(1942-2017)

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Ageing Population and Implications for Monetary Policy

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Age-dependency ratio and aging society

- Age-dependency ratio is a ratio of population in the labor force for to those not in thereof.
    - (model) it is the ratio of retired to working agents.
    - (interpretation) If its value is 60%, then there are 60 retirees for every 100 workers, on average.

- Aging societies are ones with high age-dependency ratio.

Literature Review

Kantur (2013): birth rate

- Developed two-period OLG and NK model.
- As people age, monetary policy will be less effective because retired agents only consumes and are not much responsive to interest rate.

Wong (2015): working population

- Used mortgages data, and developed life-cycle model
- Young people are more responsive to interest rate shock

Acemoglu (2017): longer retirement period (suggestion)

- Used global empirical data and run OLS regression
- Age-dependency ratio is positively correlated with economic growth

Probable causes for these non-consensual results

- Age-dependency ratio rises as
  - average working time decreases, (Wong)
  - fertility rate decreases, (Kantur)
  - average retirement period increases. (Acemoglu)

My model

- Incorporates working time, fertility rate, and retirement period.
- Overlapping Generation and New Keynesian model.
- Population in each generation is explained by life-cycle model.

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Parameters and Preview of Results

Parameters (demographic)

α working period

ω birth rate

γ retirement period

Dependent variable

φ age-dependency ratio

r reproductive to working agent ratio

$$\pi_t = \frac{\alpha\beta}{\alpha + r} E_t[\pi_{t+1}] + \frac{1-(\alpha+r)\theta}{(\alpha+r)\theta}(1-\alpha\beta\theta)\frac{1-g}{1-g+g\epsilon}\frac{4\sigma(1-g)+3\psi+3g}{3(1-g)}\tilde{y}_t$$

$$\tilde{y}_t = \frac{C^*}{1+\varphi^*}\tilde{C}_t + \frac{G^*\varphi^*}{1+\varphi^*}\tilde{G}_t + \left(\frac{\varphi^*(G^*-Y^*)}{1+\varphi^*}\right)\tilde{\varphi}_t$$

Demography: Life-cycle model (person)

States of life

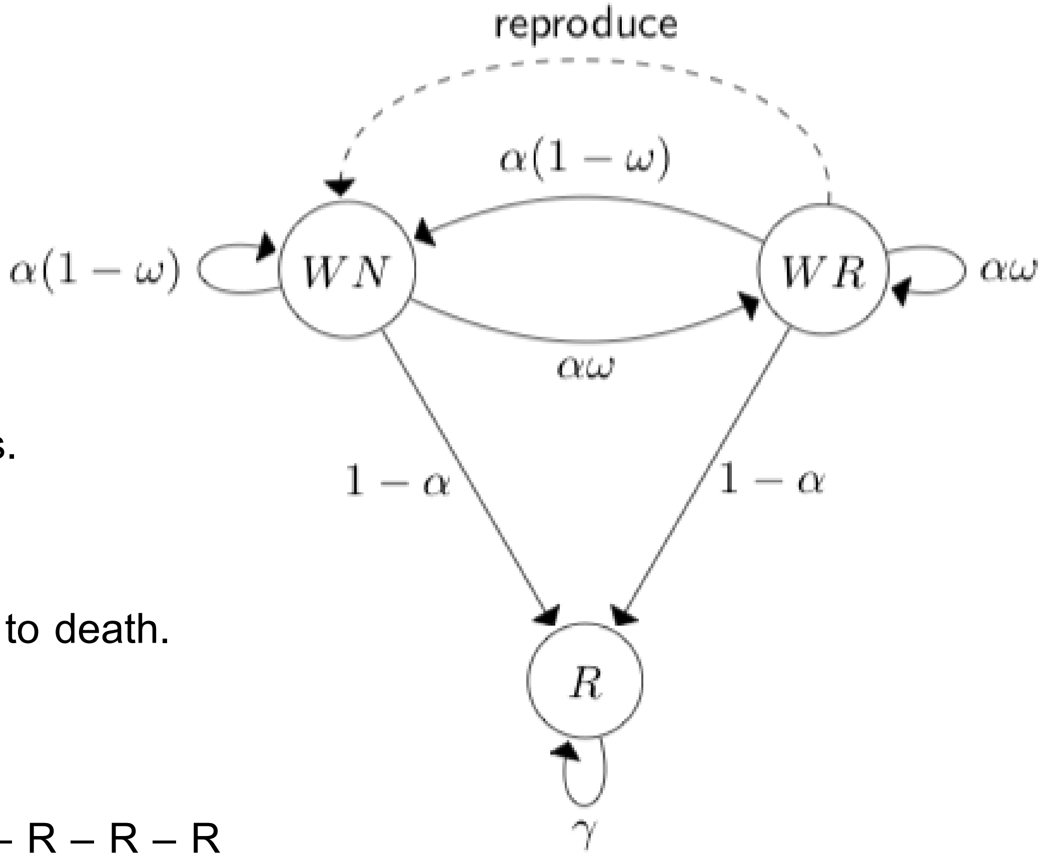
1. Worker (Normal).
2. Worker (Reproductive).
3. Retiree.

Assumptions

1. All newborns are workers.
2. Only workers are fertile.
3. Only retirees are subject to death.

Example of a life path

WN – WN – WR – WN – WR – R – R – R



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Demography: Life-cycle model (society)

Law of motions

$$WN_{t+1} = \alpha(1-\omega)WN_t + \alpha(1-\omega)WR_t + WR_t$$
$$WR_{t+1} = \alpha\omega WN_t + \alpha\omega WR_t$$
$$RT_{t+1} = (1-\alpha)WN_t + (1-\alpha)WR_t + \gamma RT_t$$

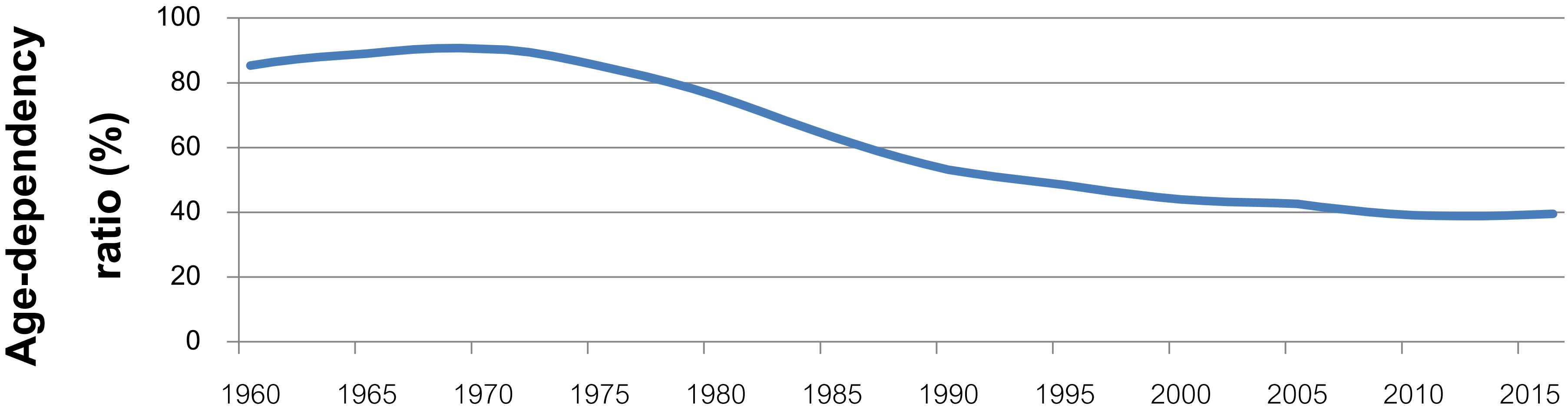
Motions of age-dependency ratio

$$r_t = \frac{WR_t}{WN_t + WR_t} \qquad r_{t+1} = \frac{\alpha\omega}{\alpha + r_t}$$

$$\varphi_t = \frac{R_t}{WN_t + WR_t} \qquad \varphi_{t+1} = \frac{(1-\alpha) + \gamma\varphi_t}{\alpha + r_t}$$

Stylized Fact

- Age-dependency ratio converges. In Thailand, it is about 39-40%.



- Model

α	ω	γ	Expected working	Expected # kids	Expected retired	A-D ratio
$\frac{43}{44}$	$\frac{9}{215}$	$\frac{24}{25}$	45	1.8	25	39.54%

Basic New Keynesian Model

- Dynamic, stochastic, general equilibrium modeling.
  - Today's actions affect future environments. Hence, every agent behaves accordingly.
- Monopolistic Competition
  - Prices are adjustable. Firms set prices to maximize profit.
- Price rigidities (follow Calvo(1993))
  - Only a fraction of firms is able to readjust their prices in each period.
- Non-neutrality of monetary policy
  - Short-term change in interest rate is not matched by one-for-one change in expected inflation.

Economy: Household

Household

- **Worker (consume, labor)**
  - maximizes expected lifetime utility, considering that they will retire.
  - owns a firm and provides labor to the other firms
- **Retiree (consume)**
  - maximizes expected retirement-time utility.
  - does <u>not</u> provide labor
- **Common economic activity among workers and retirees**
  - Bond purchase
  - Bequest

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Utility Maximization problems for household

- Worker's
  - Maximize the expected lifetime utility by choosing optimal C_k, N_k, D_k

$$\left[\sum_{k=0}^{\infty}\alpha^k\beta^k E_0\left(\frac{C_k^{1-\sigma}}{1-\sigma}-\frac{N_k^{1+\psi}}{1+\psi}\right)\right]+\left[\sum_{k=1}^{\infty}\sum_{j=0}^{k-1}\alpha^j(1-\alpha)\gamma^{k-1-j}\beta^k E_0\left(\frac{D_k^{1-\sigma}}{1-\sigma}\right)\right]$$

  - This is subject to potential/possible period budget constraints

$$\int_0^{\Phi_t} P_t(j)C_t(j)dj + Q_tB_t = B_{t-1} + W_tN_t + AW_t$$

$$\int_0^{\Phi_t} P_t(j)D_t(j)dj + Q_tB_t = B_{t-1}$$

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Utility Maximization problems for household

- Retiree's
  - Maximize the expected retired time utility by choosing optimal G_k

$$\sum_{k=0}^{\infty} \beta^k \gamma^k E_0 \left(\frac{G_k^{1-\sigma}}{1-\sigma} \right)$$

  - This is subject to period budget constraints.

$$\int_0^{\Phi_t} P_t(j) G_t(j) dj + Q_t B_t = B_{t-1}$$

Main results

1. Steady state values
2. Impulse response function

1. Equilibrium Interest Rate r*

Source	Work	Child	Retired	A-D ratio	r*	Change
Baseline	45	1.8	25	0.3954	0.339	-
Working	31.293	1.226	25	0.7	0.367	Rise
Fertility	45	0.664	25		0.374	Rise
Retired	45	1.8	66.713		0.329	Drop

Warning! The result should be interpreted *qualitatively*.

Intuition for the change in r* (in the model)

- **Decrease in working period and birth rate (r* rises)**

Source	Work	Child	Retired	A-D ratio	r*	Change
Baseline	45	1.8	25	0.3954	0.339	-
Working	31.293	1.226	25	0.7	0.367	Rise
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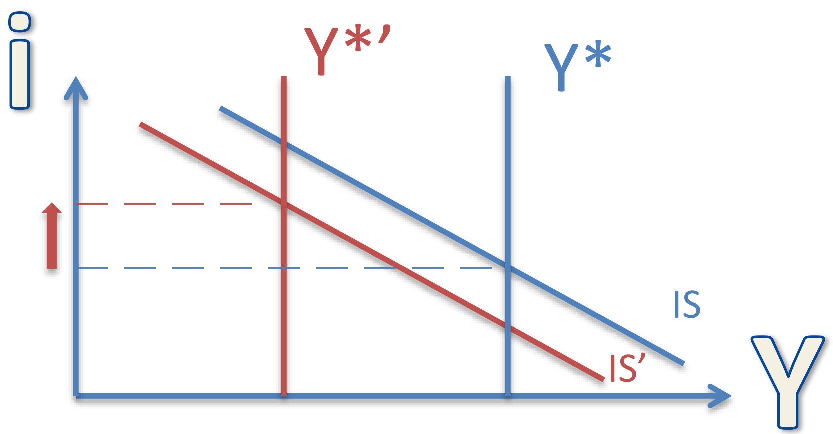
Less labor

-> Less output

-> Less income

-> Less consumption



Intuition for the change in r* (in the model) (2)

- **Increase in retirement period (r* drops)**

Source	Work	Child	Retired	A-D ratio	r*	Change
Baseline	45	1.8	25	0.3954	0.339	-
Retired	45	1.8	66.713	0.7	0.329	Drop

Workers save more to smooth their consumption

2. Monetary Policy Shock (Contractionary policy)

Baseline: age-dependency ratio = 39.54%

Alternative: age-dependency ratio = 70%

1. Decrease in working period
2. Decrease in birth rate
3. Increase in retirement period

Cumulative shock size: 100 basis points

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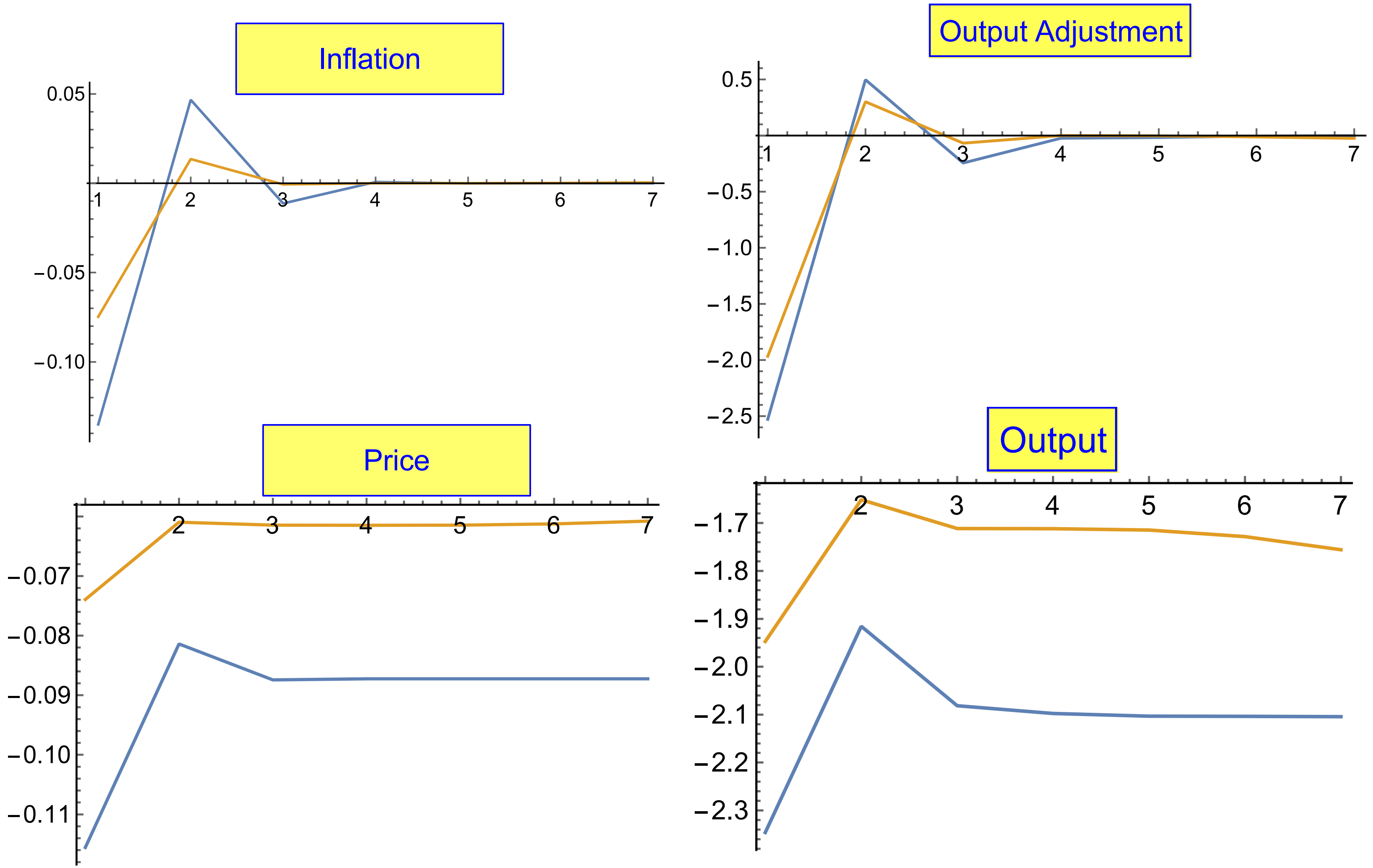
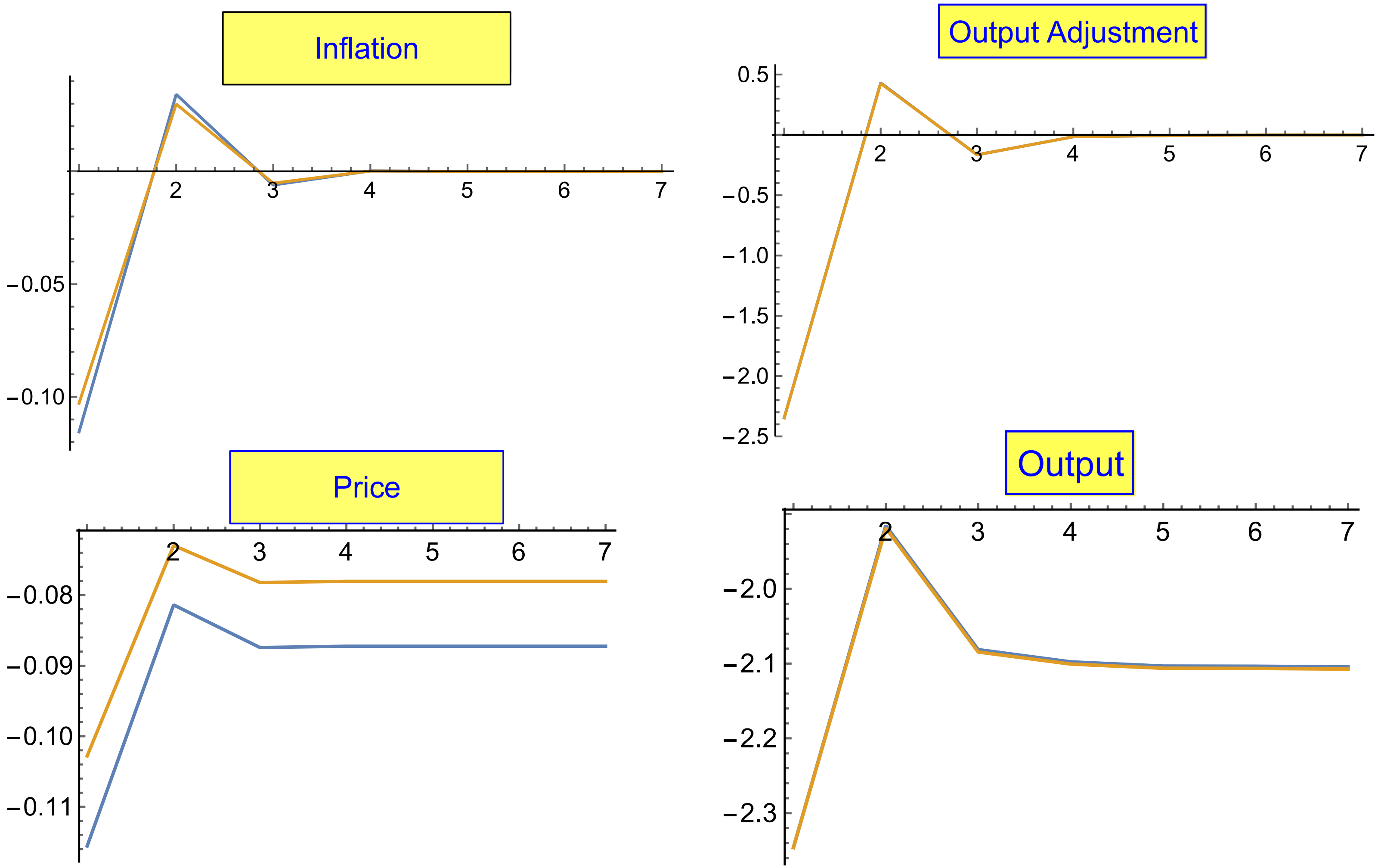
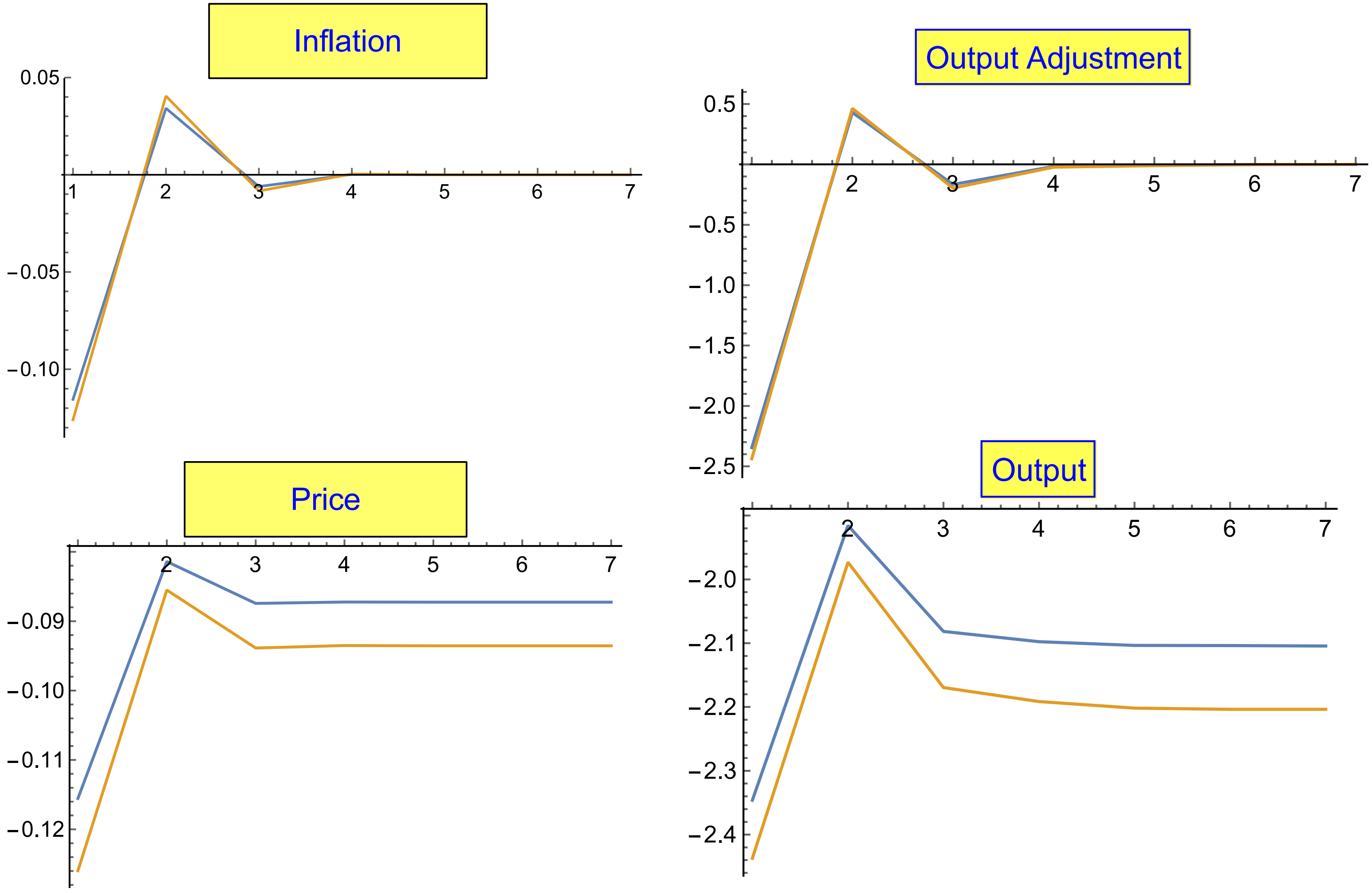
Decrease in working time (blue=baseline, orange=alternative)



Decrease in birth rate (blue=baseline, orange=alternative)



Increase in retirement time (blue=baseline, orange=alternative)



Summary of results

The effect of population aging differs according to its source.

Source	r*	Responsiveness in the Inflation Dynamics	Effectiveness of monetary policy
Working time	Rise	Less	Less
Birth rate	Rise	None	Less*
Retirement time	Drop	More*	More*

* Indicates that it is not much

This explains why Wong, Kantur, and Acemoglu arrived at different conclusions.

Policy implications

To boost interest sensitivity, structural policies are required

- **Increase working time and decrease retirement period**
  - Increase retirement age
    - 65 years
  - Create more jobs for the elderly
    - Japan's case

Caveats and further research

- Model
  - Constant probabilities of working, being reproductive, and remain retired.
  - Newborns are not calculated in the age-dependency ratio.
  - Equilibrium determinancy
- Further research
  - Asset bubbles (Gali)
  - Money transaction mechanism
  - Government’s intervention
  - (Thailand’s) potential source of population aging