Non-Traded Goods, Ageing, and Pensions in Open Economies

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Overview of this presentation

- motivation
- point of departure
- ongoing and future extensions
- concluding remarks

Motivation

- Western world is ageing rapidly
  - increased longevity (longer lives)
  - reduced fertility (fewer newborns)
  - old-age dependency ratio increases dramatically (e.g. Germany: 24% in 2000 to 49% in 2050; Japan: 25% to 72%)
- Focus of this paper: How will small open economies be affected by ageing?
- Questions we are typically interested in are:
  - what are the macroeconomic effects of demographic and pension shocks?
  - what are the welfare effects associated with pension reform?

- Difference with existing literature:
  - focus on small analytical model: identify the key mechanisms (complementary to large-scale CGE models)
  - two-sector structure: endogenous real exchange rate
  - economy-wide adjustment costs of investment due to increasing marginal cost of non-traded investment goods

Point of departure

Bettendorf & Heijdra (2004), “Population ageing and pension reform in a small open economy with non-traded goods.” Discussion Paper TI2005-021/2, Tinbergen Institute.

- Households
  - finite lives
  - two consumption goods; exogenous labour supply
  - age-dependent productivity
  - demography allows exact aggregation
  - perfect annuity markets

- Production
  - two-sectors: traded and non-traded goods
  - capital mobile across sectors
  - investment good is non-traded
- Government
  - rudimentary PAYG pension system
  - (lump-sum) labour income tax

- Full model given in **Table 1**
  - rewritten in stationary format: all growing variables in per capita terms (population $L(t)$ grows at rate n^L)
  - endogenous: P_N, W^N, W^K, k, n, x, a, a^F, γ, k_i, n_i, y_i, c_i (for $i = N, T$)
  - exogenous: g_i (for $i = N, T$), r^F, a^G, β, η, π, $\bar{z}_R$, and t_L
  - two predetermined state variables (k and a^F) and two non-predetermined "jumping" state variables (P_N and x)

Table 1: Short-run version of the model

(a) Dynamic equations:

$$\frac{\dot{P}_N(t)}{P_N(t)} = r^F + \delta - \frac{W^K(t)}{P_N(t)} \tag{T1.1}$$

$$\dot{k}(t) = n_N(t)y_N(t) - c_N(t) - g_N(t) - \left(\delta + n^L\right) k(t) \tag{T1.2}$$

$$\dot{x}(t) = \left(r^F - \rho + \alpha\right) x(t) - (\rho + \beta)\left[\eta\gamma + (\alpha + \eta)\, a(t)\right] \tag{T1.3}$$

$$\dot{a}(t) = \left(r^F - n^L\right) a(t) - x(t) + W^N(t)n \tag{T1.4}$$

Table 1, continued

(b) Static equations:

$$y_T(t) = k_T(t)^{1-\varepsilon_T} \tag{T1.5}$$

$$y_N(t) = k_N(t)^{1-\varepsilon_N} \tag{T1.6}$$

$$W^N(t) = \varepsilon_T y_T(t) = \varepsilon_N P_N(t) y_N(t) \tag{T1.7}$$

$$W^K(t) = (1-\varepsilon_T)\, k_T(t)^{-\varepsilon_T} = (1-\varepsilon_N)\, P_N(t)\, k_N(t)^{-\varepsilon_N} \tag{T1.8}$$

$$n = n_T(t) + n_N(t) \tag{T1.9}$$

$$k(t) = n_T(t) k_T(t) + n_N(t) k_N(t) \tag{T1.10}$$

Table 1, continued

(b) More static equations:

$$n = \frac{\eta\omega_0}{\alpha + \eta} \tag{T1.11}$$

$$c_T(t) = \varepsilon_C x(t) \tag{T1.12}$$

$$P_N(t)c_N(t) = (1 - \varepsilon_C)\, x(t) \tag{T1.13}$$

$$\gamma = \left(\frac{e^{-\beta\pi}}{1 - e^{-\eta\pi}}\right)\left(\frac{\bar{z}_R}{r^F + \beta}\right)(r^F + \alpha + \beta)\left(\frac{e^{-r^F\pi} - e^{-n^L\pi}}{n^L - r^F}\right) \tag{T1.14}$$

$$a\,(t) = P_N(t)k(t) + a^F(t) \tag{T1.15}$$

Model properties

- steady-state values with hat overstrike (e.g. $\hat{k}_N$ etcetera)
- constant r^F imposes lots of fixity:
  - $r^F + \delta = \widehat{W^K/P_N} = (1-\varepsilon_N)\,\hat{k}_N^{-\varepsilon_N}$: $\hat{k}_N$ fixed
  - $\hat{k}_T$, $\hat{W}^N$, $\hat{W}^K$, and $\hat{P}_N$ are function of $\hat{k}_N$ (and thus ultimately of $r^F + \delta$): also fixed
  - it follows that $\hat{y}_T$ and $\hat{y}_N$ are also constant
- hence: no long-run effect on $\hat{k}_N$, $\hat{k}_T$, $\hat{y}_N$, $\hat{y}_T$, $\hat{W}^N$, $\hat{W}^K$, and $\hat{P}_N$.
  - demand shocks (g_N or g_T)
  - demographic shocks (such as changes in η or β)
  - pension shocks (changes in π or $\bar{z}_R$)

Proposition 1 *Consider the model of Table 1 and assume that* $r^F - \rho < \eta$. *The following results can be established:*

(i) the model is locally saddle-point stable, i.e. the Jacobian matrix features two negative (stable) characteristic roots and two positive (unstable) roots;

(ii) the capital stock features smooth transitional dynamics;

(iii) there is no transitional dynamics in the real exchange rate if the traded goods sector is relatively capital intensive ($k_T > k_N$);

(iv) the real exchange rate features non-trivial transitional dynamics if the non-traded sector is relatively capital intensive ($k_N > k_T$);

(v) the long-run growth rate in the economy is equal to $n^L \equiv \eta - \beta$.

Shocks in the Core Model

- to get simple analytical results we study a special case:
  - the traded sector is relatively capital intensive (i.e. $k_T > k_N$)
  - in order to avoid having to go through a whole taxonomy of cases admitted by our model, we restrict attention to the case which we find empirically most relevant:
    - households are relatively patient ($r^F > \rho$)
    - rate of population growth is relatively low ($r^F > n^L$)
- Shocks:
  - demographic shocks (see paper for details)
  - pension shock (see below)

Pension shocks

- hold demographic parameters (β and η) constant
- two types of pension shocks:
  - decrease in pension payment ($d\bar{z}_R < 0$ so that $d\bar{t}_W < 0$ and $d\gamma < 0$ also)
  - increase in the pension age ($d\pi > 0$ so that $d\bar{t}_W < 0$ and $d\gamma < 0$ also)
- impact, transitional, and long-run effects illustrated in **Figure 4**
- key results stated in **Proposition 4**

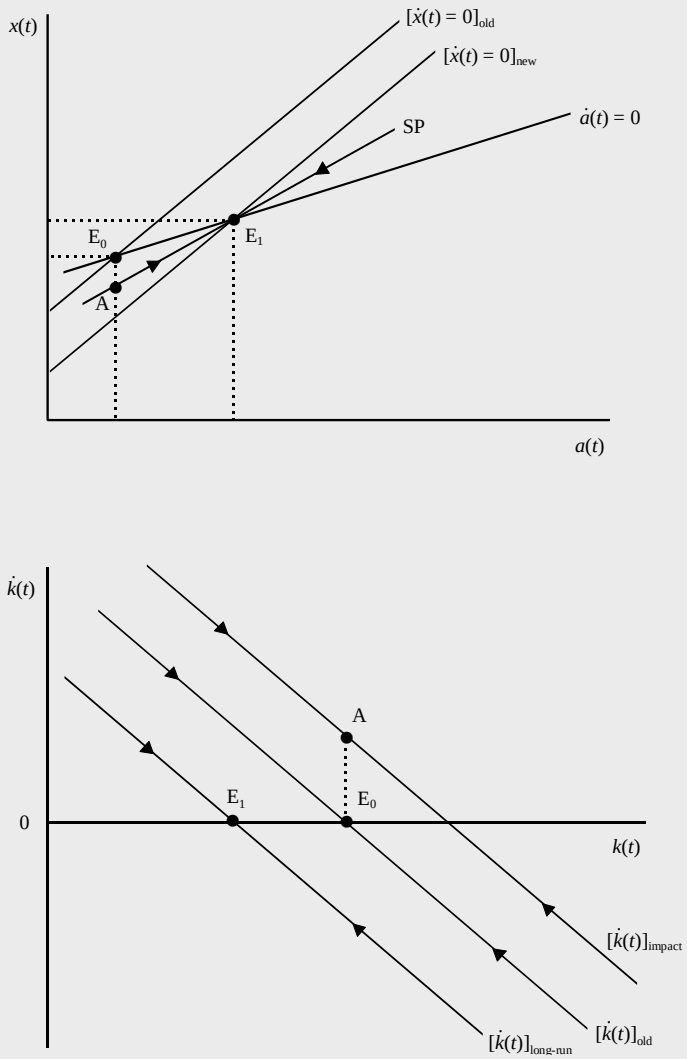


Figure 4: Lower Pension Payment - Higher Pension Age

Proposition 4 *Consider the core model and assume that the pension payment is decreased ($d\bar{z}_R < 0$) or the retirement age is increased ($d\pi > 0$). The following results can be established:*

(i) at impact, x, c_T, and c_N fall, a, k, and a^F are unchanged, and both $\dot{x}$ and $\dot{k}$ increase;

(ii) during transition, x, c_T, c_N and a^F rise monotonically, but following its initial increase, k starts to decline during the later phases of adjustment;

(iii) in the new steady state, x, c_T, and c_N are all increased, but k is decreased.

Intergenerational welfare effects

- focus on welfare effect of two types of pension reform
- Reduction in the pension payments
  - intergenerational welfare profile in **Figure 5**
  - age of critical working-age generation:

$$-v^* \equiv \left(\frac{r^F - n^L}{r^F + \beta} \right) \pi \tag{4.6}$$

  - the proportion of the existing population favoring pension reform (at time $t = 0$) is:

$$\frac{L(0)^{pro}}{L(0)} = 1 - e^{\eta v^*} \tag{4.7}$$

- majority in favour if:

$$\eta \left(\frac{r^F - \eta + \beta}{r^F + \beta} \right) \pi > \ln 2 \tag{4.8}$$

- some illustrative numbers: $r^F = 0.06$, $\beta = 0.01$, $\eta = 0.02$ (all per annum). The condition is satisfied provided $\pi > 48.5$ years, which is not unreasonable given the implied expected remaining lifetime of the population of $1/\beta = 100$ years.

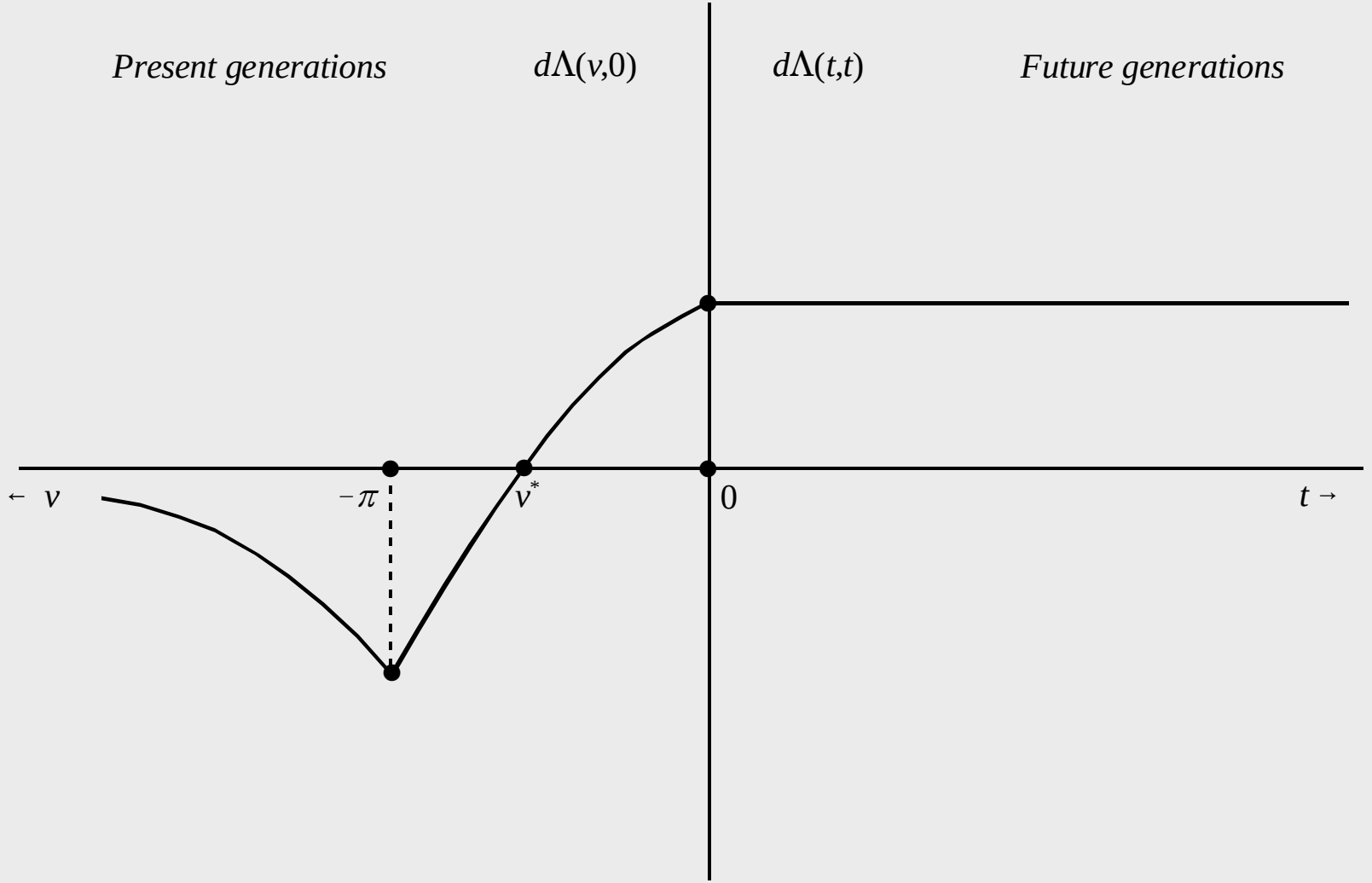


Figure 5: Intergenerational Welfare Effects of a Pension Benefit Reduction

- Increase in the pension age
  - intergenerational welfare profile in **Figure 6**
  - age of critical working-age generation:

$$-v' \equiv \left[1 + \frac{1}{\left(r^F - n^L\right)\pi} \ln\left(\frac{\varepsilon}{\varepsilon + \left(r^F - n^L\right)\pi}\right)\right]\pi \qquad (4.9)$$

  - some numbers: $r^F = 0.06$, such a majority exists for the parameter settings $\eta = 0.02$ and $\beta = 0.01$ if $\pi > 54.2$ years, whilst for the settings $\eta = 0.015$ and $\beta = 0.02$ it exists if $\pi > 66.5$ years.

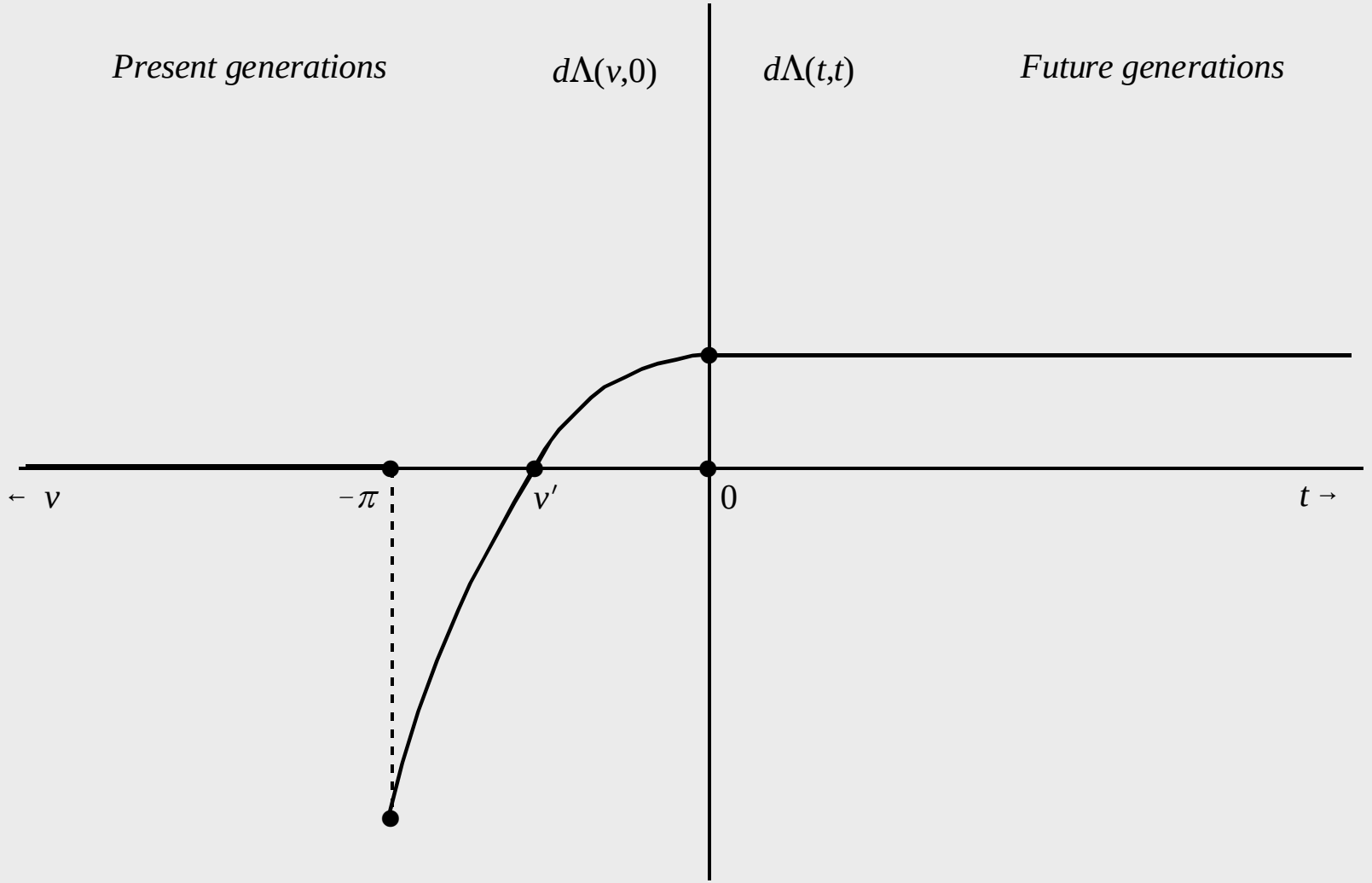


Figure 6: Intergenerational Welfare Effects of an Extension in the Pension Age

Ongoing and Future Extensions

- Age- and time-dependent birth- and mortality rates [Heijdra & Romp (2005a)]
- Endogenous retirement decision [Heijdra & Romp (2005b)]
- Endogenous tradability
- Escape from the international trade theorems (Stolper-Samuelson, Rybczynski, factor price equalization):

  (a) specific factor model

  (b) limited intersectoral capital mobility

Extension 1: Age-Dependent Mortality

Heijdra & Romp (2005a), "A life-cycle overlapping-generations model of the small open economy." SOM Research Report, Nr. 05C04, University of Groningen, February 2005.

- Households
  - finite lives: Gompertz-Makeham mortality process (see below)
  - single good; exogenous labour supply
  - demography does not allow exact aggregation
  - aggregate variables not needed
  - perfect annuity markets

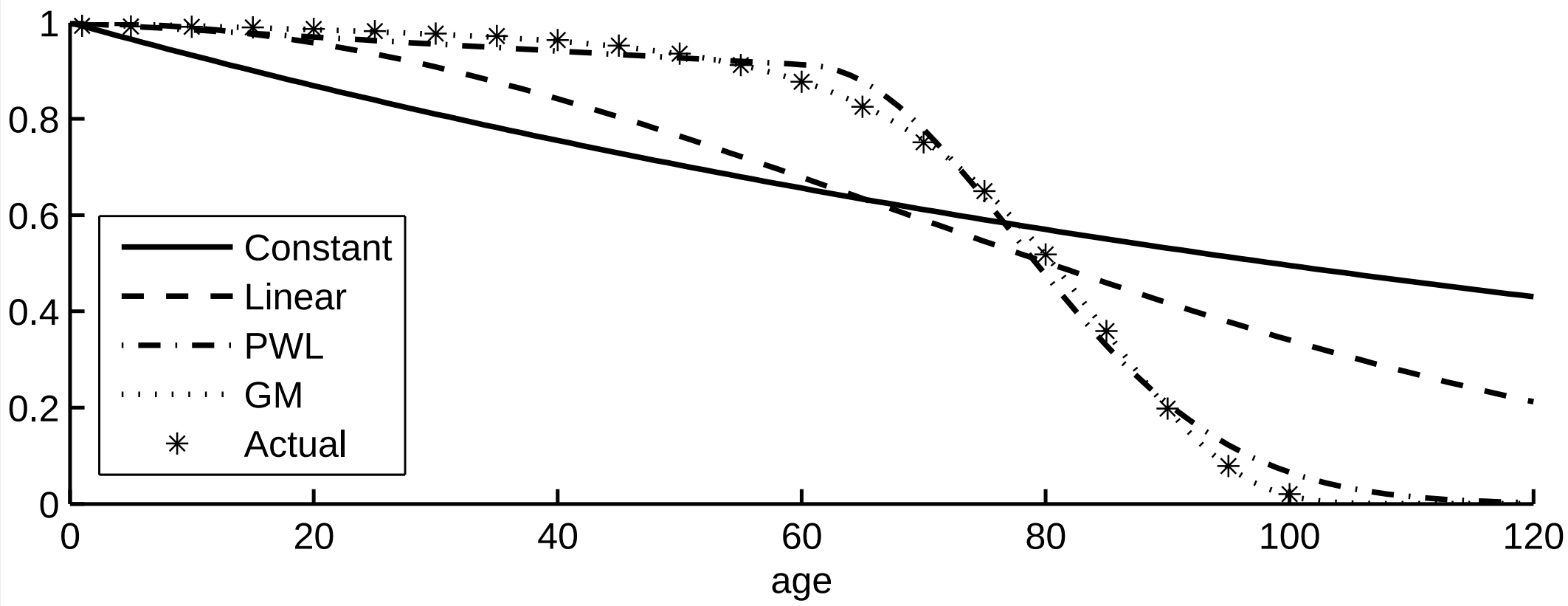


Figure 1: (a) Surviving Fraction of the Population

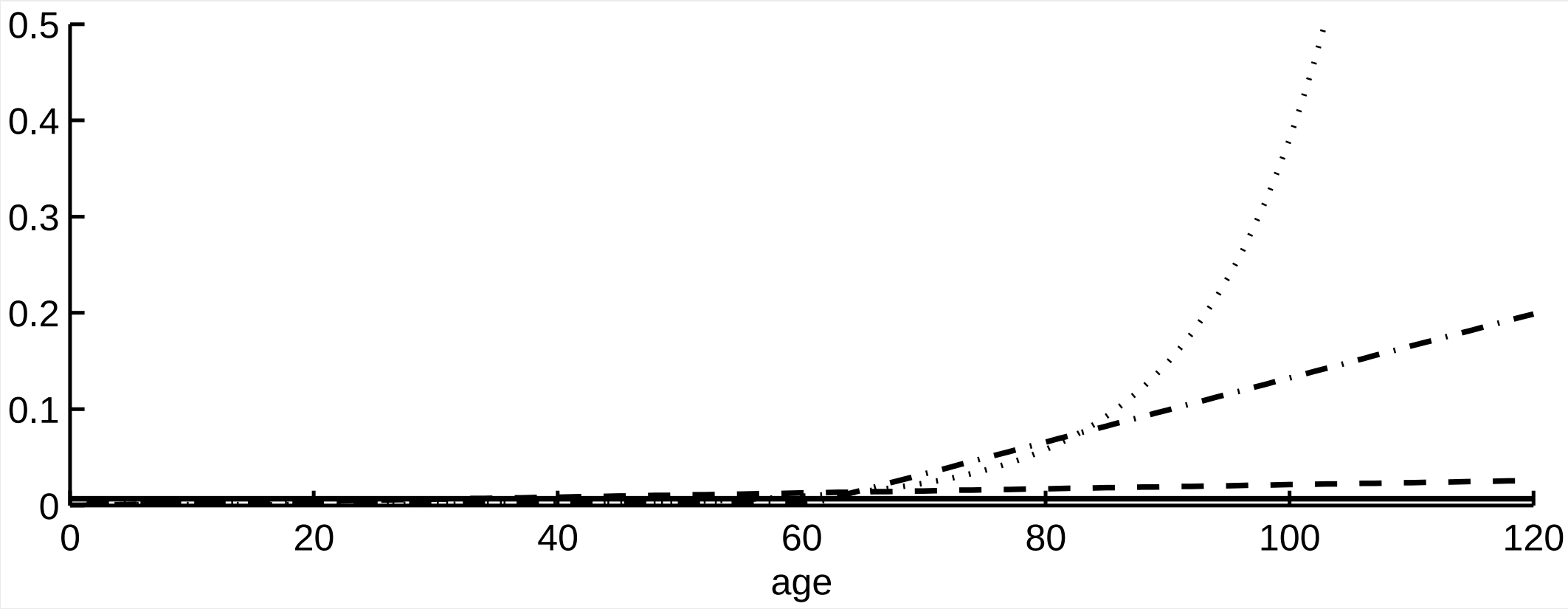


Figure 1: (b) Mortality Rate of the Population

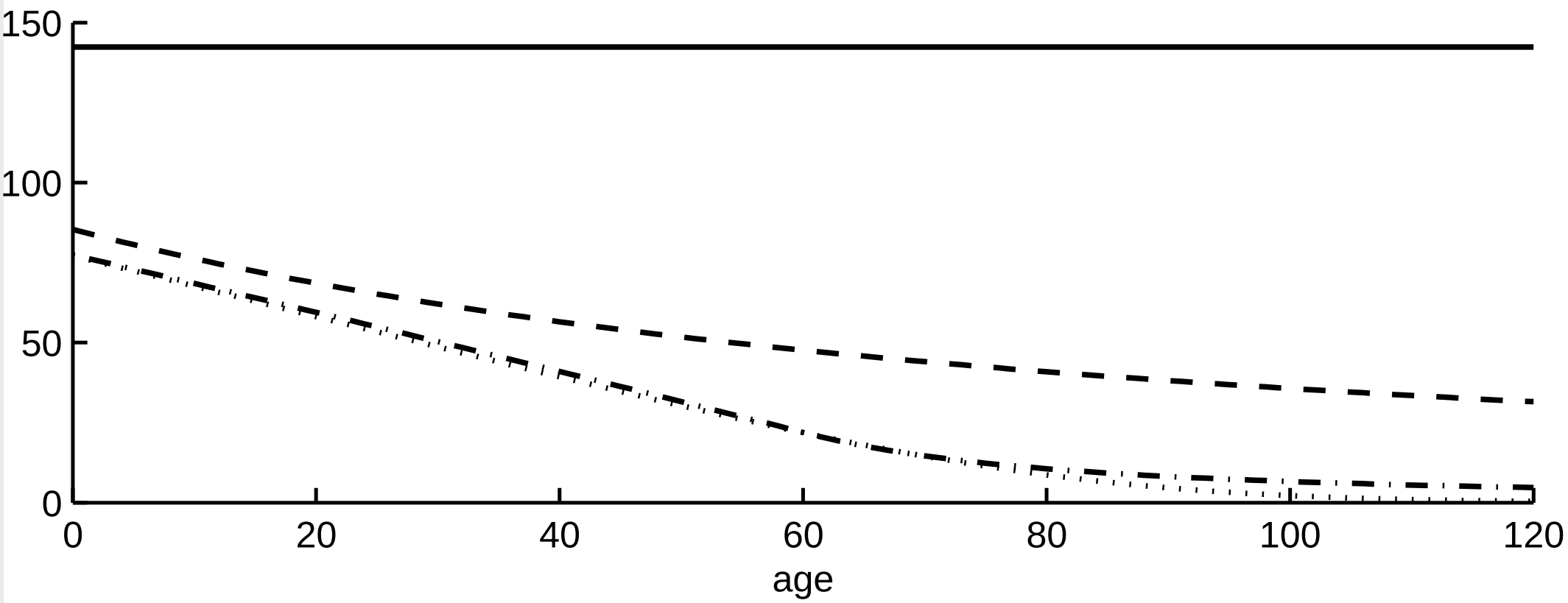


Figure 1: (c) Expected Remaining Lifetime

- Production
  - single traded good
  - no capital [or limited mobility via Tobin's q theory]
- Key results:
  - life-cycle savings pattern
  - propensity to consume age-dependent
  - demographic details do not wash out in the aggregate: much faster convergence than in the BY model
  - welfare effects may be non-monotonic

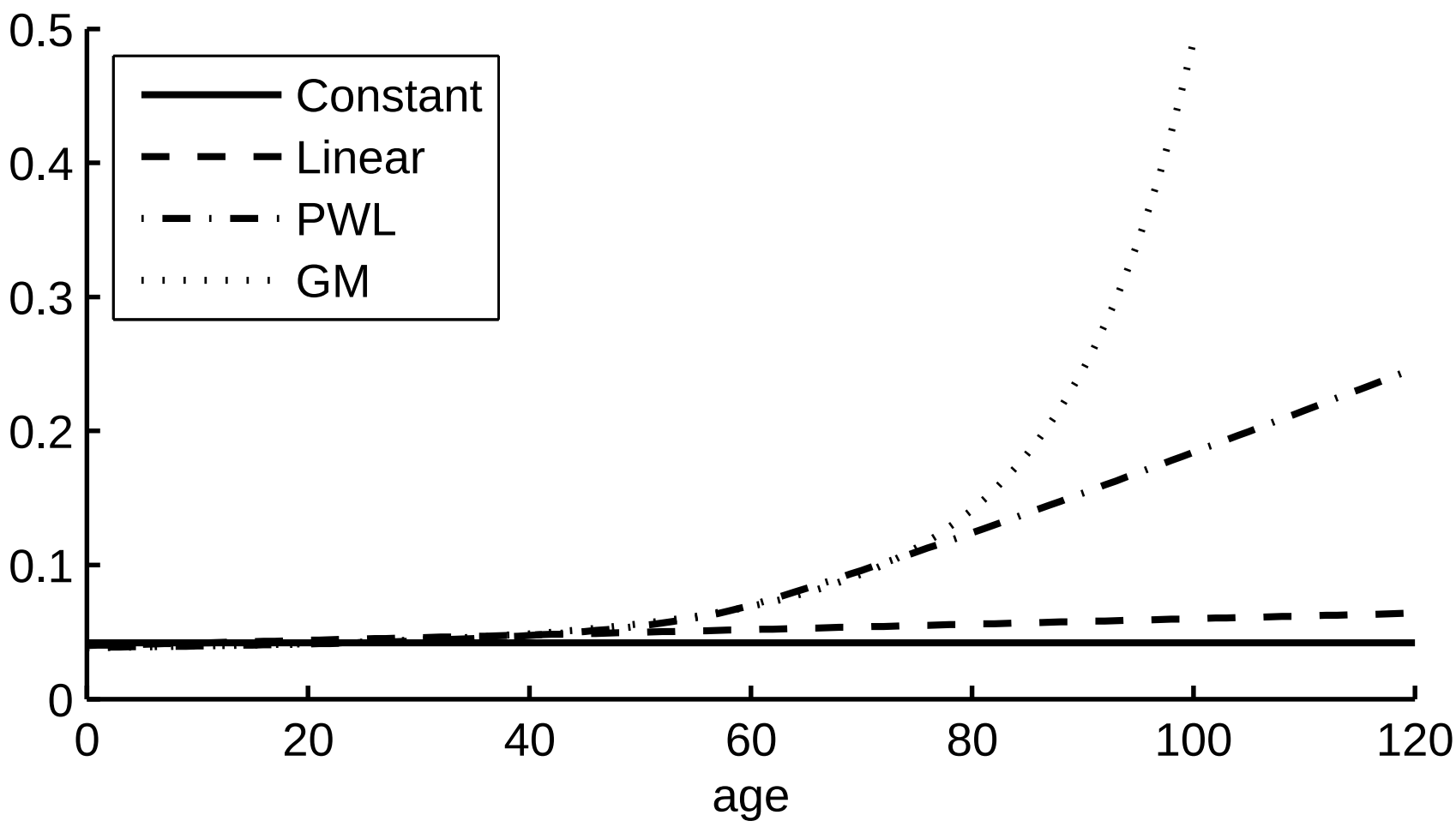


Figure 2: (a) Propensity to consume $(1/\Delta)$

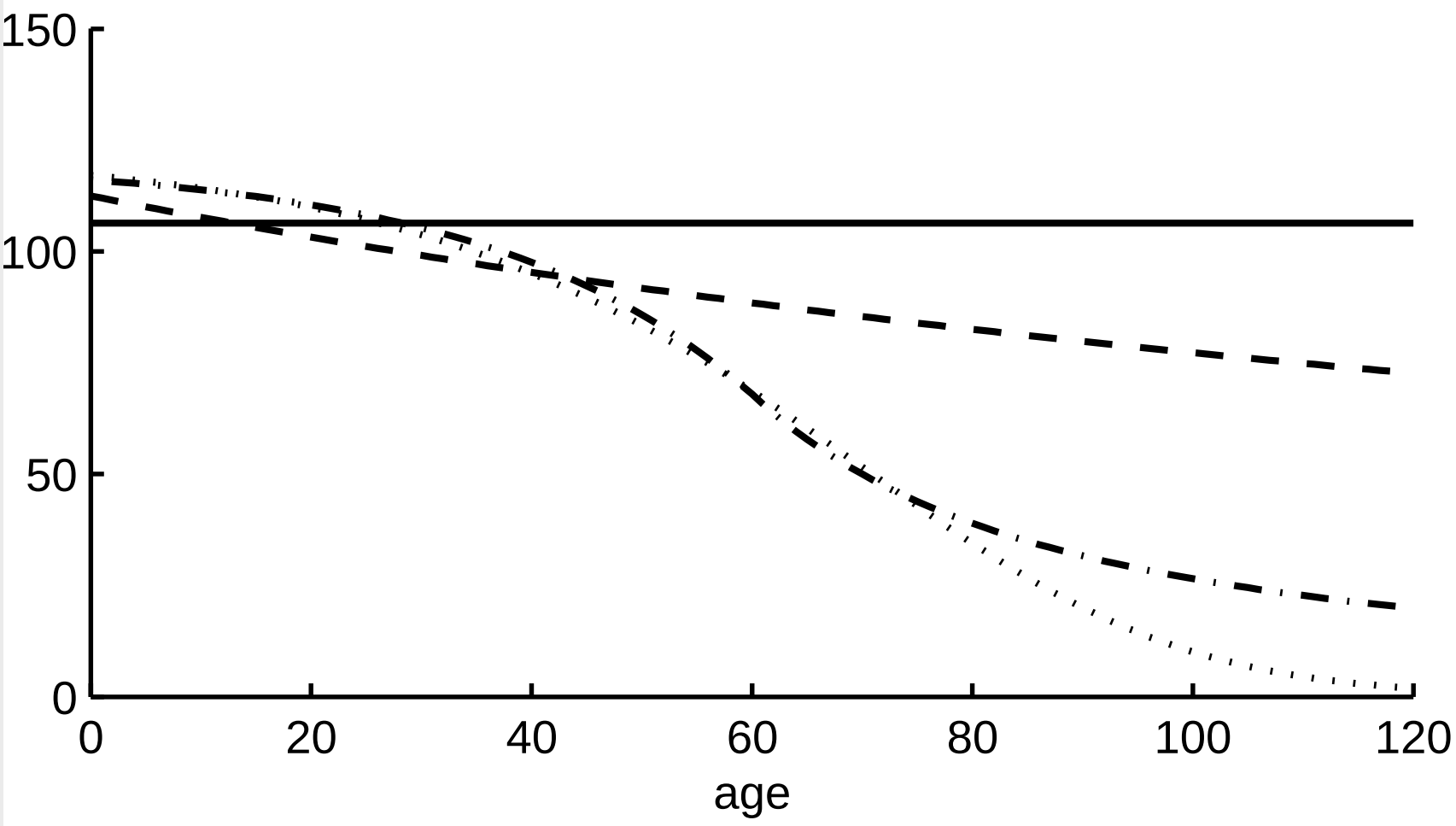


Figure 2: (b) Human wealth ($\hat{\bar{h}}$)

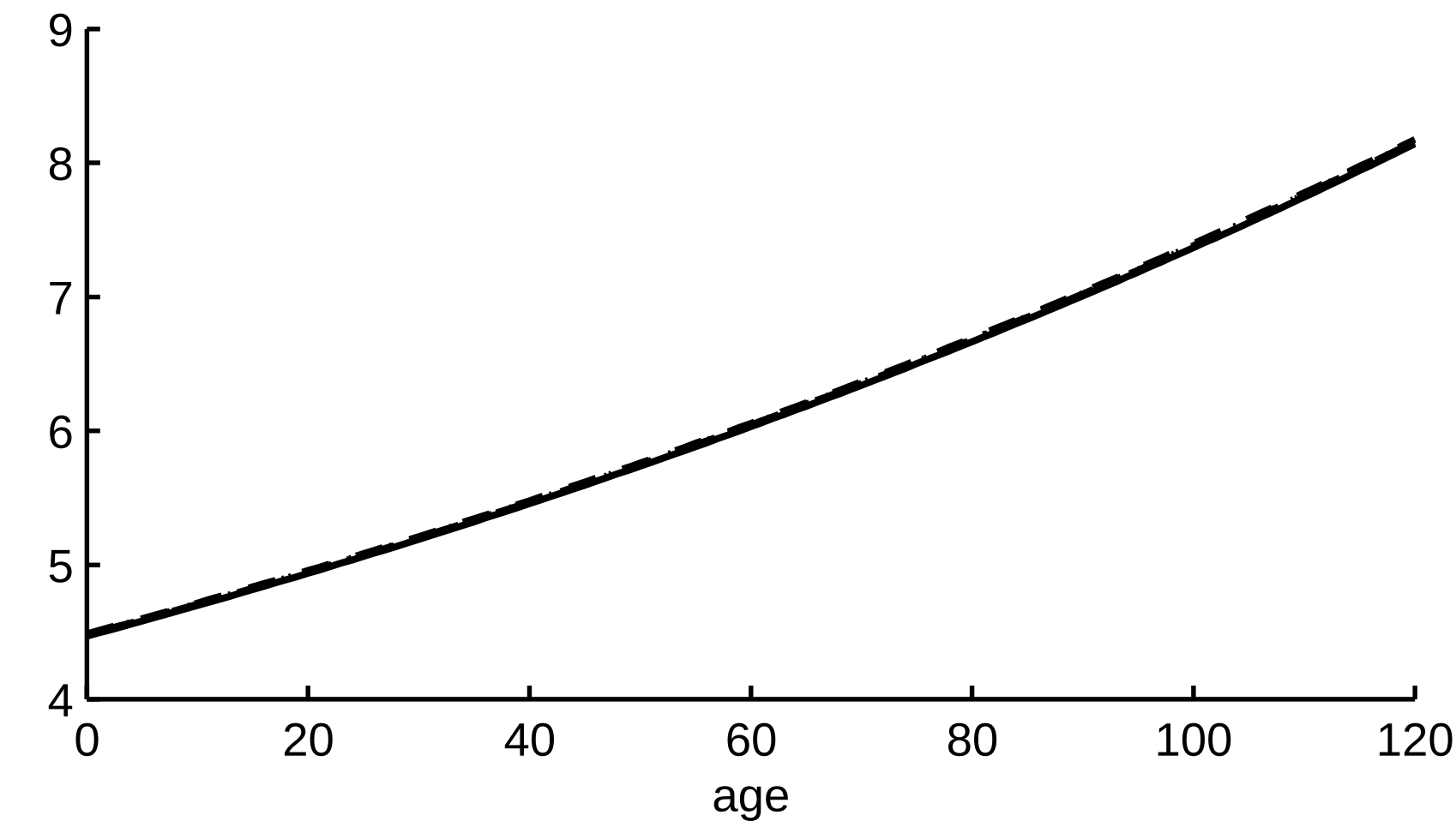


Figure 2: (c) Consumption ($\hat{\bar{c}}$)

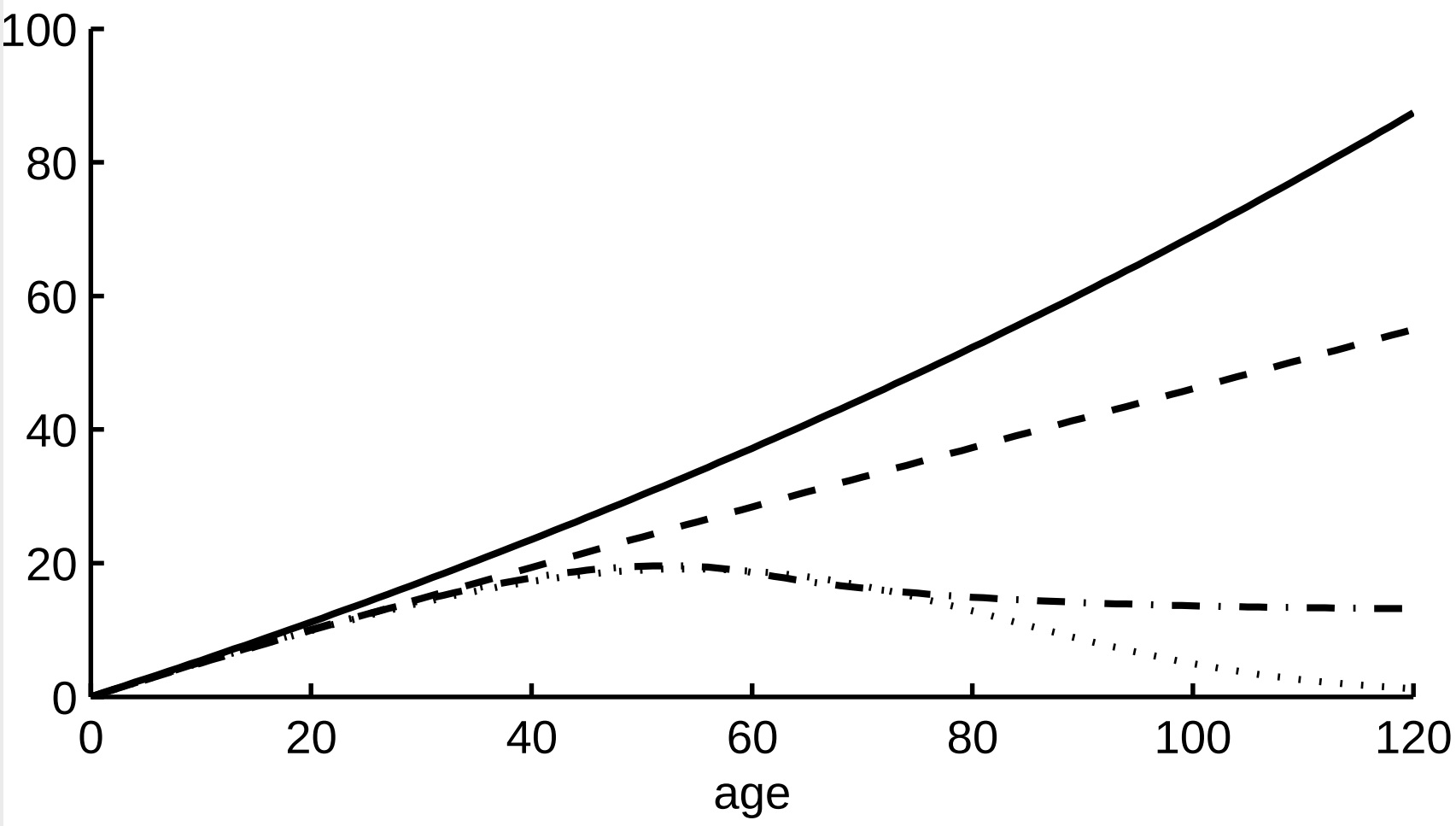
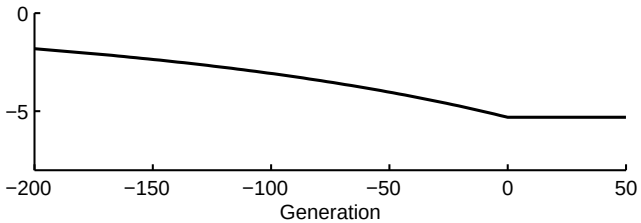


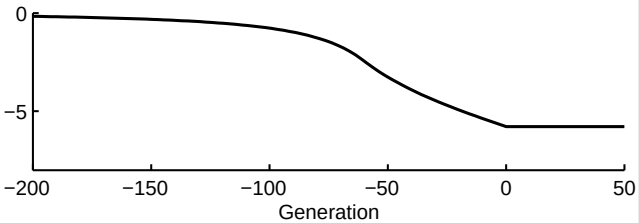
Figure 2: (d) Financial assets ($\hat{\bar{a}}$)

- Shocks studied:
  - balanced-budget fiscal policy
  - temporary tax cut
  - interest rate shock

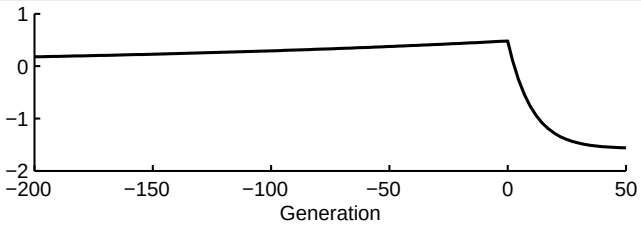
Balanced budget, constant



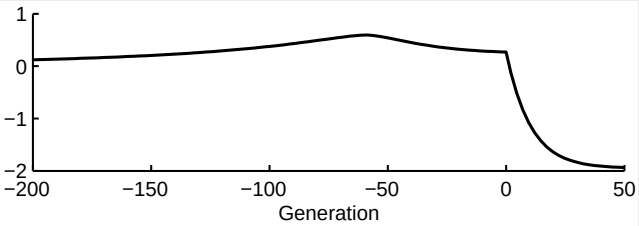
BB, piecewise linear



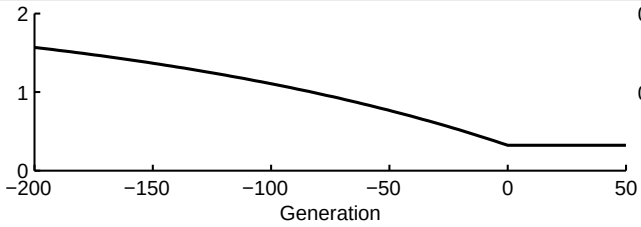
Temporary tax cut, constant



TT, piecewise linear



Interest rate, constant



IR, piecewise linear

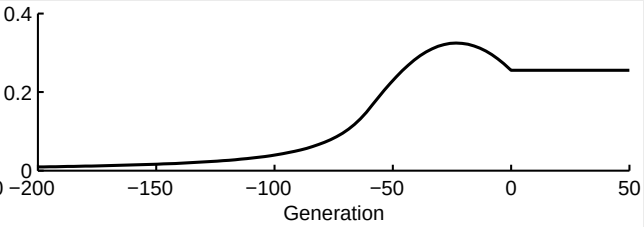
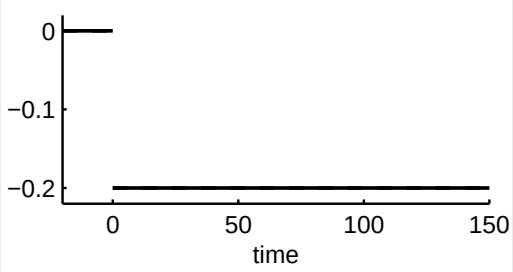
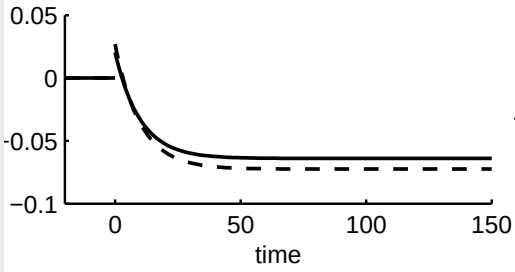


Figure 7: Welfare Effects

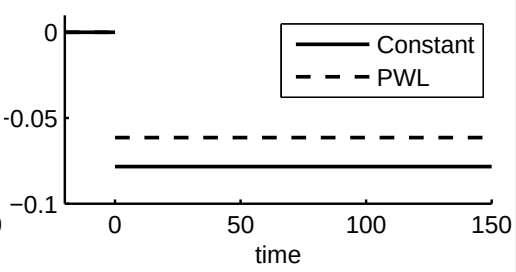
Human wealth, Balanced budget



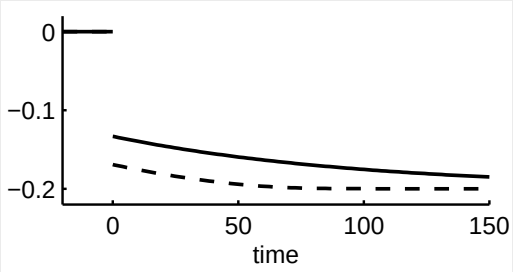
HW, Temporary tax cut



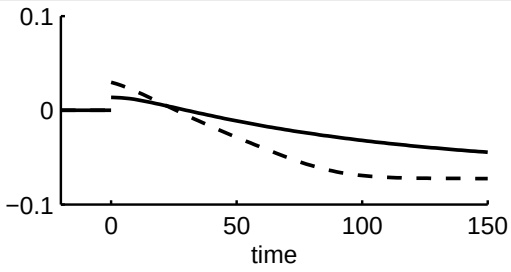
HW, Interest rate



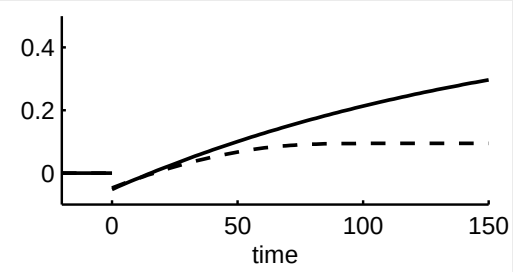
Consumption, Balanced budget



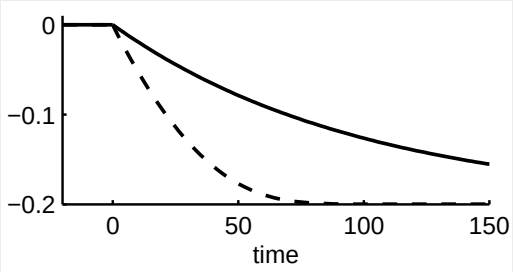
C, Temporary tax cut



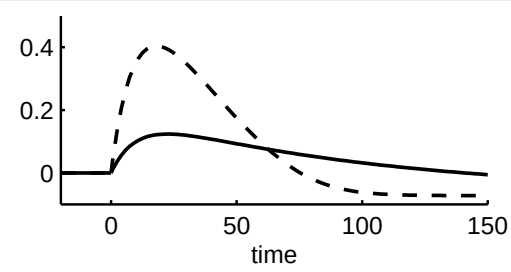
C, Interest rate



Financial assets, Balanced budget



FA, Temporary tax cut



FA, Interest rate

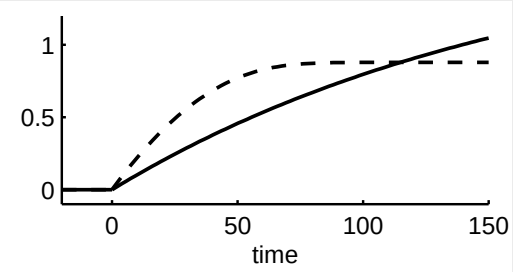


Figure 8: Relative Effect of the Shocks on Aggregate Variables

- Features to be added:
  - non-traded goods
  - PAYG pension system

Extension 2: Endogenous Retirement

Heijdra & Romp (2005b), “Life-cycle labour supply and pensions in the small open economy.” Work in progress, University of Groningen, May 2005.

- model as in H & R (2005a) but with endogenous labour supply decision
- wealth effect induces optimal retirement age
- PAYG system affects retirement decision
- Features to be added:
  - non-traded goods
  - realistically calibrated version of the model

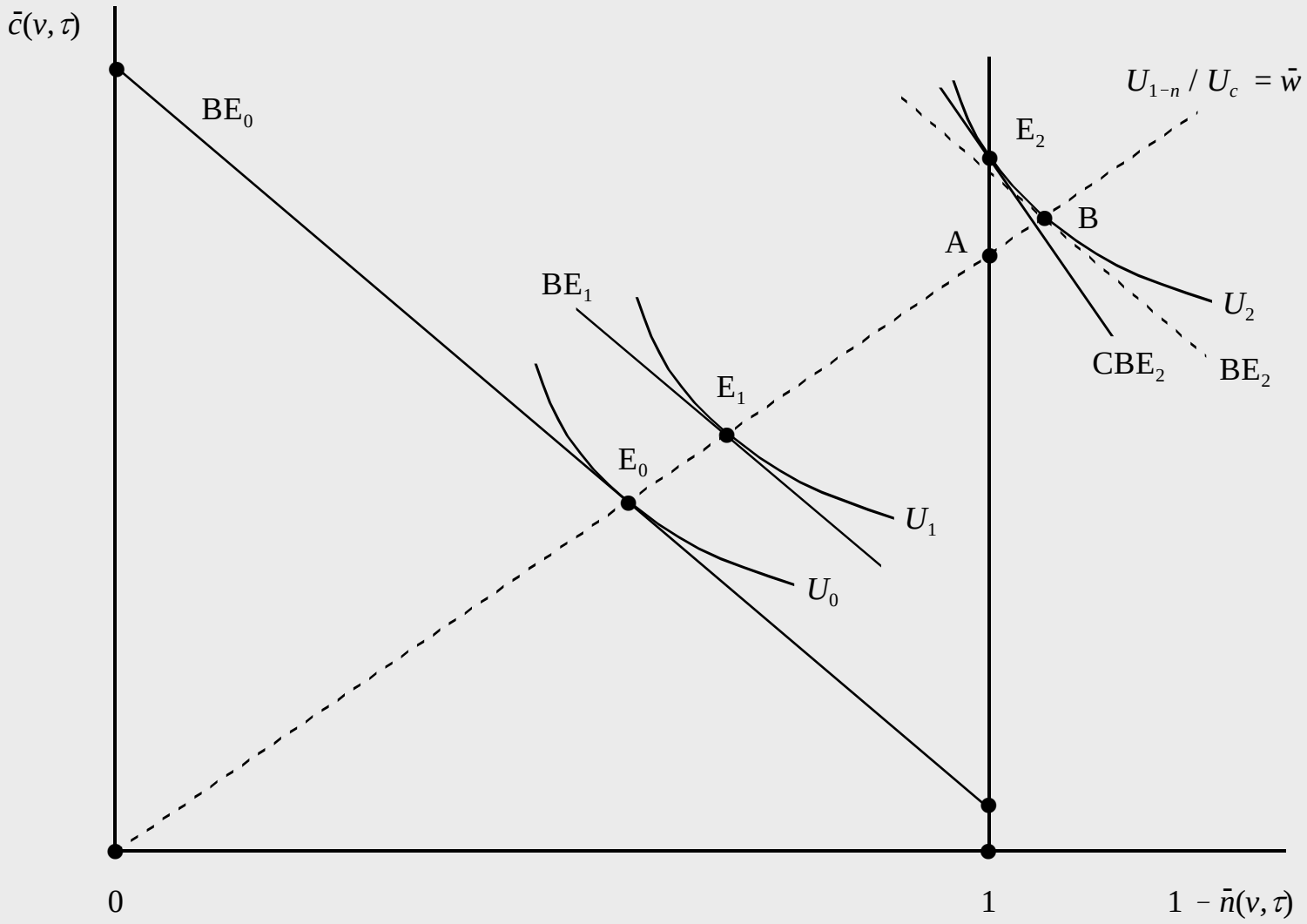


Figure 1: Consumption-Leisure Choice

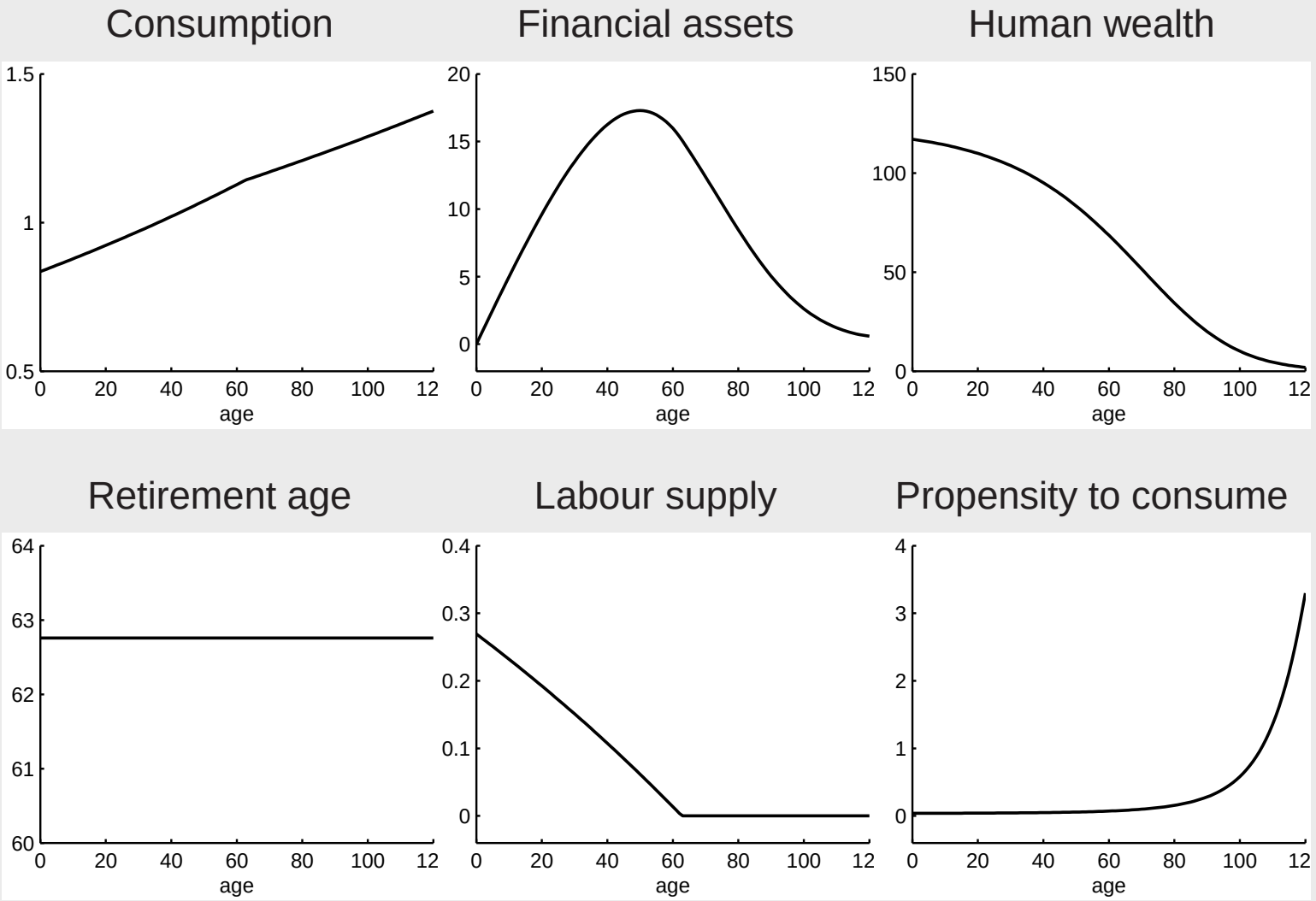


Figure 2: Life-Cycle Labour Supply Model

Extension 3: Endogenous Tradability

- so far: exogenous distinction between traded and non-traded goods
- recent literature uses transport costs and heterogeneous productivity to determine which range of goods is traded and which is non-traded
- key modeling approach by Dornbusch, Fischer, and Samuelson (*AER* 1977; *QJE* 1980).
- monopolistic competition

Concluding Remarks

- use small analytical models to study core mechanisms [that are often hidden in large "black-box" CGE models]
- special emphasis on the role of non-traded goods
- Blanchard-Yaari approach with realistic demography