts; the bottom panel displays the histories for wealth and bequests. The dashed lines refer to the young households and the solid lines refer to the old households.

As can be seen for the family shown on the left-hand side, the old household's wealth is depleted by 2012. The young household, on the other hand, accumulates wealth. Between 2000 and 2011, gifts from the young household to the old household do not occur. Following 2012, the old household obtains inter-vivos transfers from the young household (the red dashed line, which is enlarged 5x for expositional purposes). These transfers continue and increase over time as the young household accumulates more wealth. In 2026, flows of gifts stop due to the death of the old household; there is no bequest.

For the family displayed on the right-hand side, the young household's wealth decreases quickly and is exhausted by 2002. The old household's wealth decreases gradually until 2026, at which point the remaining wealth is bequeathed to the young household, and the young household's wealth jumps up. The young household obtains gifts from the old household (the solid red line, which is enlarged 20x for expositional purposes) beginning in 2002. These transfers are, however, temporary. They eventually cease due to a decrease in the old household's wealth level. Though

gifts are temporary, the young household obtains a bequest upon the old household's death.

4.1.2 Downward jump in consumption

The feature that a consumption path displays a discontinuity in the form of a downward jump upon entering a transfer region is closely related to the *Samaritan's dilemma*, known from two-period models (for example, see Lindbeck & Weibull, 1988). A future transfer recipient over-consumes knowing an additional unit saved will be “taxed” by the donor through a reduction in transfers. In contrast, when the household does not expect to receive transfers, the marginal value of saving equals the marginal utility of consumption, and so consumption is as in the standard selfish case. This drop of the consumption path is especially clearly visible for the old household in the family on the left-hand side of figure (1) when entering the transfer region in 2012.

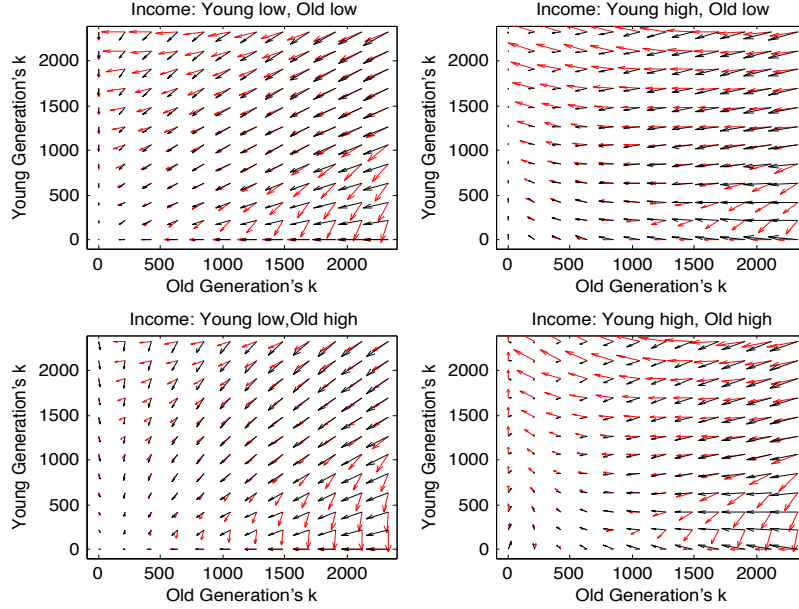
4.1.3 Similarity of IA and NA consumption policies

Figure (2) shows that consumption policies become increasingly similar to those in the NA economy in regions where the intra-family wealth distribution is more balanced. The figure compares the savings behavior of the NA economy (the black arrows) and the IA economy (the red arrows) for various combinations of a family's earnings profile. The horizontal and vertical axes represent wealth of an old and a young household, respectively. In the first graph of the top panel the young and the old household both have low earnings, while in the second graph the young household has high earnings and the old household has low earnings. In the first graph of the bottom panel, the young household has low earnings and the old household has high earnings, while in the second graph both households have high earnings.

A point in the figure corresponds to state $x = (y^1, y^2, w^1, w^2)$. The arrows emanating from x represent the young and old households' change in wealth (the continuous state), $\dot{w}^1$ and $\dot{w}^2$, when in that state, for both the IA economy and the NA economy. Along the horizontal axis only the old household owns wealth and along the vertical axis only the young household owns wealth. If a ray that emanates from the origin rotates from the horizontal axis towards the vertical axis is considered, then as the ray rotates up to the 45 degree line, the intra-family wealth distribution becomes increasingly balanced. The figure shows that, along this rotation, the savings behavior in both the IA economy and the NA economy become increasingly

similar.

Figure 2: Wealth dynamics.



Wealth evolution in the NA economy (black) and the IA economy (red) for various earnings profiles; k denotes wealth.

The intuition behind this resemblance is that inter-vivos transfers become increasingly unlikely as both households' shares of wealth become progressively similar. This resemblance to the NA economy intensifies since households in the IA economy come to rely only on themselves. Conversely, for a relatively unequal intra-family wealth distribution, gifts in the near future are more likely, and IA economy households' current consumption-savings decisions are more strongly influenced by this possibility. This consideration does not enter NA economy households' decision-making.

4.2 Deficit-Financed Tax Cuts

Having discussed the central features of the stationary equilibrium, we are now in a position to study the response in aggregate consumption to a deficit-financed tax cut (see section A.2 of the appendix for the computational strategy).

A deficit-financed tax cut has the following structure. First, the tax-cut regime lasts as long as the tax-hike regime. Second, each deficit-financed tax cut is an-

nounced one year prior to its implementation; this attempts to capture the fact that there is a lag between the announcement of a policy and its implementation (the results do not significantly change when altering the length of this lag). Third, deficits finance 3% of stationary government consumption; this ensures that debt-to-GNP ratios do not become excessively large. Finally, the debt, which has been accumulated over-and-above the steady-state level, is repaid in equal payments over the duration of the tax-hike regime.

I compute experiments over four different durations. In what I refer to as the short-term experiment, there is a two year tax-cut followed by a two year tax-hike. The next is a medium-term one, corresponding to a four year tax-cut and a four year tax-hike. One interpretation of the short- and medium-term experiment durations is to think of them as corresponding to the U.S. presidential election cycle. The third is a long-term one, which corresponds to a 25 year tax-cut and 25 year tax-hike; this experiment is intended to mimic the expected length of time young and old generations overlap at the time of implementation of the deficit-financed tax cut. In the fourth and final experiment, there is an eight year tax-cut followed by an eight year tax-hike. I refer to this experiment as a medium/long-term one and its inclusion offers a case that lies in between the medium- and the long-term experiments.

In order to measure the response of aggregate consumption to a deficit-financed tax cut, I divide the difference in aggregate consumption between the tax-cut (tax-hike) regime and aggregate consumption in the stationary equilibrium by the change in aggregate disposable income. The resulting measure is the PCT:

$$\text{PCT}_t \equiv \frac{C_t - \bar{C}}{\Delta Y^d}.$$

ΔY^d denotes the change in aggregate disposable income, C_t is time- t aggregate consumption, and $\bar{C}$ is steady-state aggregate consumption. If RE holds, then aggregate consumption remains unchanged, $C_t = \bar{C}$, and the PCT equals zero. If all households are hand-to-mouth consumers, aggregate consumption changes one-for-one with the change in the tax revenue, $C_t - \bar{C} = \Delta Y^d$, and the PCT equals one. Figure 3 illustrates the various economies' PCTs over time for the four deficit-financed tax cuts.

4.2.1 From announcement to implementation

Each change in government-financing policy is announced in 2000. The tax-cut

regime is implemented in 2001. This implementation is indicated by the first vertical dashed line. The second vertical dashed line marks the onset of the tax-hike regime. The PCTs when RE holds are shown by the horizontal lines at zero. The red lines are the PCTs for the PA economy, the black lines for the NA economy, and the blue dashed lines for the IA economy.

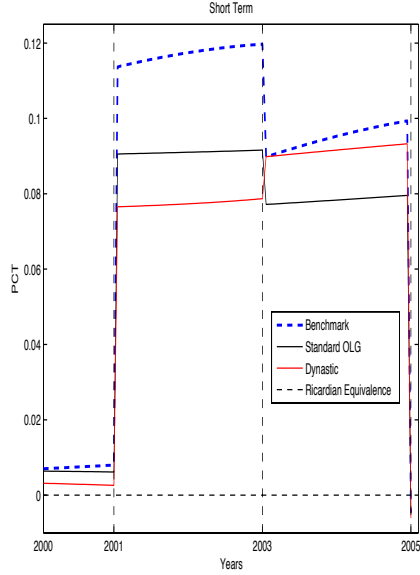
In 2000 the PCTs for all three economies jump up and the ensuing trajectories of the PCTs between 2000 and 2001 are positive.¹⁹ Both the initial jumps and the ensuing trajectories of the PCTs between 2000 and 2001 are entirely due to unconstrained households. In anticipation of an increase in future disposable income, households want to increase current consumption in order to have a smooth consumption path. Unconstrained households can increase current consumption by consuming out of their wealth. Despite the fact that PA economy households have perfect altruism, the PCT in the PA economy also becomes positive. This is because incomplete markets shorten the effective planning horizon for a PA household relative to the planning horizon of an infinitely-lived household. In the context of RE, this type of economy has been carefully studied by Laitner (1992) and Heathcote (2005).

Comparing the initial jumps of the PCTs across the four experiments, and the ensuing trajectories of the PCTs between 2000 and 2001, we see that they increase as the duration of the deficit-financed tax cut lengthens. This is because the farther into the future is the tax-hike, the larger is the extent to which the tax-cut is internalized as a permanent increase in income. Mortality risk makes it less likely that a current household is responsible for the entire tax burden. In addition, income uncertainty makes it more likely that a household's borrowing constraint will be binding at some point during the deficit-financed tax cut. Specifically, the truncation is such that economic consequences that lie beyond the time of the binding borrowing constraint are not internalized. Both of these factors truncate the effective planning horizon of households.

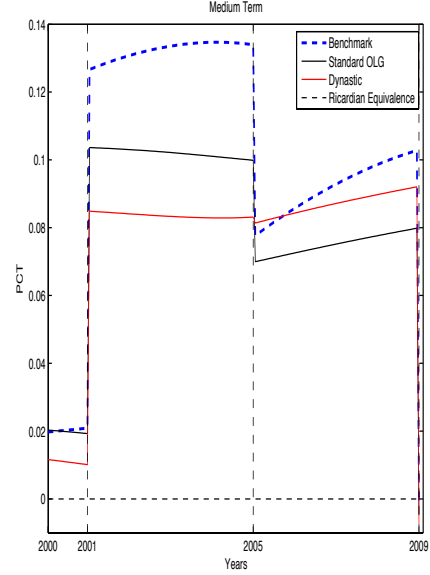
As the duration of the experiment lengthens, unconstrained households increasingly expect to be constrained at some point in the future during the experiment. From figures 4a and 4b, it can be seen that, for the short- and the medium-term experiments, the PCTs' trajectories for the IA economy roughly coincide with those from the NA economy. This resemblance disappears as the experiment lengthens,

¹⁹In order to compute the PCTs for the period between the announcement and the implementation, I use the change in aggregate disposable income of the tax-cut regime.

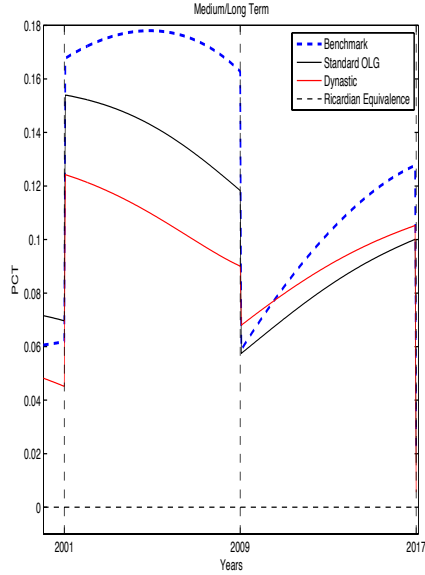
Figure 3: PCTs over time.



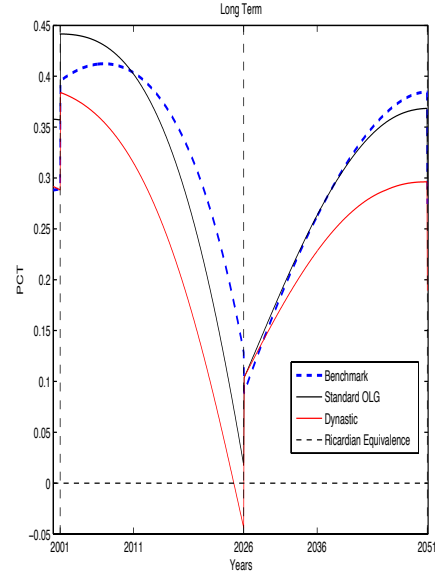
(a) Short-term Experiment



(b) Medium-term Experiment



(c) Medium/Long-term Experiment



(d) Long-term Experiment

PCTs over time for the four durations of the deficit-financed tax cut. The dashed vertical lines mark the onset of the tax-cut regime and the tax-hike regime, respectively. The horizontal lines at zero are the PCTs over time when RE holds, the red lines are the PCTs over time for the PA economy, the black lines are the PCTs over time for the NA economy, and the blue dashed lines are the PCTs over time for the IA economy.

as can be seen in figures 4c and 4d. For the medium/long-term experiment, the IA economy's PCT lies in-between the NA economy's and the PA economy's PCTs. For the long-term experiment, the IA economy's PCT practically coincides with the PA economy's PCT.

4.2.2 Tax-cut regime

The tax-cut is implemented in 2001. Once again, the PCTs in all three economies jump up. This time, however, the jumps are due to constrained households. Households that remain constrained after receiving the tax-cut act like hand-to-mouth consumers and consume the entire tax-cut. The differing magnitudes in the jump of the PCTs can be accounted for by considering the fraction of borrowing-constrained households in the stationary equilibrium of the respective economy. In the IA economy this fraction is 22.07% (of these, 15.73% are young households and 6.34% are old households). In the NA economy, this fraction stands at 14.56% (of these, 6.82% are young households and 7.74% are old households). Finally, in the PA economy, there are 13.79% of constrained households (here, there is an equal 6.89% fraction of young and old constrained households). This fraction is largest for the IA economy because, in the equilibrium of this economy, transfers only flow when the recipient is constrained, which provides an incentive to become constrained. This incentive is absent from the other two economies.

There is, however, an important caveat: not all constrained households in the IA economy increase their consumption one-for-one upon receiving the tax-cut. Since the tax-cut also crowds out private transfers, households which are recipients of private transfers prior to the tax-cut (8.41% of young households and 1.43% of old households) receive less transfers when the tax-cut takes place. Transfer recipients' consumption may therefore be unchanged or may only change by a small fraction of the tax-cut. In the PA and the NA economies, the fraction of constrained households reveals how many households act as hand-to-mouth consumers. Conversely, in the IA economy, relative resources of the households in the family play an important role.

As we have discussed so far, the differences in the PCTs' levels are largely explained by the fractions of constrained households, which themselves depend on the extent of altruism, and on the length of the experiment. The level of the PCT increases in the fraction of constrained households since these households act like

hand-to-mouth consumers. The level also increases in the duration of the deficit-financed tax cut because of the increased likelihood for an unconstrained household to be constrained at some point in the future. For the duration of the tax-cut regime, summing up the effects from the unconstrained and the constrained households, the trajectories of the PCTs in the IA economy are strictly above those from the NA economy and from the PA economy for the short, medium, and medium/long term tax-cuts.

A striking feature is the following: the PCTs in the IA economy decrease at a much slower rate than those in the other two economies. This feature is particularly evident in the long-term experiment, shown in figure 4d, where the trajectory of the PCT in the IA economy is initially below the one from the NA economy but eventually surpasses it.

The economic intuition behind the differences in the shapes of the PCTs' trajectories has to do with imperfect altruism and lack of commitment. The possibility of future transfers provides a disincentive to save out of the higher disposable income for current recipients of gifts or for households which expect to receive transfers in the future if they remain poor enough throughout the tax-cut regime. With time, the aggregate consumption policies in all economies start to prescribe consumption rates which are below those from the stationary economy in anticipation of the tax hike (we will return to this point shortly). This process occurs at a slower rate in the IA economy, however, than it does in the other two economies. As the economy approaches the date of the tax increase, it becomes increasingly likely that current households will carry the burden of paying back the accumulated debt through higher taxes. Only in the IA economy are there households which can count on being "bailed out" with private transfers when taxes increase. Households without altruism, as well as households with perfect altruism, do not have this type of moral hazard, and they therefore increase their savings at an earlier point in time.

Table 4 presents the average PCTs over the tax-cut regime in order to offer a more succinct view of the differences of the PCTs' trajectories. Unsurprisingly, this average increases in the duration of the experiment for all three economies. What is more significant is that the average PCT in the IA economy is larger than the average PCTs for the other two economies in all of the experiments. This difference is particularly stark for the short-, medium-, and the medium/long-term changes in the government-financing policy. For these durations, the PCT in the IA economy

is 29%, 30%, and 24% larger than the PCT in the NA economy and 52%, 58%, and 61% larger than the PCT in the PA economy. For the long-term deficit-financed tax cut, the average PCT of the IA economy becomes very similar to that of the NA economy; the average is merely 7% higher. In addition, the difference to the PA economy becomes less pronounced; the average is 44% higher.²⁰

Table 4: Average PCTs in terms of cents for the tax-cut regime.

Experiment	RE	NA	IA	PA
Short-run	0	0.09	0.12	0.08
Medium-run	0	0.10	0.13	0.08
Medium/Long-run	0	0.14	0.17	0.11
Long-run	0	0.32	0.35	0.24

4.2.3 PCT Decomposition

I decompose the PCTs for a given point in time in order to further our understanding behind the driving forces of the aggregate consumption dynamics during the experiment. Furthermore, this will aid us in understanding the jumps of the PCTs and their ensuing trajectories, starting with the tax-hike regime. For brevity, the discussion will concentrate on the decomposition of the PCT for the short-term experiment only; it would not substantially differ for the other durations of the experiment.

There are two main reasons why aggregate consumption during the experiment differs from its stationary value. First, consumption policies may change over time. For a given state, optimal consumption rates may differ from the stationary aggregate consumption policy. Second, the distribution of households over the state-space may change. Due to changes in consumption-savings policies, the distribution of households across the state-space during the experiment may differ from the stationary density. The PCT can be decomposed as follows:

²⁰I computed a variety of comparative statics exercises to study the sensitivity of this result. Holding the other parameters constant I computed the same exercise as shown here for various values for the altruism parameters in an empirically plausible range. Qualitatively the results are unchanged and quantitatively there are only some minor changes.

$$\text{PCT}_t = \frac{C_t - \bar{C}}{\Delta Y^d} \approx \underbrace{\frac{\text{Policy Change}}{\Delta Y^d}}_{\text{PCT-adjusted Policy Change}} + \underbrace{\frac{\text{Density Change}}{\Delta Y^d}}_{\text{PCT-adjusted Density Change}}, \quad (6)$$

where

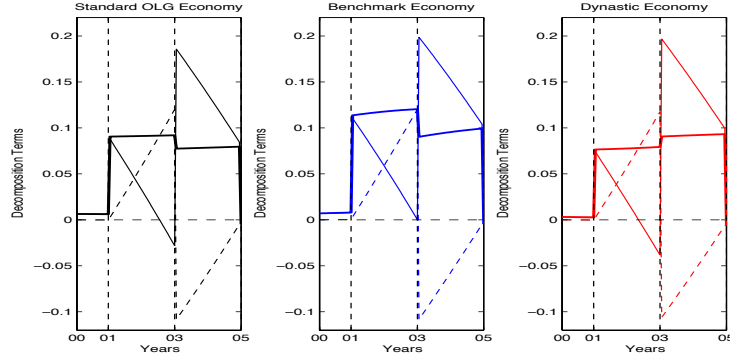
$$\text{Policy Change} \equiv \int_X \tilde{c}(x) \bar{\lambda}_t(x) dx \quad \text{and} \quad \text{Density Change} \equiv \int_X \bar{c}(x) \tilde{\lambda}(x) dx.$$

A positive value of $\tilde{c}_t(x)$ means that the time- t consumption policy stipulates a higher consumption rate than does the steady-state consumption policy for a family with state x . The aggregation of $\tilde{c}_t(x)$ over the state space, X , using the stationary density tells us how much changes in policies contribute to the difference between time- t aggregate consumption and stationary aggregate consumption. I will refer to $\int_X \tilde{c}_t(x) \bar{\lambda}(x) dx$ as the “policy-change” component. In order to obtain the contribution of the policy-change component to the PCT it is divided by the change in aggregate disposable income, ΔY^d . The resulting number is referred to as the “PCT-adjusted policy-change” component.

A positive value of $\tilde{\lambda}_t(x)$ tells us that the time- t mass of families with state x is larger than it is under the stationary density. Using $\tilde{\lambda}_t(x)$ to sum up the steady-state consumption policy, $\bar{c}(x)$, across the state space provides the contribution to the difference between time- t aggregate consumption and stationary aggregate consumption due to a change in the density. For example, a positive value of $\int_X \bar{c}(x) \tilde{\lambda}(t, x) dx$ means that a larger mass of households must be in regions of the state space where the steady-state consumption policy prescribes larger consumption rates. That is, time- t aggregate wealth is larger than steady-state aggregate wealth due to changes in consumption-savings policies. I will call $\int_X \bar{c}(x) \tilde{\lambda}(t, x) dx$ the “density-change” component. Again, in order to obtain the contribution of this term to the PCT it is divided by the change in aggregate disposable income, ΔY^d , and the resulting number is called the “PCT-adjusted density-change” component.

Figure 4 shows this decomposition for the three economies for the short-term experiment. The dashed vertical lines mark the onset of the tax-cut regime and of the tax-hike regime, respectively. The trajectories of the PCTs are shown by the thick solid lines. The dashed graphs are the PCT-adjusted density-change components and the narrow solid lines are the PCT-adjusted policy-change components.

Figure 4: Decomposition of the PCTs.



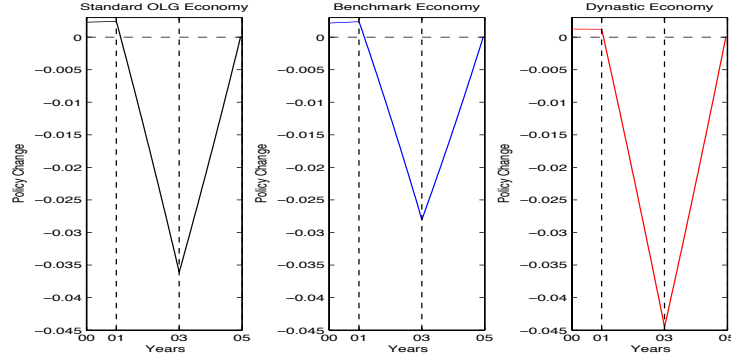
Decomposition of the PCTs for the short-term experiment, see equation (6). The dashed graphs trace out the PCT-adjusted density-change component, the narrow solid lines represent the PCT-adjusted policy-change component, and the thick solid lines are the trajectories of the PCTs, i.e. the sum of the dashed lines and the narrow solid lines.

The trajectories of the PCTs between 2000 and 2001 are entirely due to changes in the optimal policies. This can be seen from the fact that the thin and the thick solid lines coincide over this period. The policy-change component is a forward looking component and accounts for changes in household's consumption-savings choices. Since the consumption rate is a flow variable, the policy-change component can vary rapidly. The density-change component is a backward looking one and accounts for past decisions on the current level of wealth. It responds slowly since wealth is a stock variable.

In 2001, when the tax-cut is implemented, the policy-change components of the PCTs jump up. These jumps are due to changes in the constrained households' policies. For constrained households, consumption policies change one-for-one with the tax-cut. Throughout the tax-cut regime, the policy-change component for constrained households remains constant (i.e. the term policy change for these households is simply a horizontal line). As can be seen from the figure, however, the policy-change component decreases as the tax-hike regime approaches. Evidently, this must be due to changes in consumption policies of the unconstrained households.

Figure 5 shows the policy-change component for unconstrained households with positive wealth throughout the short-term experiment. The policy-change component

Figure 5: Unconstrained household's policy-change component.



Policy-change component for (unconstrained) households with positive wealth in the short-term experiment, see equation (6).

for unconstrained households decreases throughout the tax-cut regime and rapidly turns negative (for longer-term experiments the point at which the policy-change component turns negative happens later). Thus, unconstrained households time- t policies start to prescribe lower consumption rates than do the stationary policies. Households increase their savings in order to buffer for the possibility of having to pay back the accumulated debt. Consequently, more households are in states with higher wealth than when in the stationary equilibrium. As these households save more, aggregate wealth in the economy increases. This is reflected by the fact that the density-change component throughout the tax-cut regime is positive and increasing. Over time an increasing part of the aggregate consumption is explained by households having higher wealth.

Furthermore, as can be seen in figure 5, the policy-change component for households with positive wealth at a given point in time during the tax-cut regime is smallest in the PA economy. In anticipation of the tax-hike, PA economy households increase their savings relatively more than do households in the other two economies. The policy-change component for households in the IA economy more closely resembles the one from the NA economy, but is even larger. Households in the IA economy save the least in preparation for the tax-hike regime.

4.2.4 Tax-hike regime

In 2003, the tax-hike regime is implemented. The lump-sum tax increases above its stationary equilibrium value. The additional tax revenue is used to pay off the

debt, which has been accumulated over-and-above the steady-state level of debt and its associated interest payments. The additional debt is repaid in equal payments and the duration of the tax-hike regime equals the length of the tax-cut regime. The change in aggregate disposable income, ΔY^d , becomes negative and is in absolute terms larger than under the tax-cut regime, since both the debt and the accumulated interest must be repaid. Obviously, a larger tax-hike is required for longer durations of the tax-cut. This induces a purely mechanical change in the computation of the PCT, see equation (6).

When the tax-hike takes place, as can be seen from figure 4, the PCT-adjusted policy-change components jump up. This is due to both unconstrained and constrained households. The policy-change component for unconstrained households is negative, and since households have expected the change in the financing policy, consumption policies for unconstrained households change continuously (see figure 5). There is now, however, a negative change in aggregate disposable income, $\Delta Y^d < 0$, so that the PCT-adjusted policy-change component for unconstrained households switches signs. For constrained households, the policy-change component is positive before reaching the onset of the tax-hike regime. Once the tax-hike takes place, constrained households' consumption policies change discontinuously. In particular, their consumption policies prescribe a lower consumption rate than is the case in the stationary equilibrium. It follows that the policy-change component for constrained households is negative for the duration of the tax-hike regime and the PCT-adjusted policy-change component is positive.

The density-change components are positive before the onset of the tax-hike regime. Since the density changes continuously and since there is a negative change in aggregate disposable income, the PCT-adjusted density-change components switch from positive values to negative values, as can be seen in figure 4. In sum, the PCT-adjusted policy-change components outweigh the PCT-adjusted density-change components, and so the PCTs continue to be positive throughout the tax-hike regime.

Constrained households' consumption policies change one-for-one with the tax-cut. Since disposable income during the tax-hike regime is below steady-state disposable income, constrained households' consumption policies prescribe a consumption rate below the steady-state value. The PCT-adjusted policy-change component for these households is constant and positive throughout the tax-hike regime (i.e. a positive horizontal line). As can be seen in figure 4, however, the PCT-adjusted policy-

change component decreases throughout the tax-hike regime. This must be due to the unconstrained households. Consumption policies for unconstrained households prescribe increasingly higher consumption rates. These time- t consumption rates are still below the steady-state consumption rates, but gradually approach them (see figure 5). This happens since, once the tax-hike regime ends, the tax rate permanently decreases to its stationary value, and consumption policies revert to the stationary policies. As these households save less, aggregate wealth in the economy decreases and the mass of households retreats to lower wealth states. This is reflected by the term density change.

A noticeable feature of figure 4 is that the PCTs' trajectories during the tax-hike regime are more similar across the three economies than they were during the tax-cut regime (see also figure 4a). What is especially striking is the close resemblance between the PA economy's PCT-adjusted policy-change component and the IA economy's one. Figure 5 reveals that at the beginning of the tax-hike regime, the policy-change component for unconstrained households in the PA economy is smallest. This, however, translates into the largest PCT-adjusted policy-change component for unconstrained households. Adding to this the constrained households' PCT-adjusted policy-change component yields the one observed in figure 4. Thus, despite the fact that there is a smaller fraction of constrained households in the PA economy than there is in the IA economy, the PCT-adjusted policy-change components are roughly of the same size for both economies. The unconstrained households' PCT-adjusted policy-change components make up for this difference. For the NA economy, the fraction of constrained households is close to the one in the PA economy and the unconstrained households' PCT-adjusted policy-change component is larger than the one in the PA economy. This explains why the PCT in the NA economy is relatively smaller than in the other two economies.

Referring back to figure 3, it can be seen that the similarity of the PCTs' trajectories across the three economies is also present for the experiments of longer durations. For convenience, the average PCTs over the duration of the tax-hike regime are summarized in table 5. The average PCTs reflect the similarity.

4.2.5 Welfare implications

A complementary way of studying deviations from RE is through the lens of a welfare analysis. I perform welfare calculations by computing the consumption

Table 5: Average PCTs in terms of cents for the tax-hike regime.

Experiment	RE	NA	IA	PA
Short	0	0.08	0.09	0.09
Medium	0	0.07	0.09	0.09
Medium/Long	0	0.08	0.10	0.09
Long	0	0.28	0.28	0.23

equivalent variation (CEV) of a deficit-financed tax cut for a “newborn” household under the veil of ignorance.

Suppose a household can either be born into the stationary economy or into the same economy, but subject to the deficit-financed tax cut. In either case, the household does not know what its type will be – that is, the household does not know at which density point it will be. The CEV is the percentage of annual consumption a household in the stationary economy would have to be compensated with in order for that household to be as well off as in the deficit-financed tax cut economy’s equilibrium. Table 6 provides the CEVs for the three economies for the various durations of the deficit-financed tax cut.

Table 6: Consumption equivalent variations under the veil of ignorance (%).

Experiment	RE	NA	IA	PA
Short	0	0.005	0.004	0.003
Medium	0	0.015	0.009	0.007
Medium/Long	0	0.050	0.026	0.021
Long	0	0.238	0.147	0.125

The CEVs are zero in an economy with RE. Due to market incompleteness, the deficit-financed tax cut enlarges the set of feasible consumption paths a household can choose in all three economies. Households can use the tax-cut as an additional channel through which they may smooth their consumption path, while still being free to save some or all of it. As a result, the CEVs are positive and increase in the

duration of the experiment in all three economies.

Contrasting the CEVs across the economies, it can be seen that in all the computational experiments, the CEVs are largest in the NA economy, smallest in the PA economy, and the CEVs from the IA economy lie in between. Though the PCTs of the IA economy are larger than those belonging to the other two economies, it is striking to note that this same relationship does not hold for welfare implications. In particular, as judged from the aggregate consumption dynamics discussed previously, one would have expected a closer resemblance between the IA economy's welfare implications and those of the NA economy's. This, however, is not the case.

In the short-term experiment, the IA economy's CEV lies half-way between the NA economy's CEV (it is 28.6% below) and the PA economy's CEV (it is 29.6% above). In the medium-term experiment the IA economy's CEV is 44.1% below the NA economy's CEV and 28.8% above the PA economy's CEV. Only in the medium/long-term experiment does the IA economy's similarity to the NA economy increase; the IA economy's CEV is 17.9% below the NA's CEV and 24.6% above the PA economy's CEV. Finally, in the long-term experiment, the IA economy's CEV more closely resembles the PA economy's CEV; it is 17.9% larger and 38.2% smaller than the NA economy's CEV.

In the IA economy, there are households (especially young households) that are recipients of private transfers. One effect of the deficit-financed tax cut on recipients of inter-vivos transfers is the exchange of gifts, which are free of any future financial obligations, for a tax-cut. This tax-cut, however, comes with a future obligation to repay the accumulated debt with higher taxes. While households which receive private transfers throughout the entire experiment are largely unaffected, this tax-cut-for-private-transfers swap matters for households for which transfers stop flowing either prior to or during the tax-hike regime. These households will have had their inter-vivos transfers crowded out by the tax-cut. While this would leave their consumption profile unaltered, it would present a financial obligation in the form of a higher tax burden. For some transfer recipients, this mechanism implies a welfare loss. This loss depresses the CEV in the IA economy, and since it is absent from the NA economy, the resemblance between the two economies dwindles.

5 Conclusions

Standard workhorse models in macroeconomics implicitly assume that altruism is either entirely absent or perfect, leaving the implications of intermediate degrees of altruism on deviations from RE largely unexplored. Such intermediate altruism levels are in line with the empirical evidence on inter-vivos transfers. In the data, transfers do occur, contradicting the implication of the standard OLG economy, but seem to take place only in special circumstances, suggesting that family members not always act as to equalize consumption as predicted by the dynastic model. In particular, their occurrence is especially likely when the recipient is borrowing constrained, as predicted by the intermediate altruism model.

A priori, one would suspect that the response of aggregate consumption to a deficit-financed tax cut in the intermediate altruism model is in between that of the standard OLG and that of the dynastic economy. Surprisingly, this paper finds that in a plausibly calibrated imperfect altruism economy deviations from RE, in terms of changes in aggregate quantities, are often even stronger than in the standard OLG economy. The reasons have primarily to do with the larger number of constrained households and the strategic considerations present in this economy. However, the deviations from RE in terms of the PCT are misleading insofar as they do not translate to welfare implications. Indeed, in terms of welfare the imperfect altruism economy tends to be closer to the dynastic economy.

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A Appendix

A.1 Robustness: An Alternative Calibration

Are the results with respect to the IA economy robust to changes in the key parameters? Would the results change dramatically if the calibration of the economy were to rely on different values of the calibration targets? In this section, I attempt to address these questions.

I compute the PCTs and the CEVs with a re-calibrated version of the IA economy. The new values of the key parameters are chosen such that the model matches larger values of the transfer-to-wealth ratios for both the young and the old. The rationale behind the larger values of these calibration targets is as follows. The SCF only reports private transfer amounts of \$3000 and above. By comparing the transfer data from the SCF with other data sources, Gale & Scholz (1994) conclude that inter-vivos transfers are likely to be one-third larger than the amount of inter-vivos transfers reported in the SCF. Therefore, the transfer-to-wealth ratios of both the young and the old are increased accordingly. The values of the two other calibration targets (the wealth-to-GNP ratio and the wealth-poor-%) remain unchanged. The newly calibrated values of the key parameters are summarized by table 7.

The discount rate $\rho = 3\%$, and so is unchanged from the previous calibration. This is driven by the unchanged values of the wealth-to-GNP ratio and the wealth-poor-%, both of which are primarily responsible for its identification. As expected,

Table 7: Alternative Values of Key Parameters

Parameter	NA	IA	PA
ρ	3.15%	3%	5.14%
α^1	0	0.15	1
α^2	0	0.31	1

the replication of larger values for the transfer-to-wealth ratios leads to an increase in the degrees of altruism for both young and old households. The young household's degree of altruism increases from $\alpha^1 = 0.12$ to $\alpha^1 = 0.15$ and the old household's degree of altruism increases from $\alpha^2 = 0.28$ to $\alpha^2 = 0.31$.

The features of the new stationary equilibrium are qualitatively the same as those in the original stationary equilibrium (see section 4.1). In particular, transfers continue to only flow to constrained households. There are, however, more states in which transfers flow in the new calibration. This creates an additional incentive to become constrained. Consequently, the fraction of borrowing-constrained households increases slightly from 22.07% to 23.58%.

Table 8: Average PCTs (in terms of \$'s) for the tax-cut regime.

Experiment	RE	NA	IA	PA
Short	0	0.09	0.12	0.08
Medium	0	0.10	0.13	0.08
Medium/Long	0	0.14	0.17	0.12
Long	0	0.32	0.34	0.24

A convenient way to gauge the robustness of the computational experiments is to compare the average PCTs resulting from the alternative calibration with those from the previous calibration (for the counterpart to figure 3, see figure 6). The average PCTs for the duration of the tax-cut regime are presented in table 8 (compare to table 4). The results are practically unchanged. In the short- and medium-term experiments, the average PCTs are marginally larger than before. This is a consequence of the larger fraction of borrowing-constrained households now present. The

Table 9: Average PCTs in terms of cents for the tax-hike regime.

Experiment	RE	NA	IA	PA
Short	0	0.08	0.10	0.09
Medium	0	0.07	0.09	0.09
Medium/Long	0	0.08	0.10	0.09
Long	0	0.28	0.27	0.23

Table 10: Consumption equivalent variations *under the veil of ignorance* (%).

Experiment	RE	NA	IA	PA
Short	0	0.005	0.003	0.003
Medium	0	0.015	0.008	0.007
Medium/Long	0	0.045	0.024	0.021
Long	0	0.238	0.136	0.125

average PCT for the long-term deficit-financed tax cut is somewhat below the one from the benchmark calibration. A higher degree of altruism, holding the discount rate constant, renders households relatively more patient. This effect dampens the PCT and plays an increasingly important role as the duration of the deficit-financed tax cut lengthens. This can be seen in figure 7d, which shows that the initial jump of the PCT in 2000 is below its corresponding value from the previous calibration (compare to figure 4d). The average PCTs over the duration of the tax-hike regime are presented in table 9 (compare to table 5). Again, quantitatively the results only differ minutely. The short-, medium-, and medium/long-term experiments' average PCTs are slightly larger. In addition, the long-term experiment's average PCT is slightly below its corresponding value in the previous calibration.

Finally, the welfare implications, as measured by the CEVs, are shown in table 10 (compare to table 6). As before, the CEVs from the IA economy lie in between those from the PA and NA economies. The results only differ slightly. All the CEVs from the IA economy, however, are less similar than those from the NA economy and

approach the PA economy CEVs.

In addition to the alternative calibration presented here, a variety of comparative statics exercises have been conducted, in which a symmetric altruism restriction was made, such that $\alpha^1 = \alpha^2$. Specifically, the average PCTs in the IA economy have been computed, while allowing for the degree of (symmetric) altruism to vary in an empirically plausible range, holding all other parameters unchanged. The result that the average PCT over the duration of the tax-cut regime in the IA economy is larger than the one in the NA economy holds for α 's in a fairly wide range. For example, in the long-term experiment, the result holds as long as $\alpha < 0.5$.

A.2 Computational Strategy

In the following the numerical strategy to compute deficit-financed tax cut equilibria is briefly outlined. The first step is to obtain the stationary equilibrium – the definition is as in section 2.2 except that time is not a state variable. This equilibrium is computed by adapting the numerical algorithm provided by Barczyk & Kredler (2012b)'s computational online appendix. This numerical algorithm is closely related to value function iteration. A key ingredient is the use of a form of the Markov-chain approximation method for continuous-time control problems; for a more technical treatment on this see for example Dupuis & Kushner (2001).

One specific problem that arises in the current setting, which is absent in Barczyk & Kredler (2012b), is to obtain the continuation value for very large bequests. When such bequests are made, I often have to obtain V^e for levels of wealth that lie far outside the grid. An excellent method to extrapolate the function is by exploiting homogeneity. For families with large levels of wealth we can safely neglect the income dimension and thus assume that value functions and policies are homogenous. Consumption and transfer policies are linear in wealth, which translates into value functions being of form $W^{1-\gamma}$ in total family wealth; for a study of a homogeneous environment with altruism see Barczyk & Kredler (2012a). The old household's value function is then given by

$$V(w, w', y, y') = \tilde{v}(P)W^{1-\gamma}, \quad \text{where} \quad P = \frac{w}{W}, \quad \text{and} \quad W = w + w'.$$

The function $\tilde{v}$ can then be calculated from the outermost grid points²¹ from

$$\tilde{V}(P) = V(w, w', y, y')W^{\gamma-1}.$$

This gives us $\tilde{V}(P)$ on a finite grid; intermediate values can be approximated by linear interpolation. The P which realizes upon death of the parent household is given by

$$P = \frac{w + w'}{w'(y'_j) + w + w'}.$$

The methods which are used to solve for the stationary equilibrium can also be used to compute policy functions throughout the transition. Due to the absence of aggregate risk, the distribution of households over the state space is not a payoff-relevant state for the household. It follows that the policies as of time $S_1 + S_2$ are given by the ones from the stationary equilibrium. The policy functions throughout the deficit-financed tax cut are obtained by backward iteration on the HJBs, as given by equation (4). The backward iteration is initialized with the stationary value functions. Using the finite-differencing method, the policy functions at time $S_1 + S_2 - \Delta t$ are computed, where Δt is a small increment of time. Iterating backward in this way until the announcement date provides the policies and value functions for the young and the old households throughout the transition. This is the same procedure as computing the stationary equilibrium except that time is an additional state variable and the iteration ends at the time of the announcement.

What remains are the densities throughout the transition, $\{\lambda_t\}$. These are computed as follows. Prior to the announcement date, the economy is assumed to be in the stationary equilibrium. The aggregate state of the economy is therefore given by the stationary density. The stationary density is mapped forward using the transition probabilities implied by the policies obtained throughout the deficit-financed tax cut.

A.3 Altruism Parameter

This section provides an interpretation of the altruism parameter and its relationship with the coefficient of relative risk aversion.

Consider a typical per-period utility function of, say, old household i . It is as-

²¹i.e. the grid points where either the parent or the child household hold (or both) hold the maximal wealth $\bar{W}$ on the grid.

sumed to be additively separable in its own consumption and consumption of the young household j , i.e.

$$U^i(c_i, c_j) = u(c_i) + \alpha u(c_j), \quad \alpha \in [0, 1]$$

where $u(\cdot)$ is a CRRA utility. If $\alpha = 1$ we speak of perfect altruism and when $\alpha = 0$ we speak of no altruism. But what are reasonable values for this parameter? We can get a sense of what “reasonable” may mean by considering the following FOC, which in equilibrium, has to hold in the static model

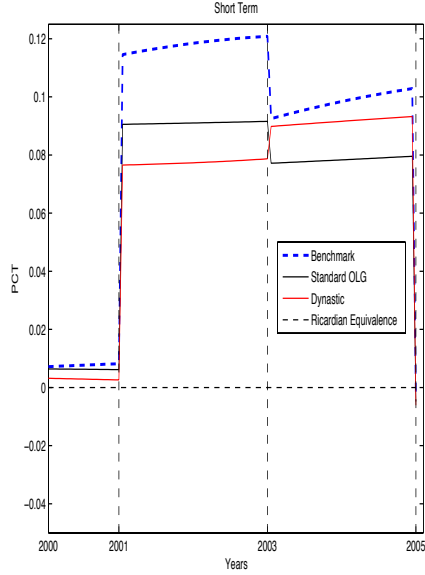
$$u_c(c_i) \geq \alpha u_c(c_j) \quad \Rightarrow \quad \alpha \leq \left(\frac{c_i}{c_j} \right)^{-\gamma}$$

If the inequality points the other way, the old household would provide the young household with a transfer since the additional utility she obtains if the young household consumes is larger than from her own consumption. On the other hand if the old household does not have enough resources to equalize this margin her marginal utility is strictly larger than the marginal utility she would obtain from consumption by the young household, in which case there are no transfers.

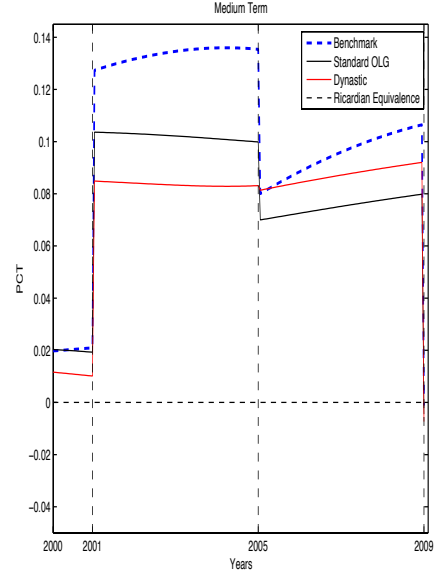
When the margin is equalized we can think about parameter values for α as the answer to the following thought experiment: What degree of consumption inequality does an (imperfect) altruist tolerate before she decides to transfer resources, which can only be consumed, from her own consumption? If, for example, a reasonable answer appears to be 2 and $\gamma = 2$ then we can infer $\alpha = (2)^{-2} = 0.25$. With logarithmic utility the interpretation is particularly simple since $\alpha_i = c_j/c_i = 0.5$: Agents who have a degree of altruism of degree 0.5 provide voluntary transfers when consumption inequality exceeds 2.

Another interesting observation which becomes evident is that it is not the absolute value of α which in itself is meaningful, but its size in conjunction with the coefficient of relative risk-aversion. From the example we see that an agent with $\gamma = 2$ and $\alpha = 0.25$ tolerates the same degree of consumption inequality as an agent with $\gamma = 1$ and $\alpha = 0.5$. Thus, in order to speak about magnitudes of altruism we have to keep in mind that this is only meaningful in the context of specifying a degree of risk-aversion.

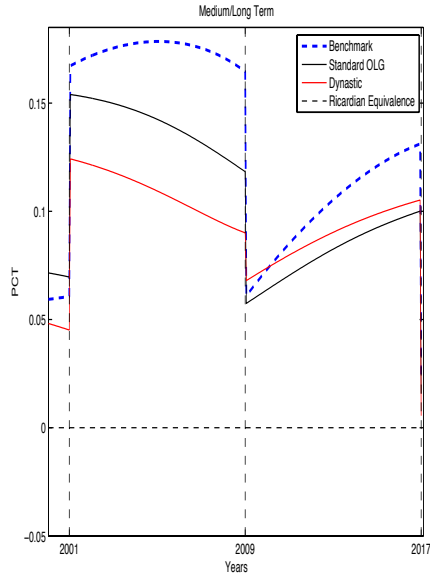
Figure 6: Alternative calibration: PCTs over time.



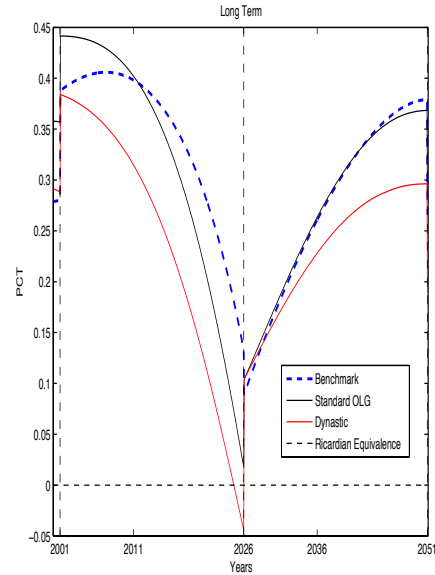
(a) Short-term Experiment



(b) Medium-term Experiment



(c) Medium/Long-term Experiment



(d) Long-term Experiment

PCTs over time for the four durations of the deficit-financed tax cut. The dashed vertical lines mark the onset of the tax-cut regime and the tax-hike regime, respectively. The horizontal lines at zero are the PCTs over time when RE holds, the red lines are the PCTs over time for the PA economy, the black lines are the PCTs over time for the NA economy, and the blue dashed lines are the PCTs over time for the IA economy.