Self-fulfilling Beliefs, Terms-of-Trade Dynamics, and Economic Welfare

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  - Drop in the level of GDP of 4.25% in advanced economies after severe recessions [Aikman et al., 22'].

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- Large shocks can cause equilibrium shifts in coordination games with incomplete information (Draghi's speech) [Morris & Yildiz, 19'].
- Models of endogenous growth and non-linearities [Cerra et al., 23']

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  - Japan 90s' [Obstfeld, 10'], Argentina 80s' [Dornbusch & De Pablo, 89'; Adler et al., 18'].

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  - Japan 90s' [Obstfeld, 10'], Argentina 80s' [Dornbusch & De Pablo, 89'; Adler et al., 18'].

- International business cycles literature uses dynamic models with a unique steady state [Backus et al.,92'].
  - Transitory (small) shocks have transitory effects.

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- I develop a two-country Overlapping Generations (OLG) model that displays multiple equilibria.
- I use Negishi's method to rewrite the problem in an easier way. [Not today]
- I show conditions for multiplicity of steady states.
- I simulate a large and transitory negative endowment shock and show:
  - It can cause a shift from one equilibrium to another in combination with self-fulfilling beliefs about future *ToT*.
  - Shifts of this kind have substantial and permanent welfare effects.

Contribution

1. Theoretical: OLG model with multiple equilibria in which transitory shocks generate permanent effects.
   - Derives multiplicity from general assumptions on preferences and endowments.
   - Explain a permanent deterioration in the *ToT* and depreciation in the *RER*.
   - Equilibrium shifts have substantial and permanent welfare effects.
2. Methodological: I apply Negishi's method to OLG economies.
   - Dimension reduction by solving social planning problem.
   - Dynamical system that depends on the number of countries rather than the number of goods.

Theoretical Framework

- OLG: Heterogeneous time preferences between countries $\rightarrow$ *global imbalances*.
- Multiple steady states are associated with different *ToT*.
- The model display globally indeterminate dynamics.
- Perfect foresight exercise: One-off unanticipated endowment shock.
- An equilibrium shift has permanent effects in consumption and welfare.
- Beliefs as an independent driver of economic outcomes:
  - E.g. role of public announcements in FX interventions [Fratzscher et al. 19'], Draghi's speech.

Related Literature

- Canonical OLG: Surveys in [Geanakoplos & Polemarchakis, 91'], [Weil, 08'].
- Social planning problem: [Negishi, 60'], [Kehoe & Levine, 85'], [Kehoe et al.,92'], [Beker & Espino, 11'], [Brumm & Kubler, 13'], [Bloise & Siconolfi, 22'].
- International business cycles: Representative agent: [Backus et al.,92'], [Mendoza, 02'], [Aguiar & Gopinath, 07'], [Garcia-Cico et al., 10'][Corsetti et al., 08'], [Bodenstein, 10', 11'], [Bianchi, 11'], [Schmitt-Grohe & Uribe, 21'], [Itskhoki & Mukhin, 21'].; OLG: *RER* fluctuations, monetary: [Platonov, 19'], [Bambi & Eugeni, 21']; Global imbalances: [Buiter, 81', Ghironi et al., 08'], [Eugeni, 15'], [Auclert et al., 21'].; Multiple steady states: [Krugman, 99'], [Chang & Velasco, 01'].
- Indeterminacy: Local: [Benhabib & Farmer, 94', 99']; Global: [Kaplan & Menzio, 16'], [Benhabib et al., 2018'], [Branch & Silva, 21'].

Roadmap

1. Introduction
2. Planner's Problem
   - Negishi's Method
3. Multiple Steady States
   - Global Dynamics in OLG
4. International Business Cycles
5. Experiments
6. Conclusions

Negishi's Method in a Nutshell

- Method to compute equilibria by solving a social planning problem.
- Social planner maximizes a social welfare function s.t. resource constraints.
- Allocations of the planner indexed by welfare weights: Pareto efficient.

Computation of Equilibrium

Planner's problem	Competitive equilibrium
Optimality conditions	Optimality conditions
Feasibility	Market clearing
Transfer function	Budget constraints

- Negishi: Define individual transfer functions that indicate the extent to which the planner's allocations violate the budget constraints.

Multiplicity in a Static Economy

- [Toda & Walsh, 17']: Two goods and two countries with isoelastic preferences,
  - Domestic country: $\dfrac{(1-\gamma)^{\sigma} x^{1-\sigma} + \gamma^{\sigma} y^{1-\sigma}}{1-\sigma}$
  - Foreign country: $\dfrac{\gamma^{\sigma} x^{*1-\sigma} + (1-\gamma)^{\sigma} y^{*1-\sigma}}{1-\sigma}$
  - $(1-\gamma)$: Utility weight, $1/\sigma$: Elasticity of substitution
- Endowments are symmetric, fixed, and normalized to unity:
  - Domestic country: $e = (1-\varepsilon,\ \varepsilon)$
  - Foreign country: $e^{*} = (\varepsilon,\ 1-\varepsilon)$

Multiplicity in a Static Economy

- Symmetry $\rightarrow \alpha = \alpha^*$ is an equilibrium welfare weight. Then $q = \frac{\alpha^*}{\alpha} = 1$ and $p = 1$ in the competitive equilibrium.

- Let $\mathcal{T}(q)$ be the transfer function of the domestic country.

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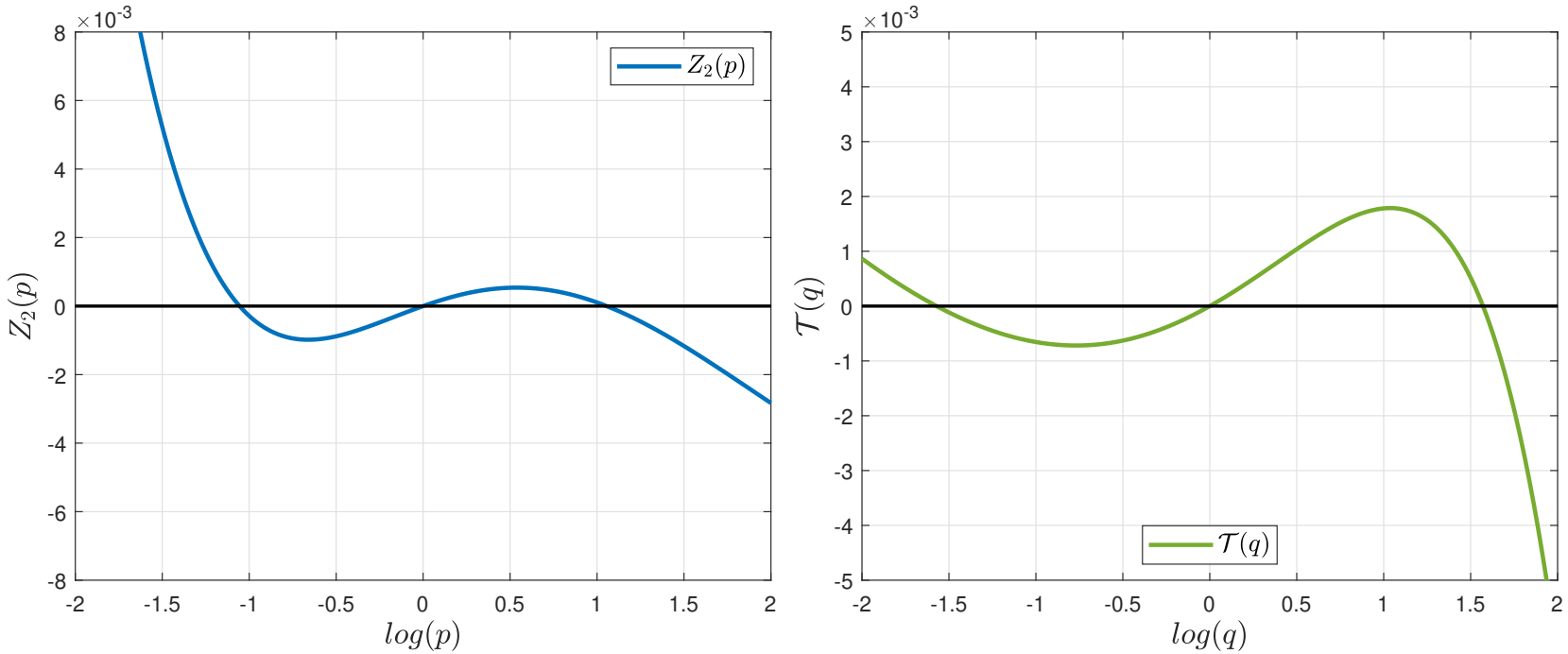
- Symmetry $\rightarrow \alpha = \alpha^*$ is an equilibrium welfare weight. Then $q = \frac{\alpha^*}{\alpha} = 1$ and $p = 1$ in the competitive equilibrium.
- Let $\mathcal{T}(q)$ be the transfer function of the domestic country.
- $\left.\frac{\partial \mathcal{T}(q)}{\partial q}\right|_{q=1} > 0$ implies:

$$\frac{1}{\sigma} < 1 - \frac{1}{2}\left(\frac{\varepsilon}{\gamma} + \frac{1-\varepsilon}{1-\gamma}\right)$$

where $0 < \gamma < 1$, $0 < \varepsilon < 1$ and $\frac{1}{\sigma}$ is the elasticity of substitution between good x and y.

Figure 1: Two approaches for multiplicity



(a) Excess demand good y (b) Transfer function domestic country

Note: $Z(q)$: Aggregate excess demand for good y with relative price p. $\mathcal{T}(q)$: Transfer function to the domestic country with relative welfare weight q.

Multiple Steady States in OLG

- Time indexed by $t = \{1, 2, ..., \infty\}$.
- Two countries and two goods each period. Exchange economy.
- Foreign country denoted by star superscript $(^*)$.
- Identical generations, two periods life (WLOG, [Balasko et al., 80']).
- Time separable preferences and constant discount factor (β, β^*).
- Each consumer faces a single budget constraint.
- No storage, no fiat money, no trade frictions, no externalities.
- Dynamically efficient.

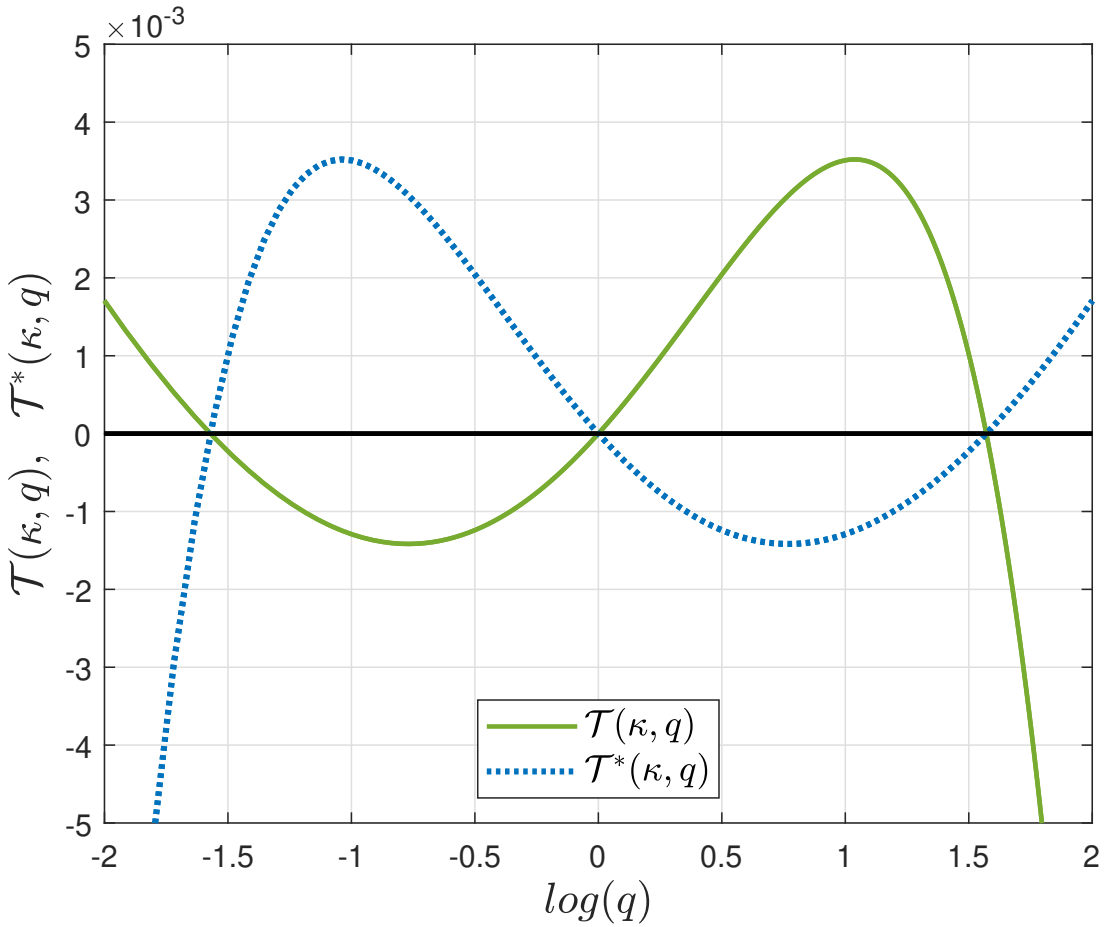
Multiple Steady States in OLG

- Consider an extension of the static case to an OLG economy.
- Assume equal time preferences between countries $\rightarrow \beta = \beta^*$.
- Assume the parameters satisfy the multiplicity condition in the static economy.
- Given endowments, the steady state transfer functions

$$\mathcal{T}\left(\kappa, \kappa, \kappa, \kappa, q, e_y, e_o\right) = 0$$
$$\mathcal{T}^*\left(\kappa, \kappa, \kappa, \kappa, q, e_y^*, e_o^*\right) = 0$$

have three solutions in (κ, q).

Figure 2: Transfer Functions in Steady State under $\beta = \beta^*$

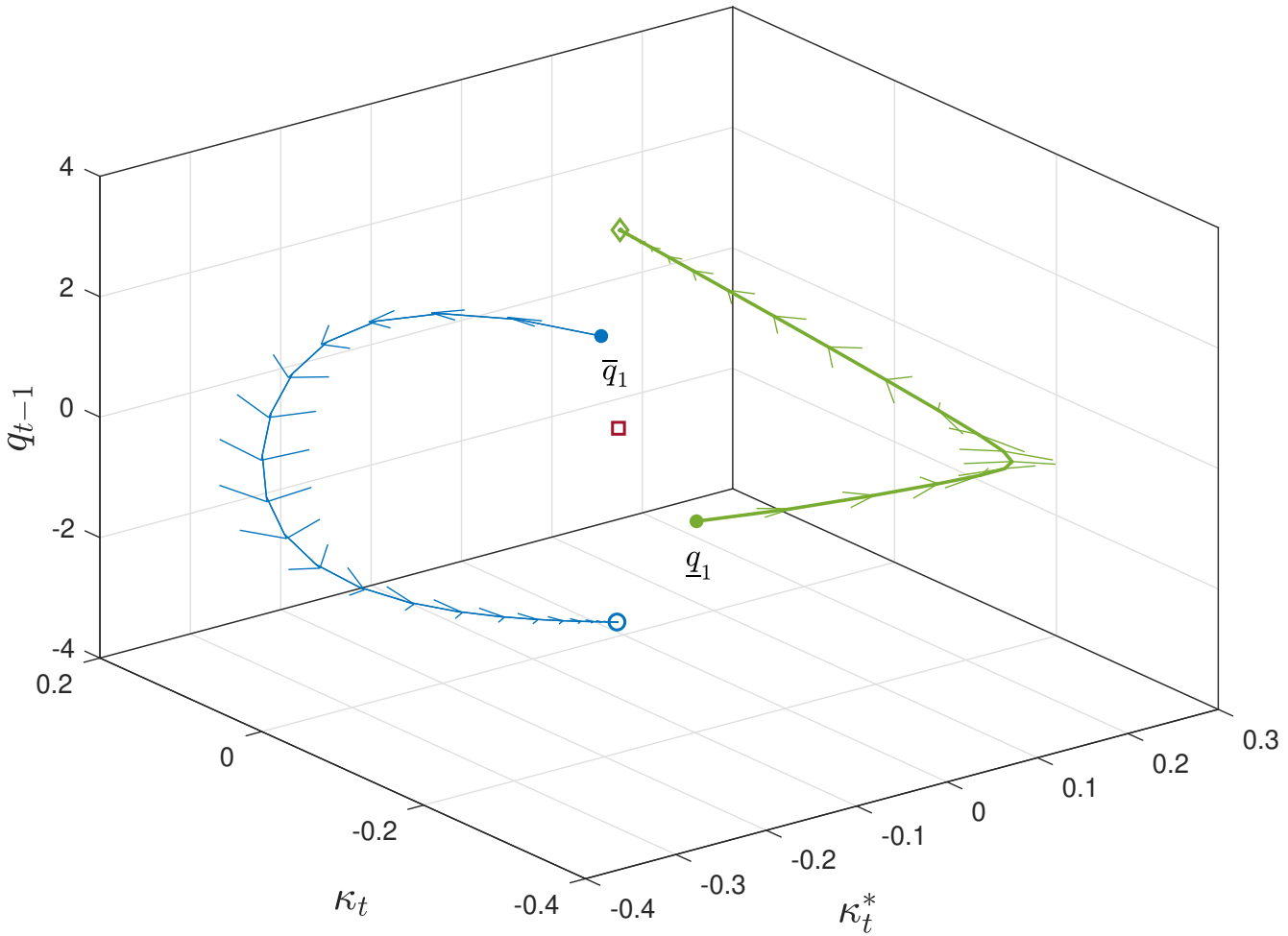


The figure shows the transfer functions, $\mathcal{T}(\kappa, \kappa, \kappa, \kappa, q)$ and $\mathcal{T}^*(\kappa, \kappa, \kappa, \kappa, q)$ against different values of the logarithm of q when $\kappa = \beta = \beta^*$.

Global Dynamics in OLG

- Two locally determinate (saddle-path) steady states: "lower" and "upper".
- One dynamically unstable steady state: "middle".
- Region of global indeterminacy: Isolated equilibrium paths converging to different steady states $\rightarrow$ beliefs are self-fulfilling.

Figure 3: Solutions of the Dynamical System under $\beta = \beta^*$



The figure shows the solutions of the dynamical system $F(V_t, V_{t+1})$ under multiplicity. The arrows in each manifold represent the direction of the endogenous variables in three dimensions. Values are in logarithms.

International Business Cycles

- Consider now an OLG where $\beta \neq \beta^*$.
- Define the Lagrange multipliers of the planner as λ_t and ϕ_t. Then,

$$ToT: \ p_t = \frac{\phi_t}{\lambda_t} = \left(\frac{\gamma}{(1-\gamma)}\frac{x_t^t}{y_t^t}\right)^{\sigma}$$

$$CA_t = \left(e_t^t - x_t^t + e_t^{t-1} - x_t^{t-1}\right) + p_t\left(w_t^t - y_t^t + w_t^{t-1} - y_t^{t-1}\right)$$

$$RER: \ \xi_t = \frac{P_t^*(p_t)}{P_t(p_t)} = \frac{\left((1-\gamma)(p_t)^{\frac{\sigma-1}{\sigma}} + \gamma\right)^{\frac{\sigma}{\sigma-1}}}{\left((1-\gamma) + \gamma(p_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}}$$

- Where $P_t(p_t)$ and $P_t^*(p_t)$ are domestic and foreign price indexes.
- All functions of welfare weights.

Calibration

- Recall the condition for multiplicity,

$$\frac{1}{\sigma} < 1 - \frac{1}{2}\left(\frac{\varepsilon}{\gamma} + \frac{1-\varepsilon}{1-\gamma}\right)$$

- Fix ε and γ, then compute $1/\sigma$.

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Table 1: Calibration for Multiple Steady States and Global Imbalances

Parameter	Value
Home bias in consumption	$(1-\gamma) = 0.83$
Elasticity of substitution between traded goods	$1/\sigma = 0.37$
Intertemporal elasticity of substitution	$1/\sigma = 0.37$
Endowment distribution	$\varepsilon = 0.01$
Domestic discount factor	$\beta = 0.83$
Foreign discount factor	$\beta^* = 0.87$

Some Evidence on Parameter values

- Home Bias in Consumption: Relative consensus.
  - Can be reinforced through preferences, trade costs, and non-tradable goods: [McCallum, 95']; [Obstfeld & Rogoff, 01'].
  - Standard calibrations for $(1-\gamma)$:

    [Itskhoki & Mukhin, 20']: 0.93;
    [Bodenstein, 11']: [0.72-0.94];
    [Eichenbaum et al. 20']: 0.875.

Some Evidence on Parameter Values

- Trade elasticity of substitution: Wide range of estimates for $1/\sigma$.
  - U.S aggregate data: [Whalley, 84']: 1.5; [Hooper et al. 98']: 0.6; [Taylor, 93']: 0.22.
  - Standard calibration is 1.5 ([Backus et al. 95']; [Chari et al. 02']; [Itskhoki & Mukhin, 20']).
  - Better performance in IBC models when $1/\sigma < 1/2$: [Heathcote & Perri, 02']; [Benigno & Thoenissen, 08']; [Collard & Dellas, 07'].
  - Bayesian DSGE estimation: [Rabanal & Tuesta, 10']: [0.01-0.91]; [Lubik & Schorfheide, 06']: 0.4.
- [Corsetti et al., 08']: Distribution costs in terms on non-traded goods allow for multiplicity for $1/\sigma \approx 1$.

Steady States

Table 2: Steady State Values under Multiplicity

Variable	Lower	Middle	Upper
Domestic Current Account (CA)	0.03	0.05	0.07
Real Exchange Rate (ξ)	0.60	0.90	1.84
Terms of Trade (p)	0.45	0.85	2.56
Domestic Welfare Weights growth (κ)	0.85	0.85	0.86
Foreign Welfare Weights growth (κ^*)	0.85	0.85	0.86
Relative Welfare Weight (q)	0.29	0.77	4.17
Domestic Welfare ($\mathcal{U}_{\mathcal{W}}$)	0.40	0.35	0.22
Foreign Welfare ($\mathcal{U}^*_{\mathcal{W}}$)	0.24	0.32	0.41

Note: The table shows the steady state values of each variable under multiplicity. Steady states are defined as lower, middle, and upper depending on the value of the relative welfare weight (q). Welfare is computed as the lifetime indirect utility function in the steady state and expressed in the table using an exponential function.

Steady States

- κ^* and κ are equal in each steady state.
- In the middle steady state, $q \neq 1$.
- $CA \neq 0$ but quantitatively small.
- ToT deteriorates from the lower to the upper steady state, while RER depreciates.
- Substantial welfare differences between the lower and the upper steady state.

Experiment

Steady states transition

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  - The economy starts in the lower steady state.

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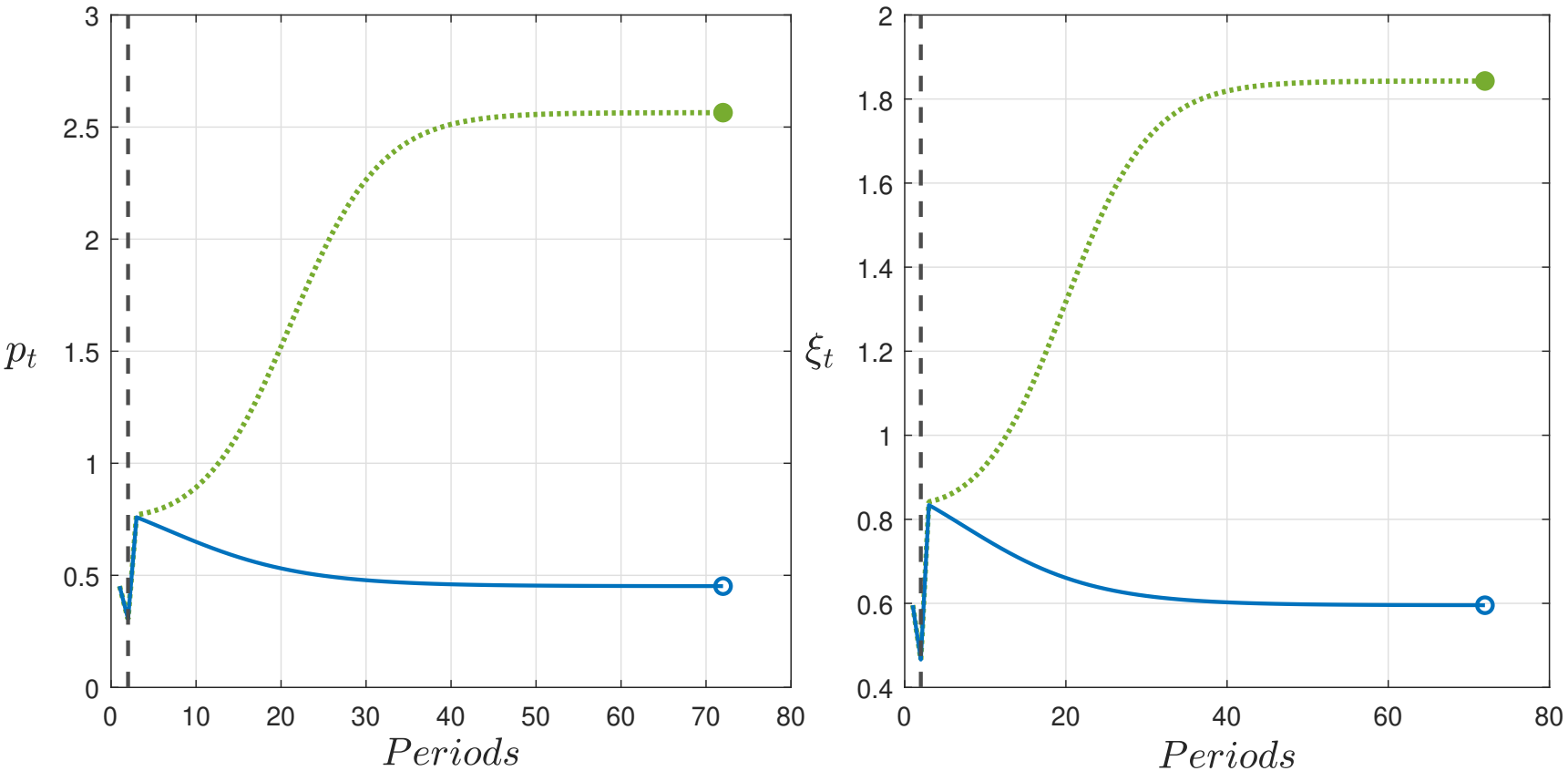
  - If the economy transitions to the upper steady state $\rightarrow$ Permanent effect.
  - If the economy transitions to the lower steady state $\rightarrow$ Transitory effect.

Experiment 1

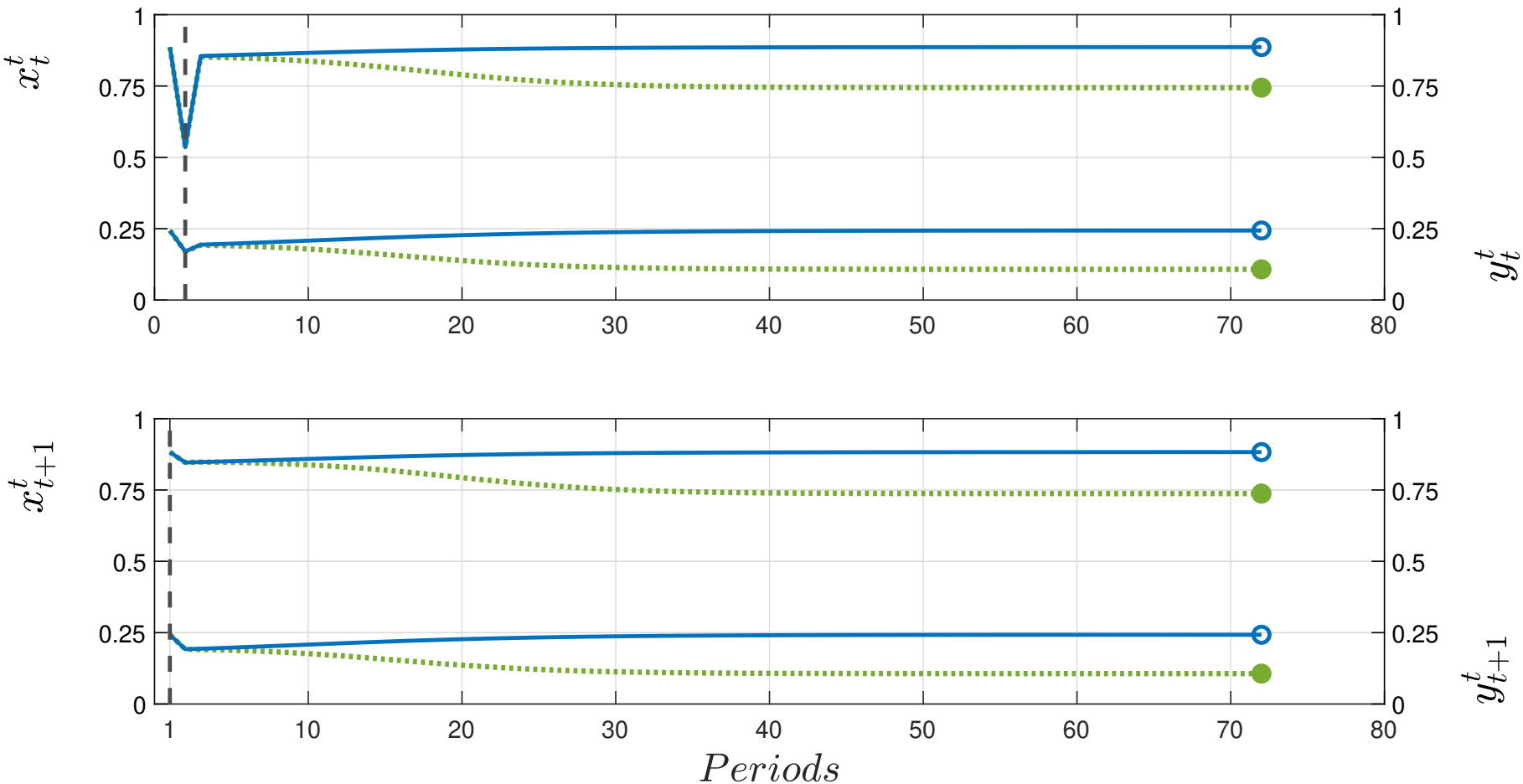
Figure 4: Terms of Trade and Real Exchange Rate



Note: The left panel plots the terms of trade, p_t, and the right panel the real exchange rate, ξ_t.

Experiment 1

Figure 5: Domestic Consumption



Conclusions

- Theoretical model in which large and transitory shocks can generate permanent effects on economic welfare in combination with self-fulfilling beliefs.
- Explanation for large and persistent fluctuations in the *ToT* and the *RER* based on equilibrium shifts.
- I develop an application of Negishi's method to an OLG exchange economy.
- Beliefs as an independent driver of macroeconomic outcomes.