Facing Demographic Challenges:
Pension Cuts or Tax Hikes

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Osaka University - April 2015

Demographic shift and population ageing

- Demographic transition:
  - decreased birth rate i.e. high to low fertility
  - decreased death rate or longer life expectancy
- Population ageing: later stage of demographic transition
- The increase in the number and proportion of older people in society

Demographic shift: Lower fertility rate

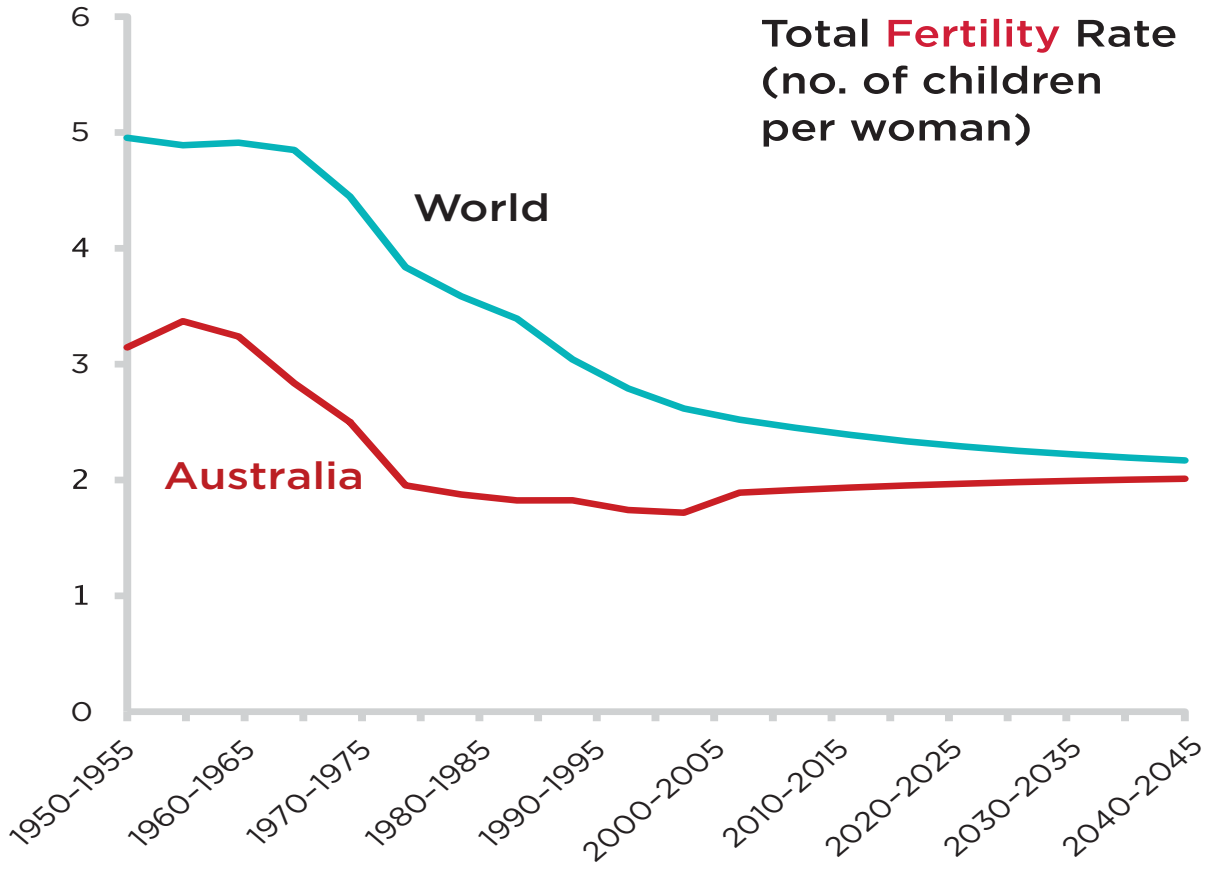


Figure 2: Decrease in Fertility Rate, CEPAR (2012)

Demographic shift: Higher life expectancy

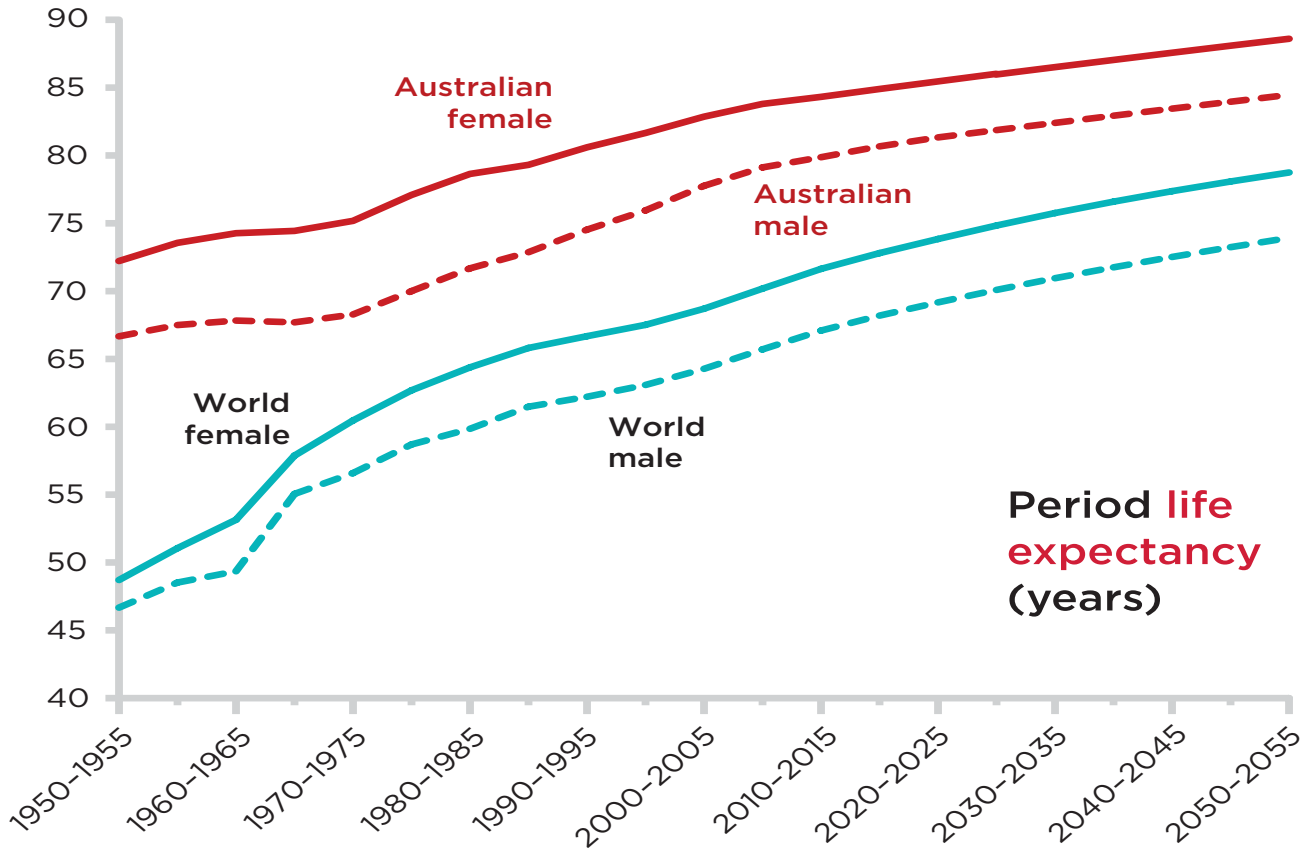


Figure 3: Increase in Life Expectancy, CEPAR (2012)

Population ageing in Australia

Treasury (2007, 2010), ABS (2012), and Productivity Commission [PC] (2008, 2013)

- Pronounced ageing of Australia's population over next 40 years (2010-50):
  - 65+: Increase from 13.6% to 23% by 2050;
  - Aged dependency ratio: Increase from 0.21 to 0.38 by 2050.
  - Youth dependency ratio: Decrease from 28% to 25% by 2050.
- Pronounced increase in the population size
  - 22 to over 33 million people by 2050.

Population ageing: Australia vs. the World

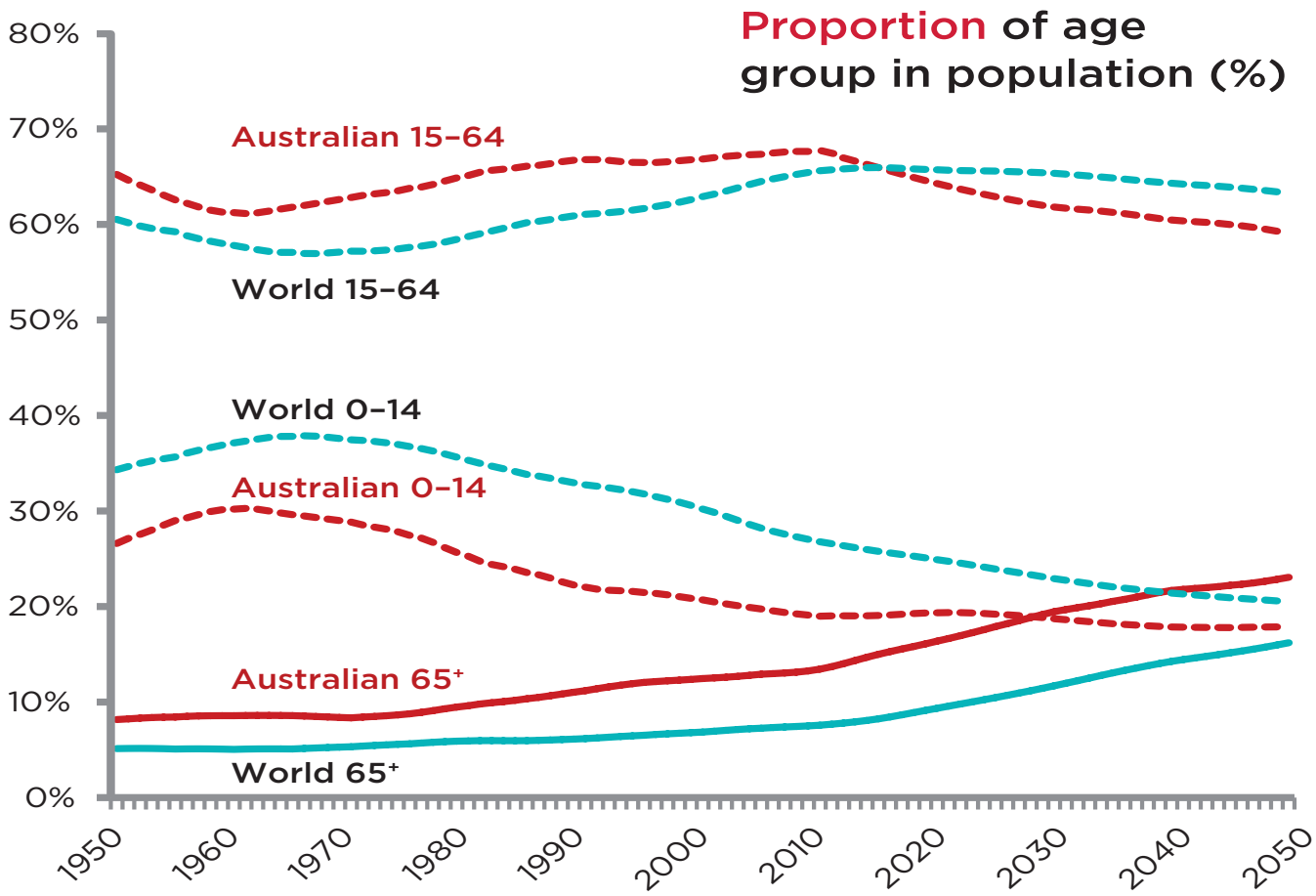


Figure 4: Changes in Age Structure, CEPAR (2012)

Australia: Ageing and fiscal challenges

- Changes in the demographic structure and size of Australia's population expected to have important implications for
  - fiscal sustainability
  - economic growth, inequality and welfare
- Productivity Commission (2005, 2013) and Treasury (2010, 2015)
  - assess the economic effects of demographic shift
  - using micro-simulation models.

This Paper

1. Construct a large-scale overlapping generations (OLG) model that incoporates:
   - behavioural responses of households and firms
   - dynamic general equilibrium channels
2. Quantify the fiscal cost of population ageing in Australia,
3. Eveluate the macroeconomic and welfare effects of two fiscal reforms
   - Pension cuts
   - Tax hikes

Preview of Main Findings

1. Demographic shift lowers living standard and increases in the fiscal cost of age-related spending
   - GDP per capita lowers by around 6 % in 2050
   - Age-related government expenditures from 17% of GDP in 2010 to 22% of GDP in 2050

2. Fiscal reforms to mitigate the fiscal cost result in different macroeconomic effects
   - Pension cuts improve macro aggregates, especially GDP per capita
   - Income and payroll tax hikes worsen macro aggregates

3. The welfare effects vary across income groups and generations
   - Pension cuts and consumption tax hike hurt the poor most
   - Future generations prefer pension cuts over tax hikes

Related Literature

- USA: Nishiyama (2006, 2012), Kitao (2012) , Jung and Tran (2014)
- Japan: Muto et al (2012), Imrohoroglu et al. (2014), Braun and Joines (2014), Kitao (2015)
- Australia: Kudrna, Tran and Woodland (2013)

Outline

- Model
- Calibration
- Experiments and results
- Sensitivity analysis
- Conclusion and discussion

MODEL

Model: Key Features

- Dynamic general equilibrium model
- Sectors: Household, firm, government, and foreign
- Markets: Consumption goods, labor, and capital
- Small open economy

Household: Demographics

- Agents live at most 101 years: 0-20 as child and 21-100 as adult.
- There are 101 generations aged 0-100 years in every time period t
- $N_{a,t}$ is the cohort size of age a in time t. The cohort size is driven by the sex-specific and age-dependent fertility, mortality and immigration rates $N_{a,t} = N^m_{a,t} + N^f_{a,t}$.
- The size of each gender-specific cohort evolves over time according to

$$N^g_{a,t} = \begin{cases} (1 - d^g_{a,t}) \cdot N^g_{a-1,t-1} + M^g_{a,t}, & \text{for } a > 0, \\ \omega^g \sum_{a=15}^{49} N^f_{a,t} f_{a,t}, & \text{for } a = 0, \end{cases}$$

- The total population is a sum of all generations alive in period t as $P_t = \sum_{a=0}^{100} N_{a,t}$.

Household: Overlapping Generations

Time (t)	*1*	*2*	*3*	*4*	...	*t*	...	*100*	...	*T*	...	...
Generations												
-100	**100**											
-99	**99**	100										
-98	**98**	99	100									
...	**...**	...										
...	**...**	...				100						
-66	**66**	67	68	...	...	99	100					
-65	**65**	66	67	...		98	99	100				
...	**...**	...										
-a	**...**	...										
...		....										
-22	**22**	23	24	...					...	100		
-21	**21**	**22**	**23**	**...**		**a**	**...**	**...**	**...**	**99**	**100**	
...	**...**	...	...	...								
...	**...**	...	...	...								
-2	**2**	3	4	...								
-1	**1**	2	3	...								
0	**0**	1	2	...	20	21	...	...		...	...	100
+1		0	1	2	...	...	...	...		...	...	...
+2			0	1	...	...	...	...		...	...	...
...						...	...	...		...	...	...
+t						0	1	2	...	...	...	...

Household Program

- Endowments:
  - Labor productivity: skill- and age-dependent ability to work
  - Lifetime: random and up to 101 years
- Two stages of living: (i) 0 to 20 as a child and (ii) 21 to 100 as adult
- Adult households make economic decisions
  - Derive utility from consumption and leisure
  - Decide on sequences of consumption, savings, and leisure/labor to maximize its lifetime utility

Household: Preferences, Constraints and Optimization I

- Preferences:

$$U_t = \frac{1}{1-\frac{1}{\gamma}} \sum_{a=21}^{100} S_{a,i} \left(1+\beta\right)^{21-a} \left[\left(c_{a,i}\right)^{\left(1-\frac{1}{\rho}\right)} + \alpha_a \left(l_{a,i}\right)^{\left(1-\frac{1}{\rho}\right)} \right]^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}}$$

where,

$c_{a,t}$: consumption, $l_{a,t}$: leisure,

$S_{a,i}$: unconditional survival probabilities

γ,: the inter-temporal elasticity of substitution, ρ: the intra-temporal elasticity of substitution, α_a,: the leisure distribution parameter, and β: the rate of time preference.

Household: Preferences, Constraints and Optimization II

- The period budget constraint:

$$A_{a,t} + (1+\tau^c)\, c_{a,t} = (1+r)A_{a-1,t-1} + w_t e_a (1-l_{a,t}) + AP_{a,t} + SA_{60} + SP_a + FB_{a,t} + B_t - T(y_{a,t}),$$

where,
$(1+r)A_{a-1,t-1}$: investment income, $w_t e_a (1-l_{a,t})$: labour earnings, $AP_{a,t}$: age pension, $SP_{a,t}$ and $SA_{60,t}$: superannuation contributions and payouts, $FB_{a,t}$:family benefits, B_t,: bequest receipts, $T(y_{a,t})$: the sum of income taxes, w_t: wage rate, e_a: work ability.

- Household problem: Households maximise the expected lifetime utility function subjected to the budget constraints.

Firm: Technologies and Optimization I

- The representative firm demands capital, K_t, and labour, L_t, to produce a single all purpose output, Y_t.
- The production technology is given by

$$F(K_t, L_t) = \kappa \left[\varepsilon K_t^{(1-1/\sigma)} + (1-\varepsilon) L_t^{(1-1/\sigma)} \right]^{[1/(1-1/\sigma)]},$$

where, κ is the productivity constant, ε denotes the capital intensity parameter and σ is the elasticity of substitution in production.

- Capital formation is subject to the adjustment costs given by

$$C(I_t, K_t) = \frac{\psi}{2} \frac{I_t^2}{K_t}$$

which are assumed to be quadratic in net investment, I_t, and where ψ is the adjustment cost coefficient.

Firm: Technologies and Optimization II

- The firm profit is given by

$$\pi_t = F(K_t, L_t) - (1 + cr) w_t L_t - C(I_t, K_t) - I_t$$

- The firm maximises the present value of all future profit payments subject to the capital accumulation equation, as described by

$$\max_{\{K_t,\ L_t,\ I_t\}} \quad \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} \left[\left(1 - \tau^f\right) \pi_t \right.$$

$$\text{s.t.} \qquad K_{t+1} = I_t + (1 - \delta) K_t,$$

where τ^f stands for the effective corporation tax rate and δ is the capital depreciation rate.

Government: Budget Constraint and Fiscal Policies I

- The consolidated government is given by

$$\Delta D_t + Tax_t = rD_t + G_t + TR_t,$$

where, ΔD_t,: new debt, Tax_t,: tax revenue, rD_t,: interest payments, G_t: government final consumption, and TR_t: social transfer payments

- Tax revenue (Tax_t): income taxes, consumption tax, corporate taxes.

- The government consumption (G_t): education, healthcare, aged care, and government purchases of other goods and services.

$$G_t = \sum_{a=0}^{20} edu_a N_{a,t} + \sum_{a=0}^{100} hc_a N_{a,t} + \sum_{a=65}^{100} ac_a N_{a,t} + \overline{G}_t \cdot P_t.$$

Government: Budget Constraint and Fiscal Policies II

- Social transfer payments: family benefits $FB_{a,t}$ and age pension payments $AP_{a,t}$.

$$TR_t = \sum_{a=21}^{60} FB_{a,t} N_{a,t} + \sum_{a=65}^{100} AP_{a,t} N_{a,t}.$$

  - The family benefits, $FB_{a,t}$, are assumed to be exogenous and to be received by households between ages 21 and 60 years.
  - The age pension payments, $AP_{a,t}$, are endogenous and paid to households aged 65 and over and subject to income test:

$$AP^i_{a,t} = \max\left\{\min\left\{p, p - \theta\left(\widehat{y}^i_{a,t} - IT\right)\right\}, 0\right\},$$

    where assessable income $\widehat{y}^i_{a,t}$

Competitive Equilibrium I

Given government policy settings for tax rates and the old-age pension system, the population growth rate, world interest rate, a steady state competitive equilibrium is such that

(a) a collection of individual household decisions $\left\{\left\{c_{j,t}, l_{j,t}, a_{j,t}\right\}_{j=21}^{J}\right\}_{i=1}^{I}$ to solve the household problem;

(b) the firm chooses labour and capital inputs to solve the profit maximization problem;

(c) the current account is balanced and foreign debt, FD_t, freely adjust so that $r_t = r^w$, where r^w is the world interest rate;

Competitive Equilibrium II

(d) the labour, capital and goods markets clear

$$
\begin{aligned}
L_t &= \sum_{i \in I} \mu^i \sum_{j \in J} e^i_j (1 - l^i_{j,t}) N_{j,t}, \\
q_t K_t &= \sum_{i \in I} \mu^i \sum_{j \in J} a^i_{j-1,t-1} N_{j,t} - FD_t, \\
Y_t &= \sum_{i \in I} \mu^i \sum_{j \in J} c^i_{j,t} N_{j,t} + I_t + G_t + TB_t,
\end{aligned}
$$

where μ^i gives intra-generation shares and $N_{j,t}$ is the size of cohort age j at time t.

(e) the government budget constraint is satisfied.

(f) the skill-specific bequest transfer is equal to the total amount of assets within each skill type left by the deceased agents, $B^i_t = \sum_{j \in J} d_{j,t} a^i_{j,t} \phi_{j,t}$, where the term $d_{j,t}$ denotes the age-specific mortality rates and $\phi_{j,t}$ denotes the cohort shares.

CALIBRATION

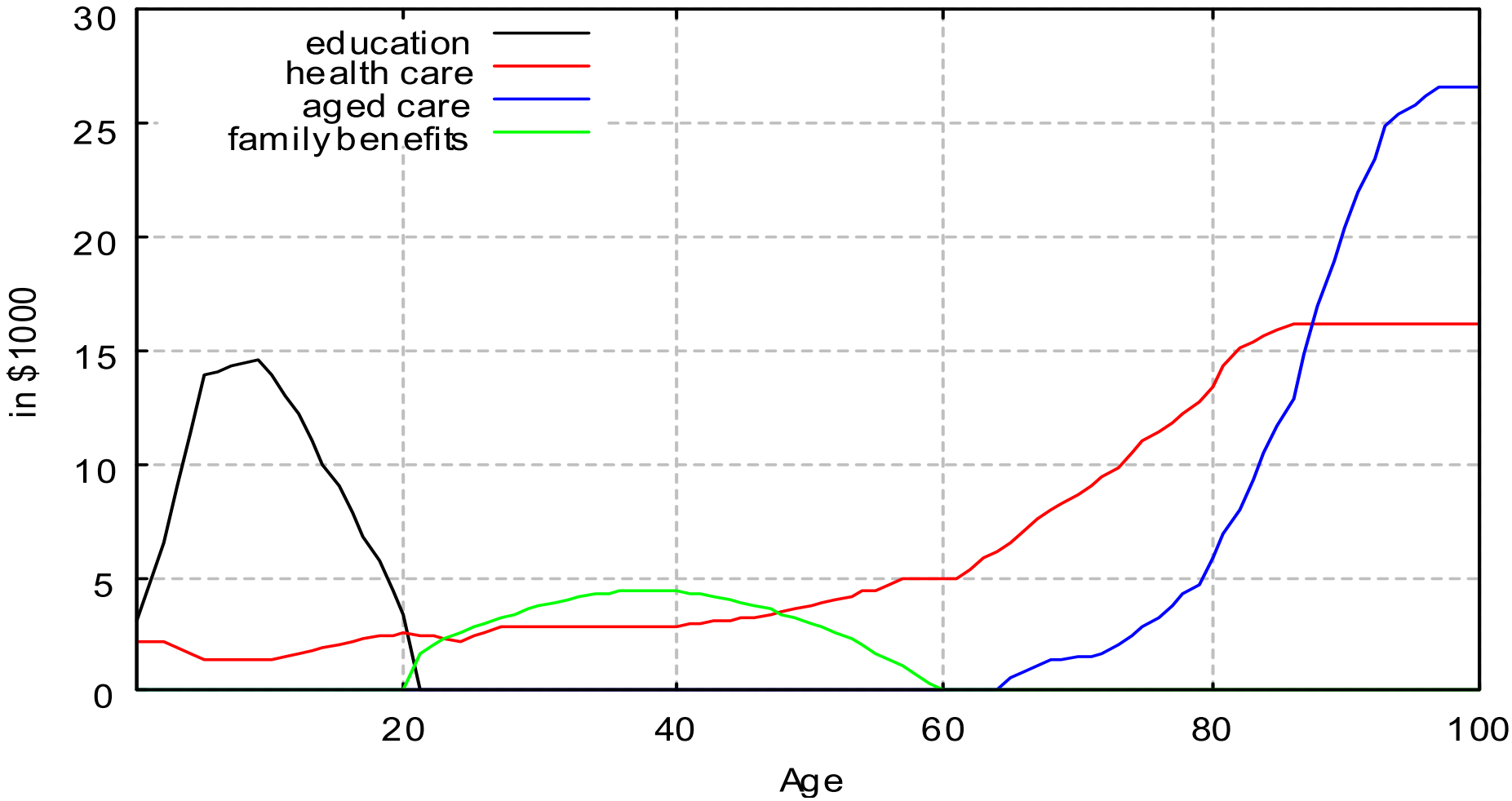
Calibration

- Values assigned to model parameter
  - taken from related literature for most *utility parameters;*
  - calibrated for most *production parameters*;
- Initial asset distribution in base year (2012).
- Labor productivities derived the estimates of the wage function for males (Reilly et al. (2005))
- Average age-specific government expenditures on
  - education, healthcare and aged care - taken from PC (2013);
  - family benefits - derived from 2010 HILDA survey.
- match the data in 2012 for *tax and pension parameters*.

Calibration: Key parameter values

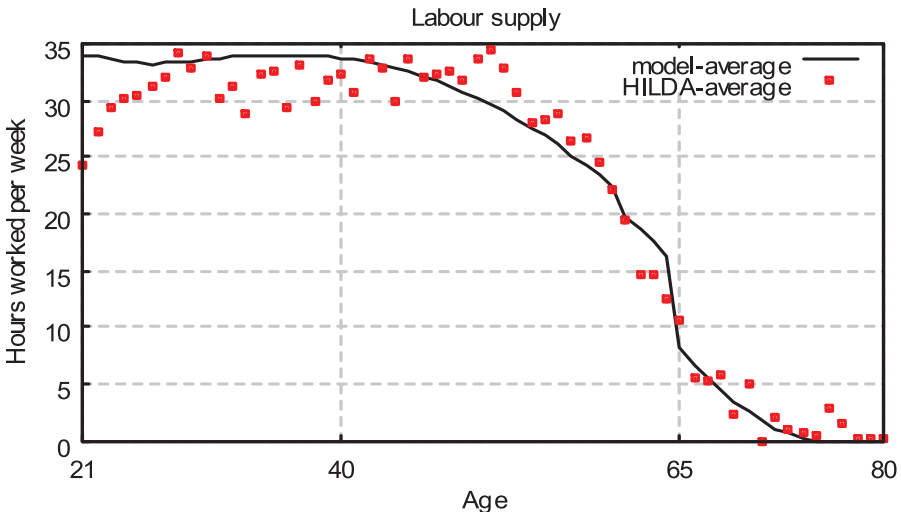
Description	Value	Source
Utility function		
Inter-temporal elasticity of substitution	0.3	Literature
Intra-temporal elasticity of substitution	0.4	Literature
Subjective rate of time preference	0.02	Calibrated
Leisure parameter [a]	2-2.5	Literature
Technology		
Production constant	0.897	Calibrated
Elasticity of substitution in production	0.987	Calibrated
Capital share	0.45	Data
Depreciation rate	0.071	Calibrated
Adjustment cost parameter	2.242	Calibrated
Age pension		
Maximum age pension p.a. (in $10000)	0.1747	Data
Income test threshold (in $10000)	0.0398	Data
Income reduction rate	0.5	Data
Superannuation		
Mandatory contribution rate	0.09	Data
Contribution tax rate	0.15	Data

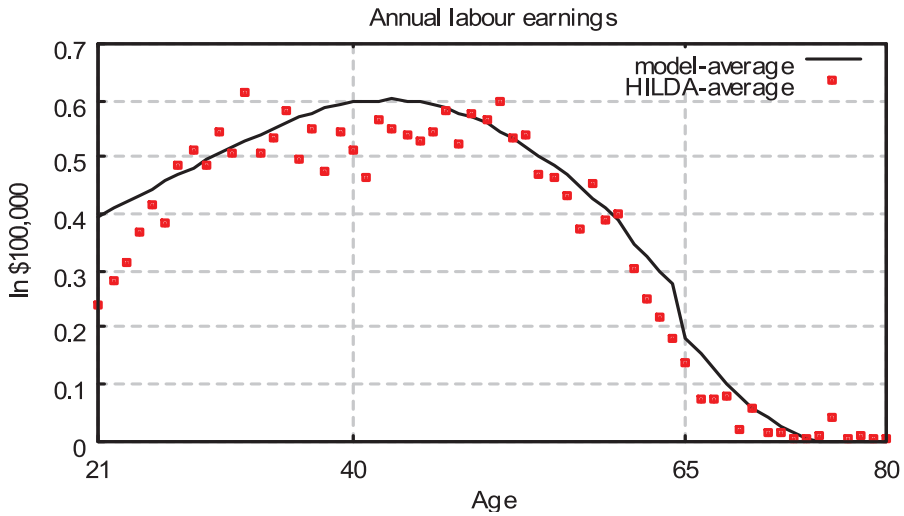
Calibration: Life-cycle profiles of public expenditures



Notes: Health care, aged care and education expenditure profiles are taken from Productivity Commission's (2013) report and deflated at a 3 percent rate to year 2010; Family benefits profiles are derived from 2010 HILDA individual data set.

Model vs. Data: Life-cycle profiles





Model vs. Data: Age Pension

Model vs. Data: Macro aggregates

Variable	Model 2012	Australia 2008-12
Expenditures on GDP (% of GDP)		
Private consumption	51.61	54.75
Investment	26.49	27.60
Government consumption	19.83	18.10
Trade balance	2.07	-0.54
Net income shares and Gini coefficient		
Lowest quintile	0.07	0.08
Second quintile	0.12	0.13
Third quintile	0.18	0.17
Fourth quintile	0.24	0.23
Highest quintile	0.38	0.40
Gini coefficient	0.34	0.33

Notes: Government expenditures and tax revenues expressed in % of GDP are replicated exactly because we compute adjustment parameters for each government indicator.

EXPERIMENTS

Experiments

1. Quantifying the fiscal cost of demographic shift
2. Examine the implications of fiscal options to mitigate fiscal pressure

The Fiscal Cost of Demographic Shift

- Demographic shift according to projections based on Productivity Commission (2013)
- Keep the benefits of age-related spending programs unchanged, but adjust non-aged related spending to balance the budget

Demographic projections

Assumptions - Productivity Commission's MoDEM 2.0

- Several demographic scenarios constructed over next 100 years
  - 2010 cohort sizes
  - MoDEM 2.0 assumptions for vital rates.
- Baseline projection with medium fertility, survival and net immigration:
  - Fertility rate: 1.8 to 1.7 babies per woman by 2018;
  - Life expectancy at birth: 79 to 88.2 years for males and 84 to 90.8 years for females by 2053.
  - Net immigration: 177,000 people per year;
- Low and high demographic projections
  - Low (High) fertility rate increases to 1.5 (1.9) babies per woman by 2018;
  - Low (High) life expectancy at birth increases to 85.3 (93.8) years for for males and 89 (95.8) years for females by 2053.

Demographic projections

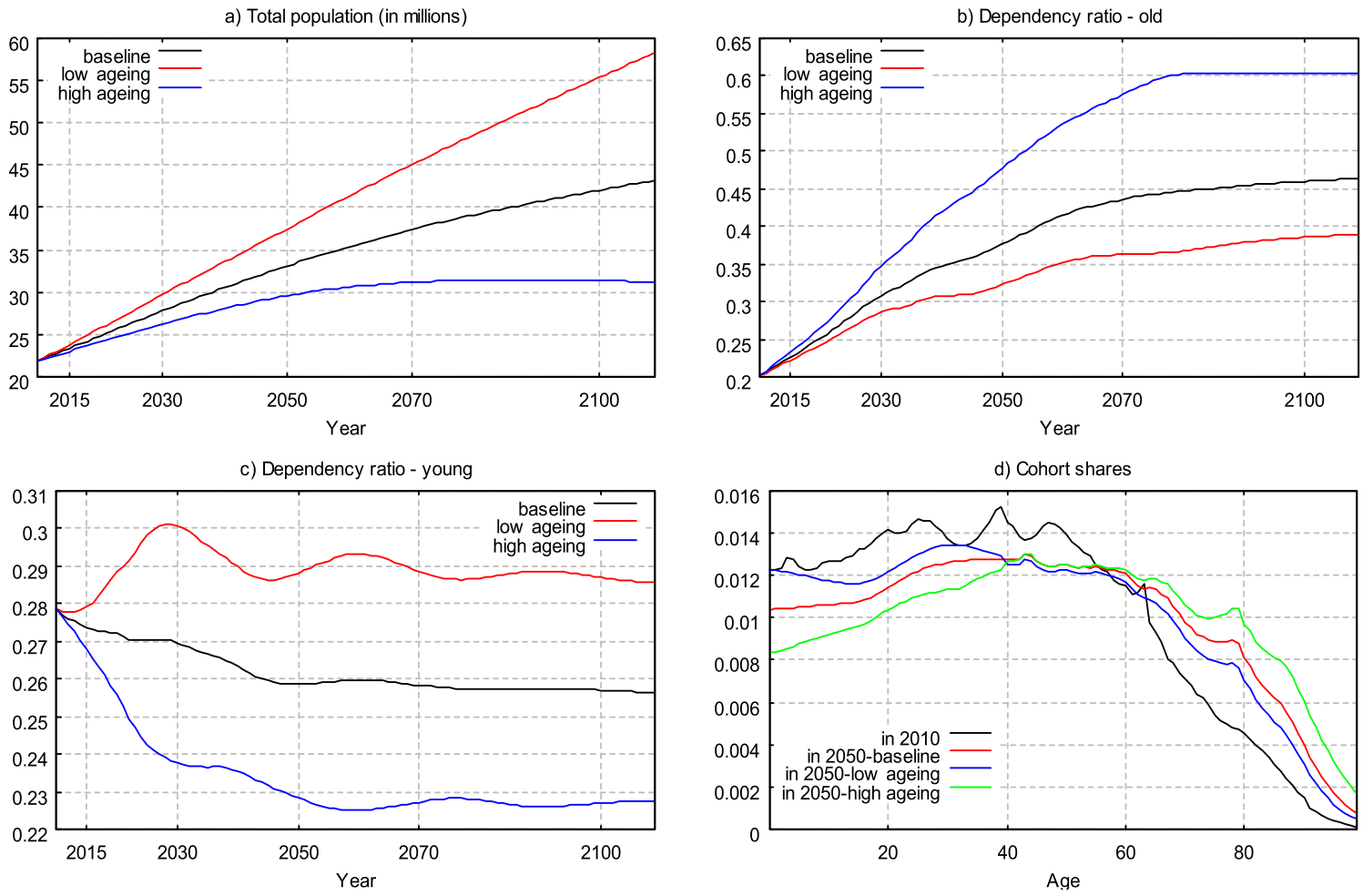
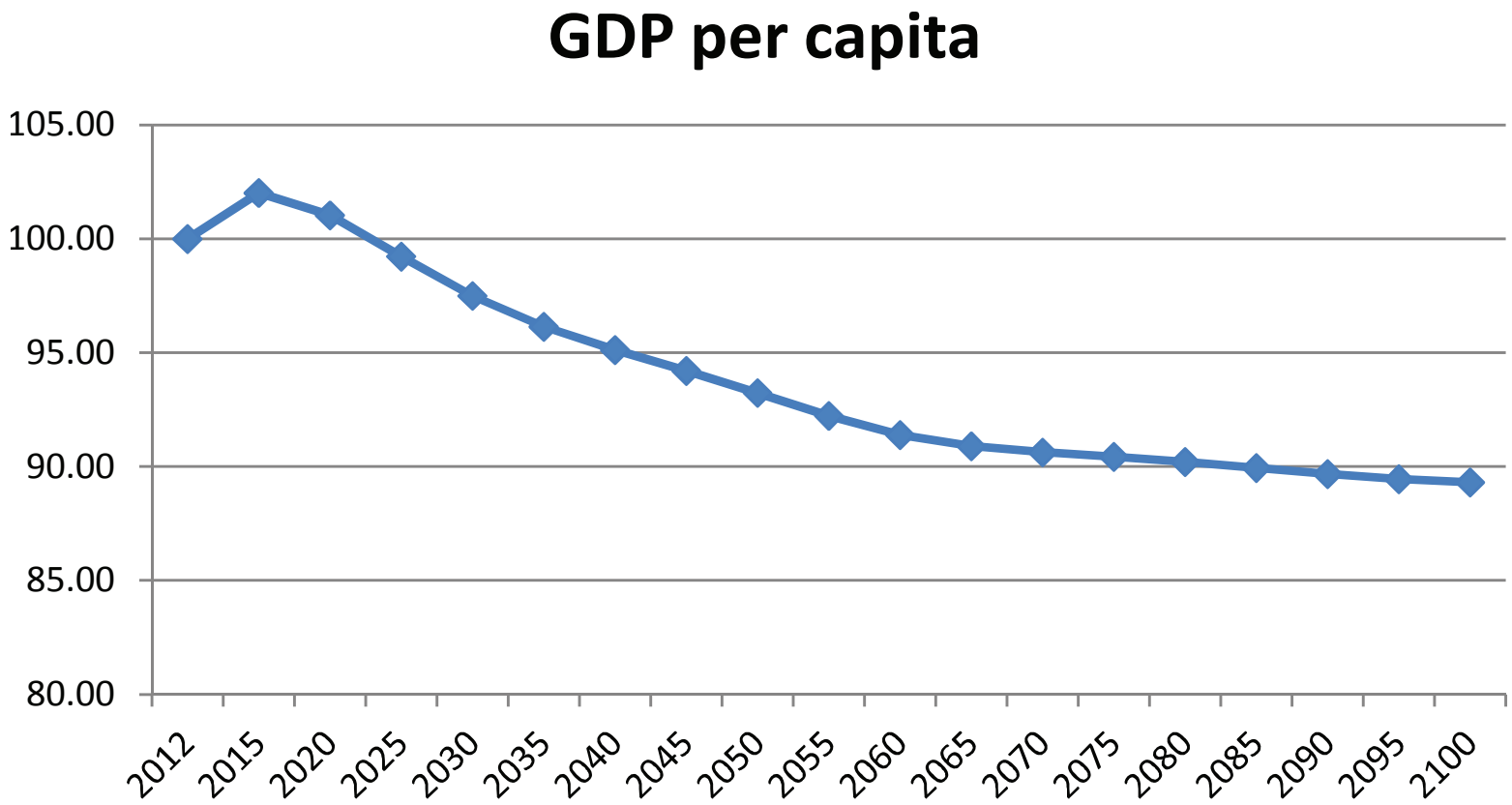


Figure 5: Baseline and alternative projections - population statistics

Demographic Shift: Living Standard



Demographic Shift: Macroeconomic effects

Percentage changes in per capita variables relative to 2012

Variable	2015	2030	2050	2100
1) Labour supply	3.04	-3.11	-7.51	-11.63
Wage rate	-1.25	0.07	0.15	0.30
2) Domestic assets	3.23	21.87	35.40	39.64
Capital Stock	0.19	-2.97	-7.20	-11.03
Asset price	-0.30	-1.44	-1.70	-2.04
3) Output (GDP)	2.01	-2.50	-6.77	-10.69
National product (GNP)	2.56	1.34	-0.33	-3.05
Consumption	-2.60	0.14	3.70	5.73

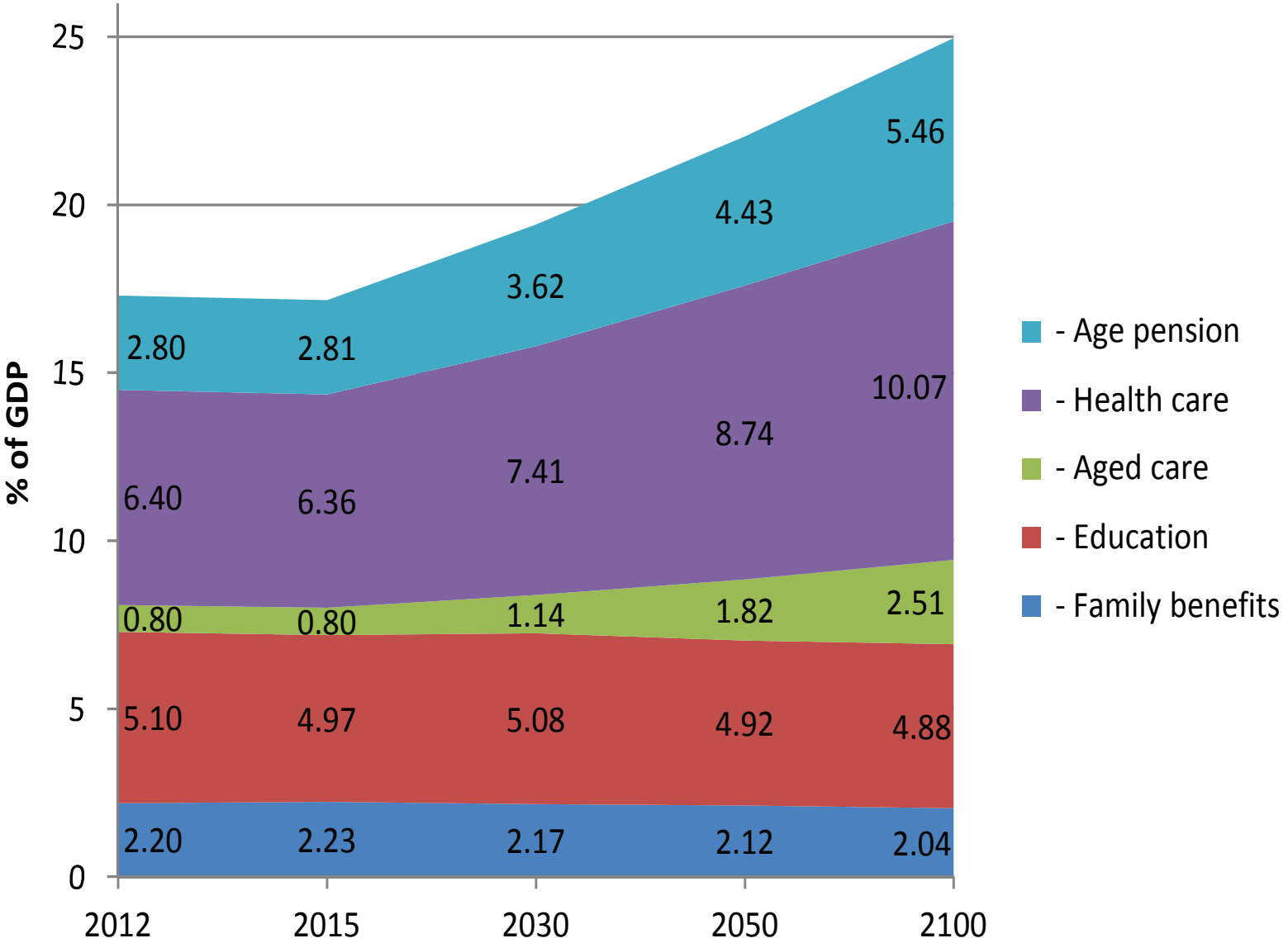
Demographic Shift: Fiscal effects

Implications for selected government indicators in % of GDP

Variable	2015		2030		2100	
1) Total tax revenue	26.72	1.6	28.09	2.1	30.37	1.1
- Income tax	10.34	3.1	11.00	4.8	11.70	2.2
- Consumption tax	7.16	-2.6	7.70	0.1	8.88	5.7
2) Age related spending	17.17	1.7	19.42	18.6	24.97	61.1
- Health care	6.36	1.3	7.41	12.8	10.07	40.6
- Aged care	0.80	2.5	1.14	38.6	2.51	180.0
- Age pension	2.81	2.3	3.62	26.1	5.46	74.0
3) Other expenditures	7.70	4.3	6.85	-11.3	3.56	-57.7

Notes: Underlined numbers show percentage changes relative to 2010.

Demographic Shift: Age-related spending in % of GDP



Fiscal reforms

- Reform 1 - Pension cuts: access age, maximum benefit, and taper rate
- Reform 2 - Tax hikes: consumption, income, and payroll
- Reform 3 - Combination of pension cuts and tax hikes

Reform 1: Pension cuts

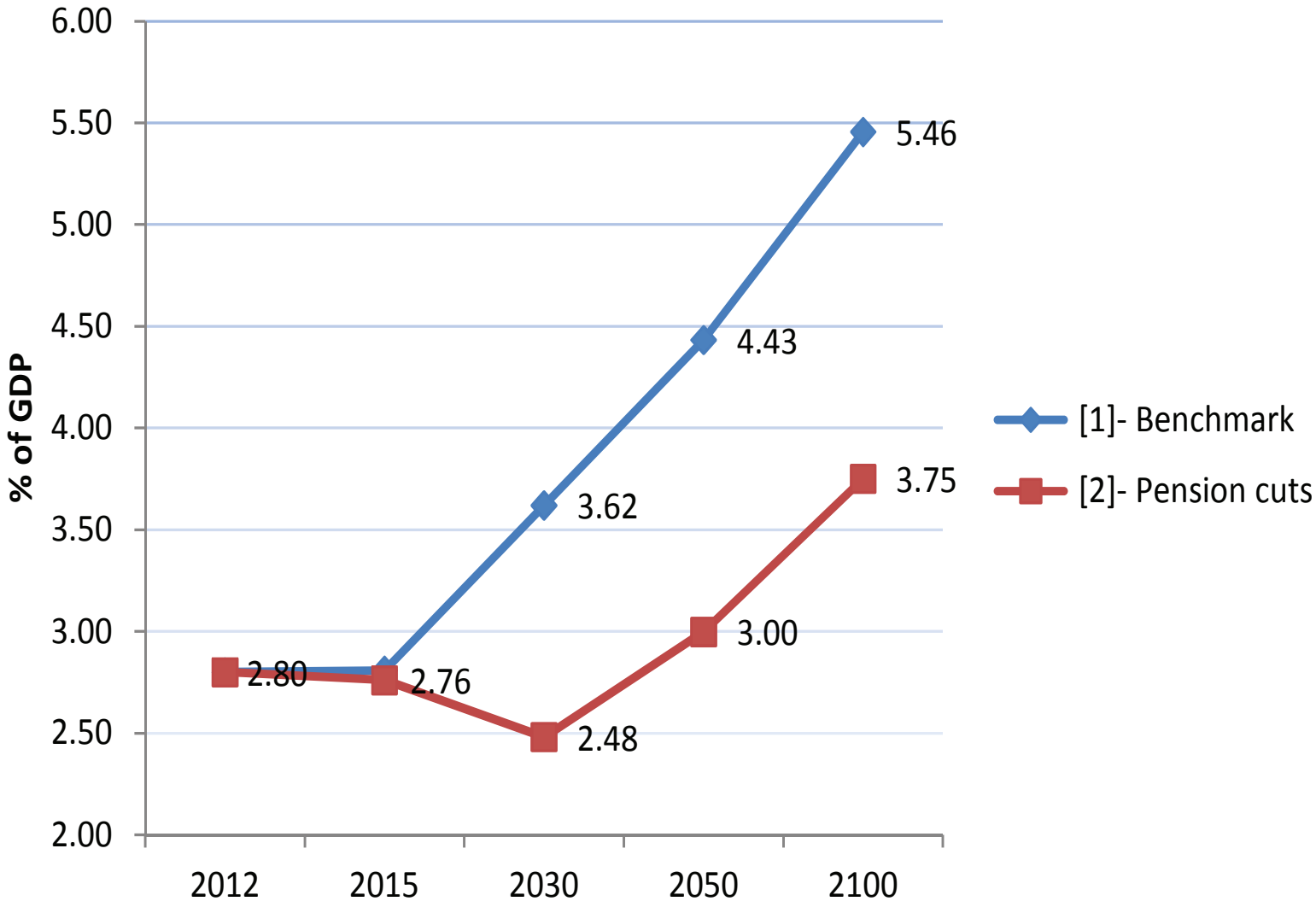
- Recall that the means tested age pension, $AP_{\widehat{a}}$, is calculated as

$$AP_{\widehat{a}} = \max\left\{\min\left\{p, p - \theta\left(\widehat{y}_{\widehat{a}} - IT\right)\right\}, 0\right\},$$

  where $\widehat{a}$: pension access age, p: maximum pension, θ: taper rate, $\widehat{y}_{\widehat{a}}$: assessable income and IT: income threshold.

- The age pension cuts include
  1. increases in $\widehat{a}$ from 65 to 66 in 2018 and to 67 in 2023;
  2. reductions p by 5% in 2018 and further 5% in 2023;
  3. increases in θ from 0.5 to 0.625 in 2018 and to 0.75 in 2023;
- Notice that, non-age related spending adjusts to balance the government budget

Pension Cuts: Age Pension in % of GDP

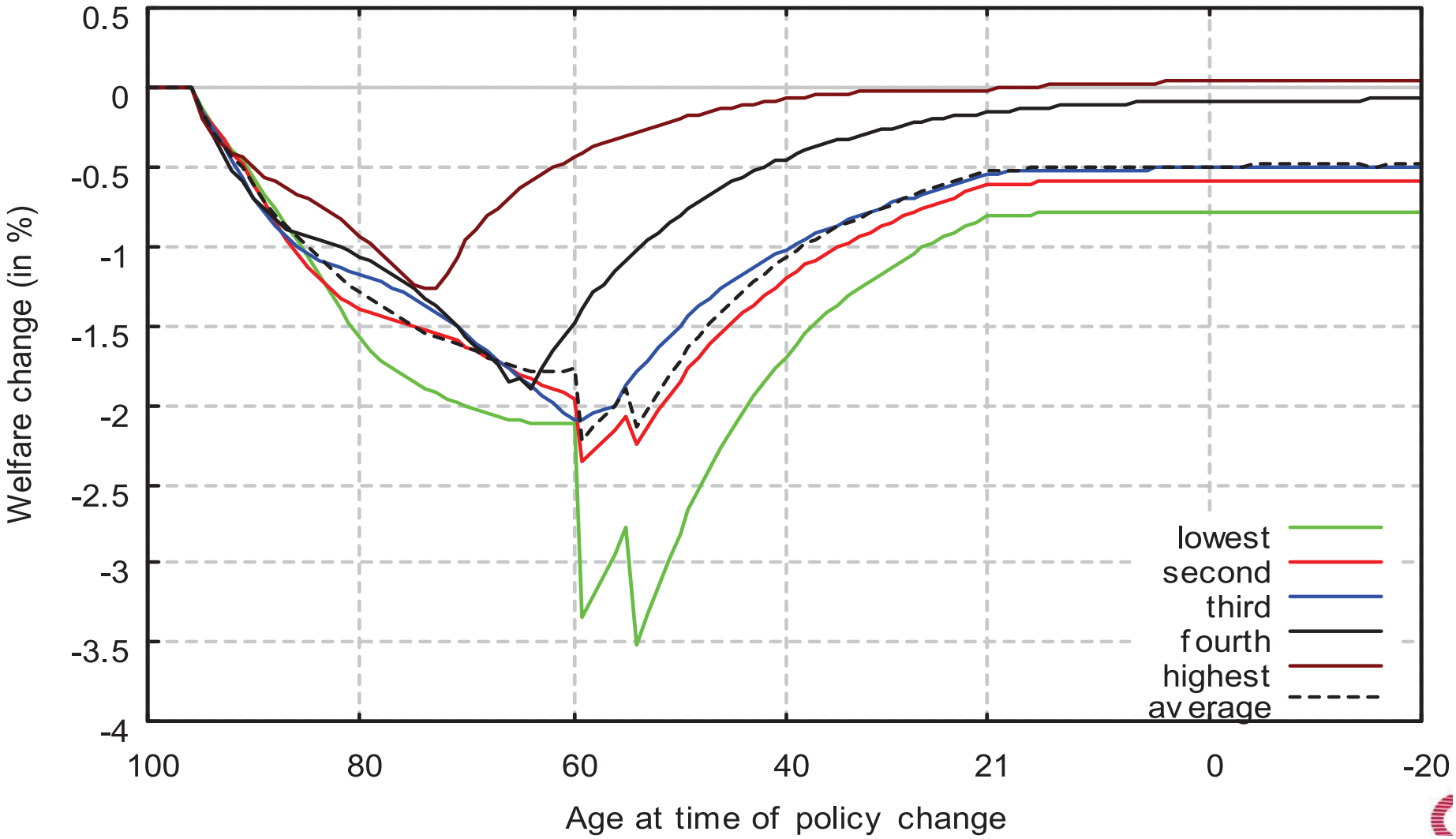


Pension Cuts: Macroeconomic effects

Percentage changes in per capita variables from baseline transition

Variable	2015	2030	2050	2100
1) Labour supply	1.41	1.57	1.19	1.05
Domestic assets	0.73	4.31	5.71	6.12
Consumption	-1.14	-0.63	-0.21	-0.09
2) Total tax revenues	0.37	0.81	0.77	0.69
- Income tax	1.19	1.55	1.42	1.27
- Consumption tax	-1.14	-0.63	-0.21	-0.09
Age related expenditures	-0.14	-5.67	-6.35	-6.67
- Age pension	-0.84	-30.39	-31.57	-30.52
Other expenditures	1.59	19.40	29.48	52.63

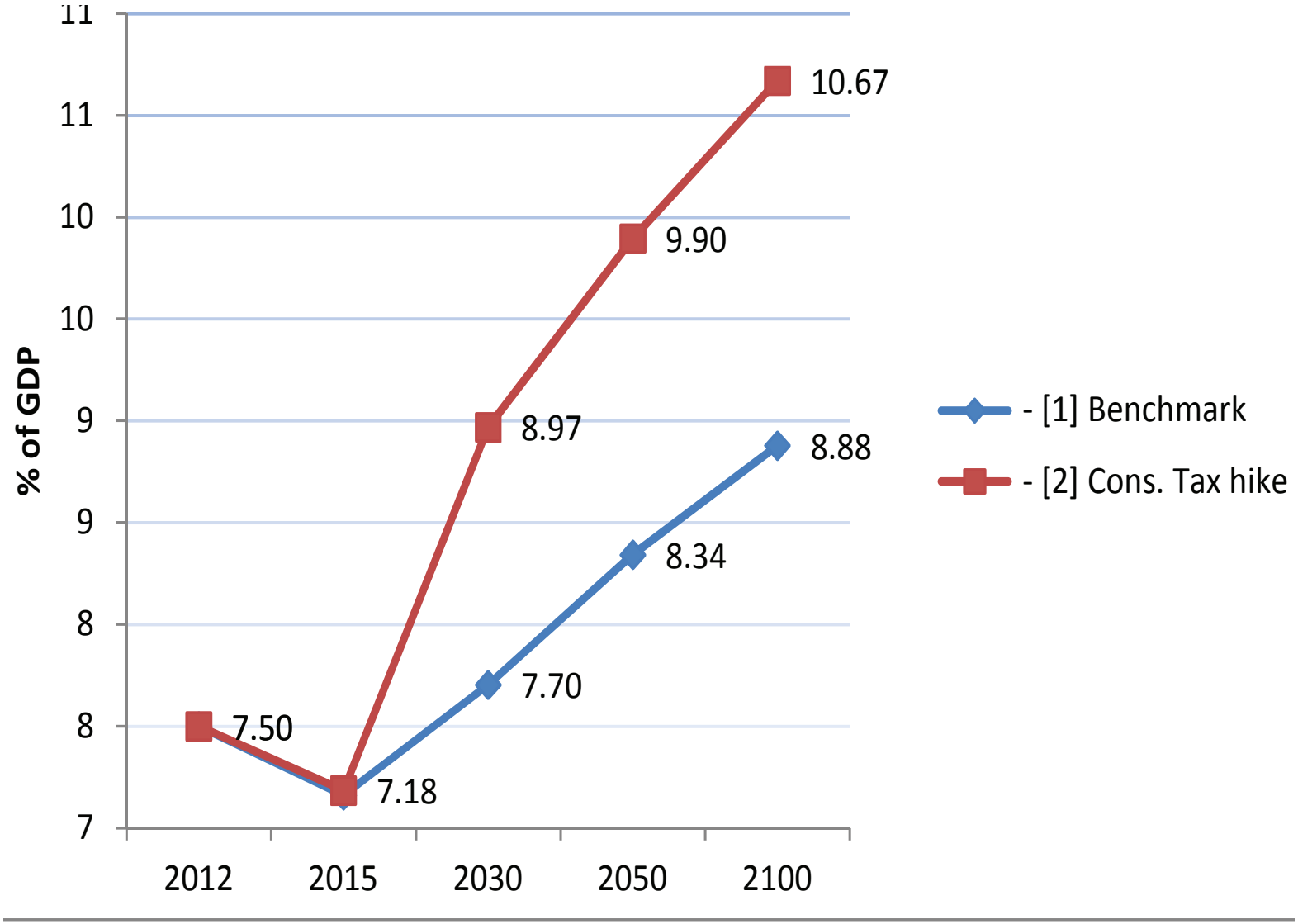
Pension Cuts: Welfare effects



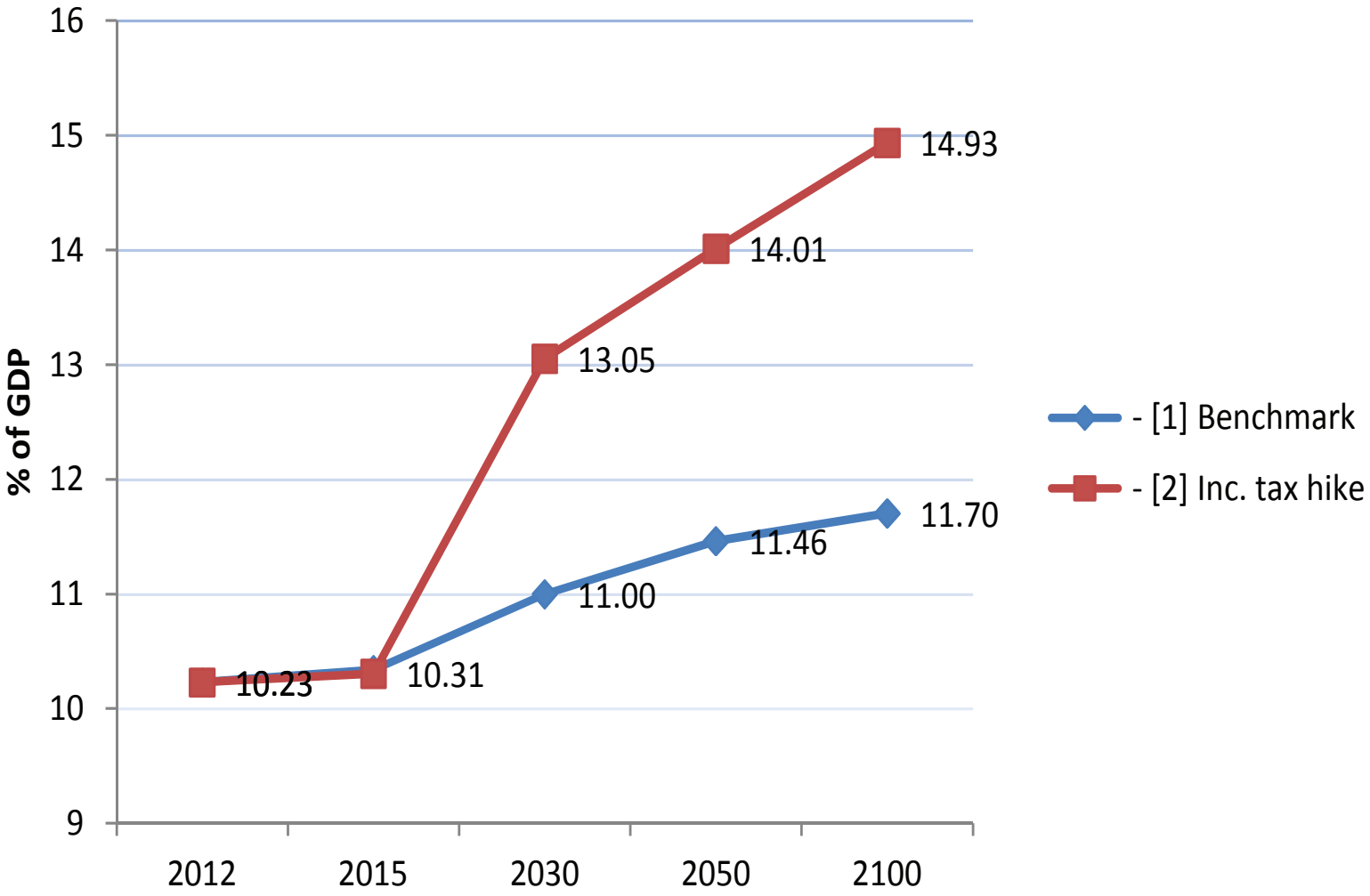
Reform 2: Tax hikes

- Keep all age-related spending commitments as in 2012
- Increases consumption tax or income tax or payroll tax
- Each tax hike generates the same improvements in non-age related spending as the aggregate pension cut.

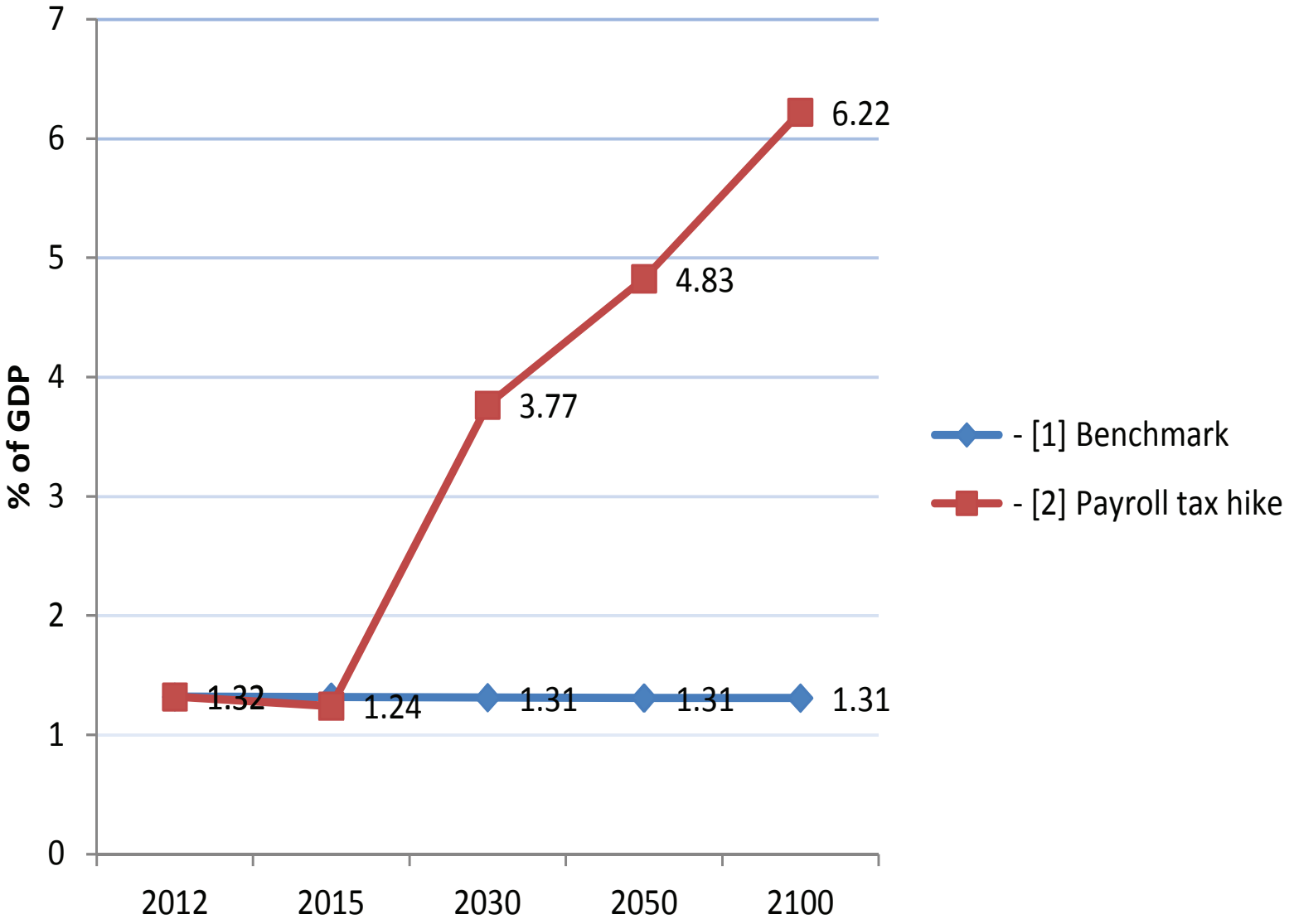
Reform 2 - Consumption tax hike: Tax revenue in % of GDP



Reform 2 - Income tax hike: Tax revenue in % of GDP



Reform 2 - Payroll tax hike: Tax revenue in % of GDP



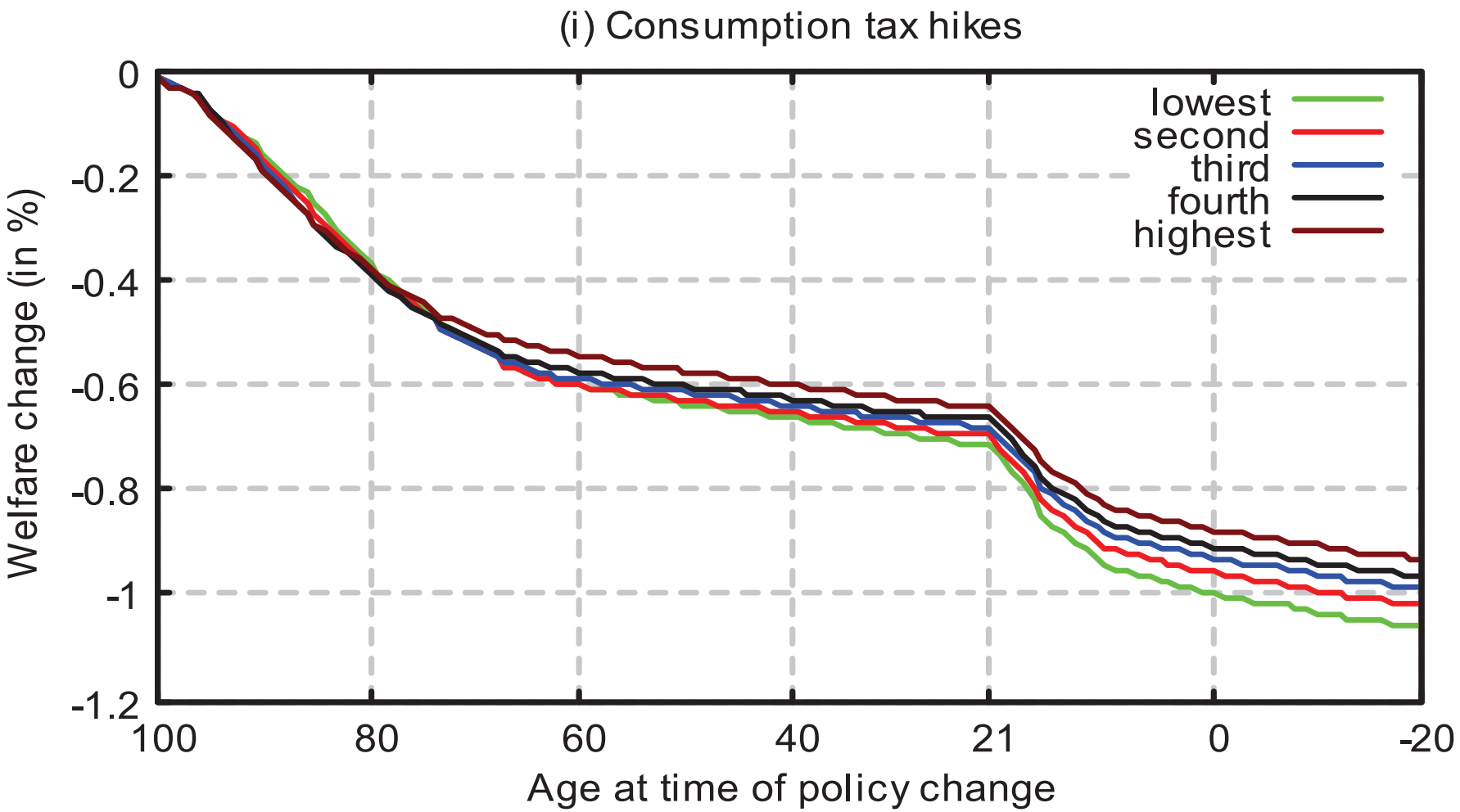
Reform 2 - Tax hikes: Macroeconomic effects

Percentage changes in selected variables from baseline transition

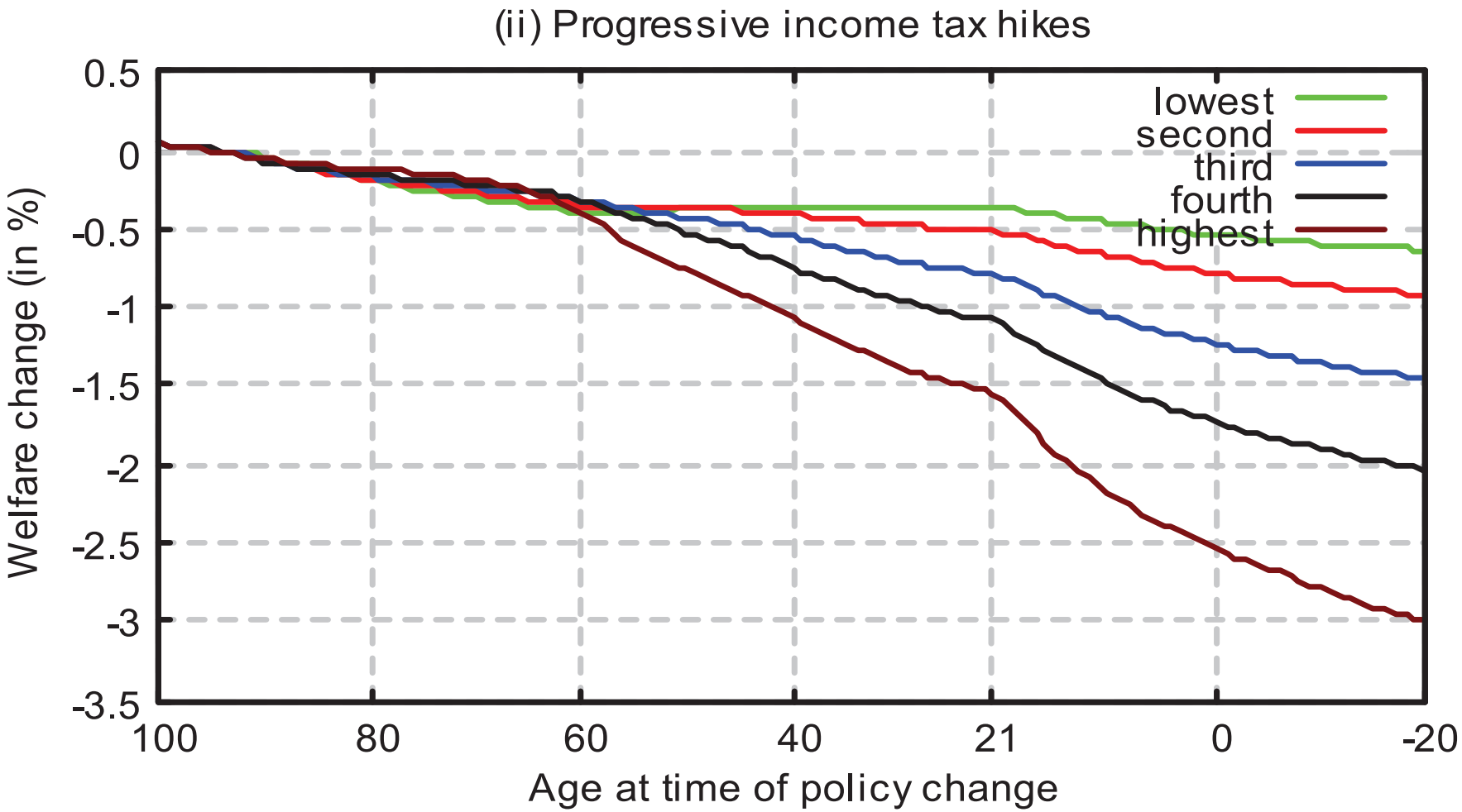
Variable	(i) Consumption tax			(ii) Income tax		
	2015	2030	2100	2015	2030	2100
Labour supply	0.50	0.06	0.23	1.28	-2.57	-1.30
Domestic assets	0.23	0.84	0.24	0.45	-1.39	-14.21
Income tax revenue	0.44	0.37	0.30	0.48	15.89	25.94
Consumption tax revenue	0.63	16.52	20.45	-0.48	-3.14	-8.60
Tax rate [a]	1.15	19.05	23.87	-0.70	20.04	35.60

Notes: [a] Changes in (i) consumption tax rate and (ii) average income tax rates.

Consumption tax hikes: Welfare effects



Income tax hikes: Welfare effects



Reform 3: A mix of pension cuts and take hikes

- Pension cuts as in reform 1
  - (i) Higher access age, (ii) Lower Maximum benefit, and Higher taper rate
- Tax hikes to balance the government budget:
  - (i) Consumption tax or
  - (ii) Payroll tax

Pension cuts and tax hikes: Macro effects

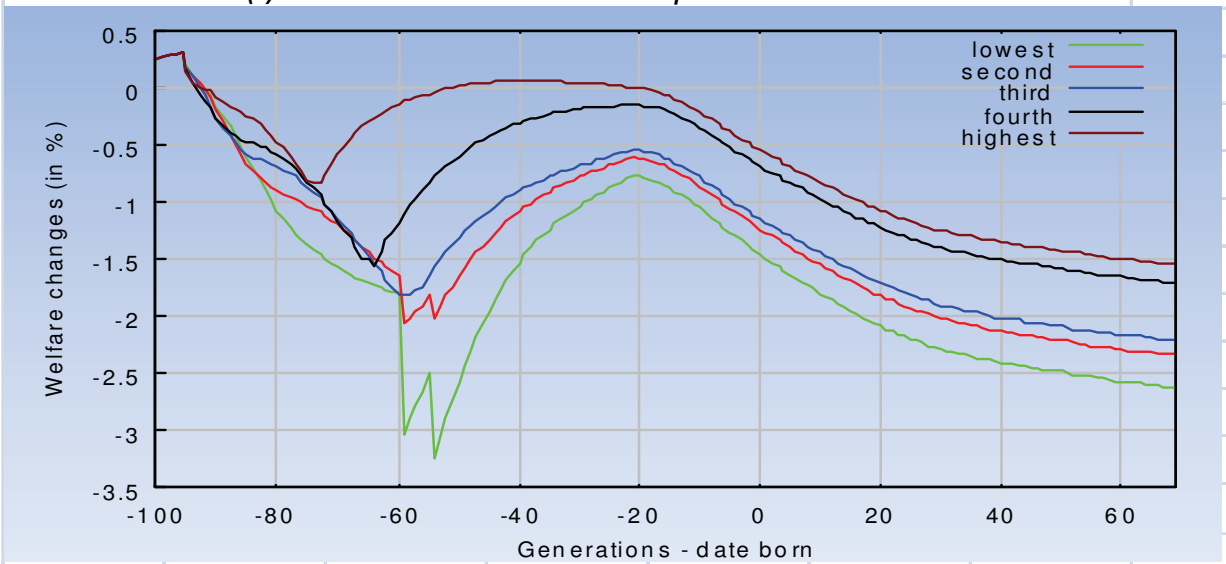
(Percentage changes in the selected macroeconomic variables from baseline transition)

Variable	(i) Consumption tax				(ii) Payroll tax			
	2015	2030	2050	2100	2015	2030	2050	2100
Labour supply	1.43	1.83	1.19	1.27	1.36	2.71	0.54	-1.04
Domestic assets	0.72	5.71	8.15	7.38	0.60	8.13	12.32	-2.14
Output (GDP)	0.92	1.79	1.19	1.27	0.89	2.63	0.52	-0.95
Consumption	-0.30	0.20	-1.32	-4.18	0.00	0.72	-1.45	-11.17
Total tax revenues	-1.26	-0.83	3.84	10.41	-1.29	-0.86	3.83	11.03
- Income taxes	1.24	2.35	2.37	1.92	2.86	7.08	0.28	-20.30
- Payroll taxes	1.01	1.77	1.18	1.28	-49.86	-95.78	88.56	532.89
- Consumption taxes	-7.19	-8.06	9.27	32.14	0.00	0.72	-1.45	-11.17
Age related spending	-0.13	-5.71	-6.49	-6.83	-0.18	-5.74	-6.50	-6.08
- Age pension	-0.78	-30.61	-32.25	-31.25	-1.11	30.80	-32.30	-27.83
Tax rate [a]	0.13	0.13	0.16	0.20	0.01	0.00	0.05	0.19

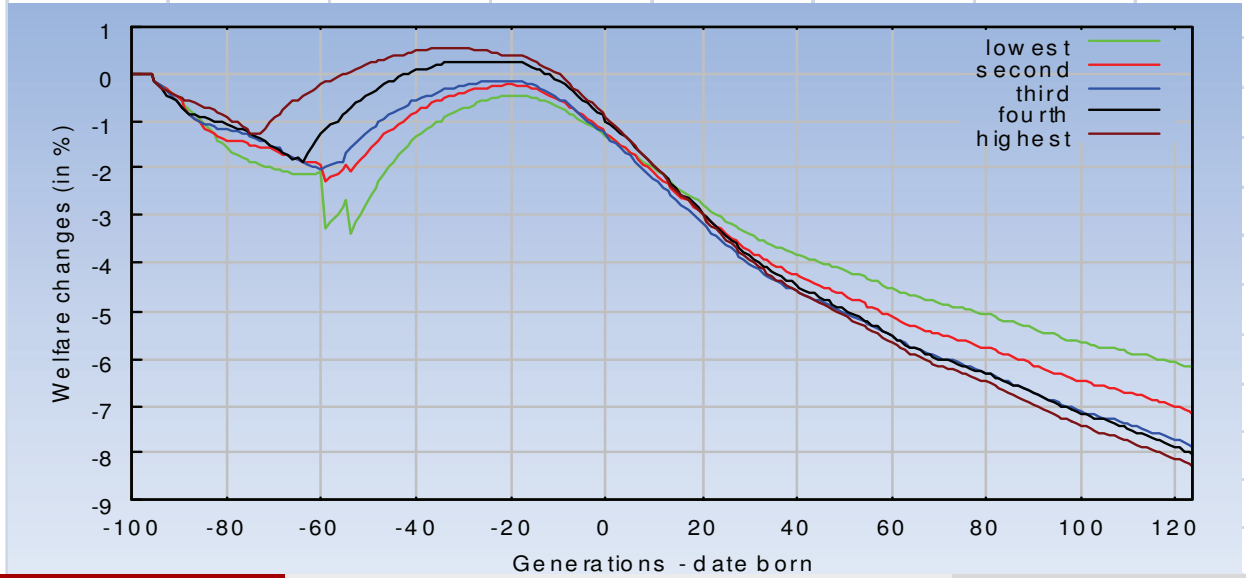
Notes: [a] These are changes in (i) consumption tax rate, or (ii) payroll tax rate to generate the same improvements in non-age related expenditures as under the aggregate pension cut.

Pension cuts and tax hikes: Welfare effects

(i) Pension cuts and consumption tax hike



(ii) Pension cuts and payroll tax hike



Sensitivity analysis

- High and low demographic projections
- The role of behavioural responses
- Consumption tax adjudts to maintain budget balance
- Imperfect capital mobility with endogenous interest rate

Conclusions

- Analysis of demographic shift and fiscal reforms in Australia, using a small open economy, overlapping generations (OLG) model.
- Simulation findings show
  - The demographic challenges are significant (in terms of fiscal cost and living standard).
  - Fiscal reforms (Pension cuts or tax hikes or both) results in trade offs between efficiency and inequality.
- The existing tax-transfer system is not designed for ageing society.
- A structural reform is needed but how?
  - economic constraints, political constraints

Remark: Population ageing as a global issue

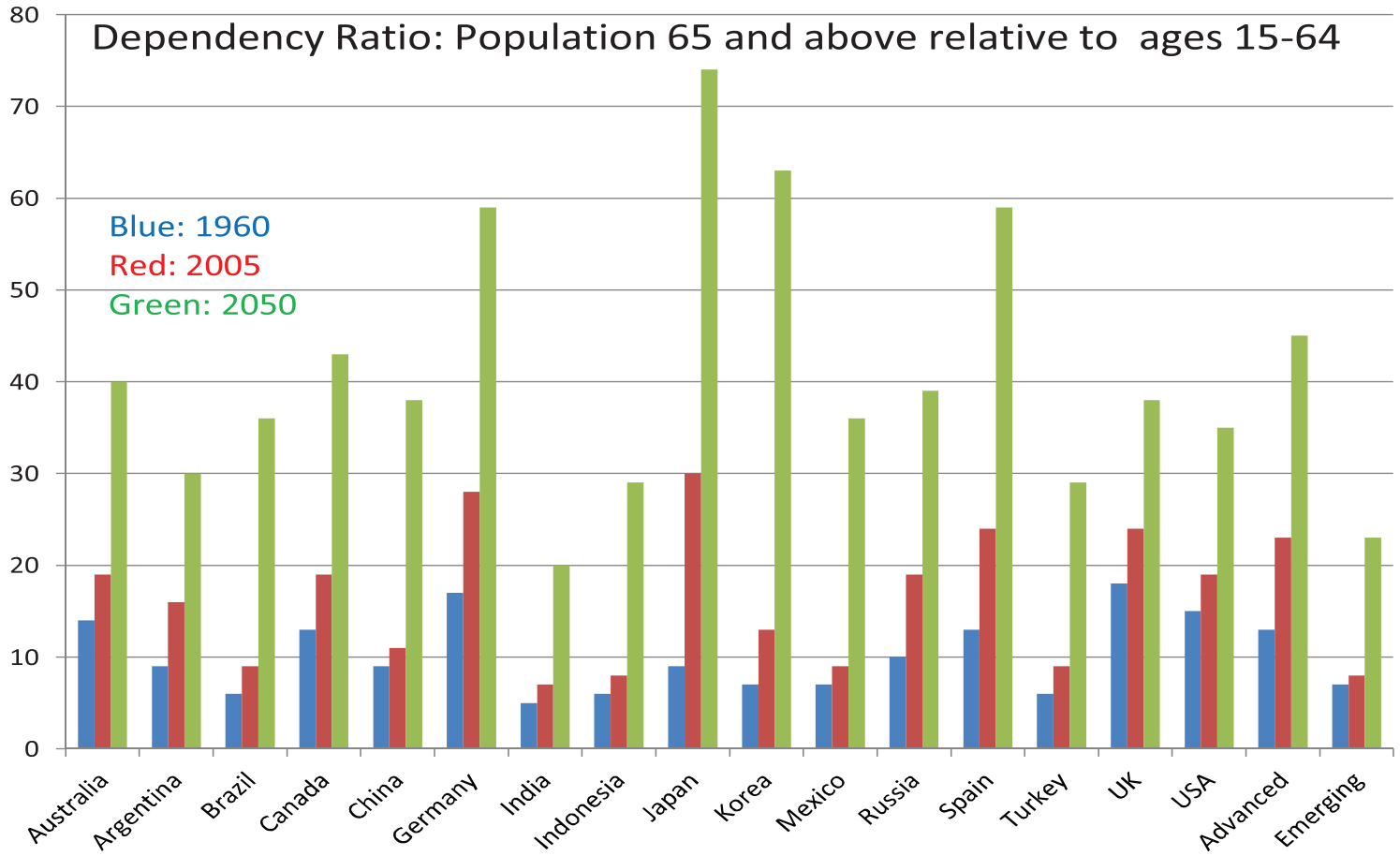


Figure 7: Changes in Dependency Ratio

Remark: Fiscal stress in advanced economies

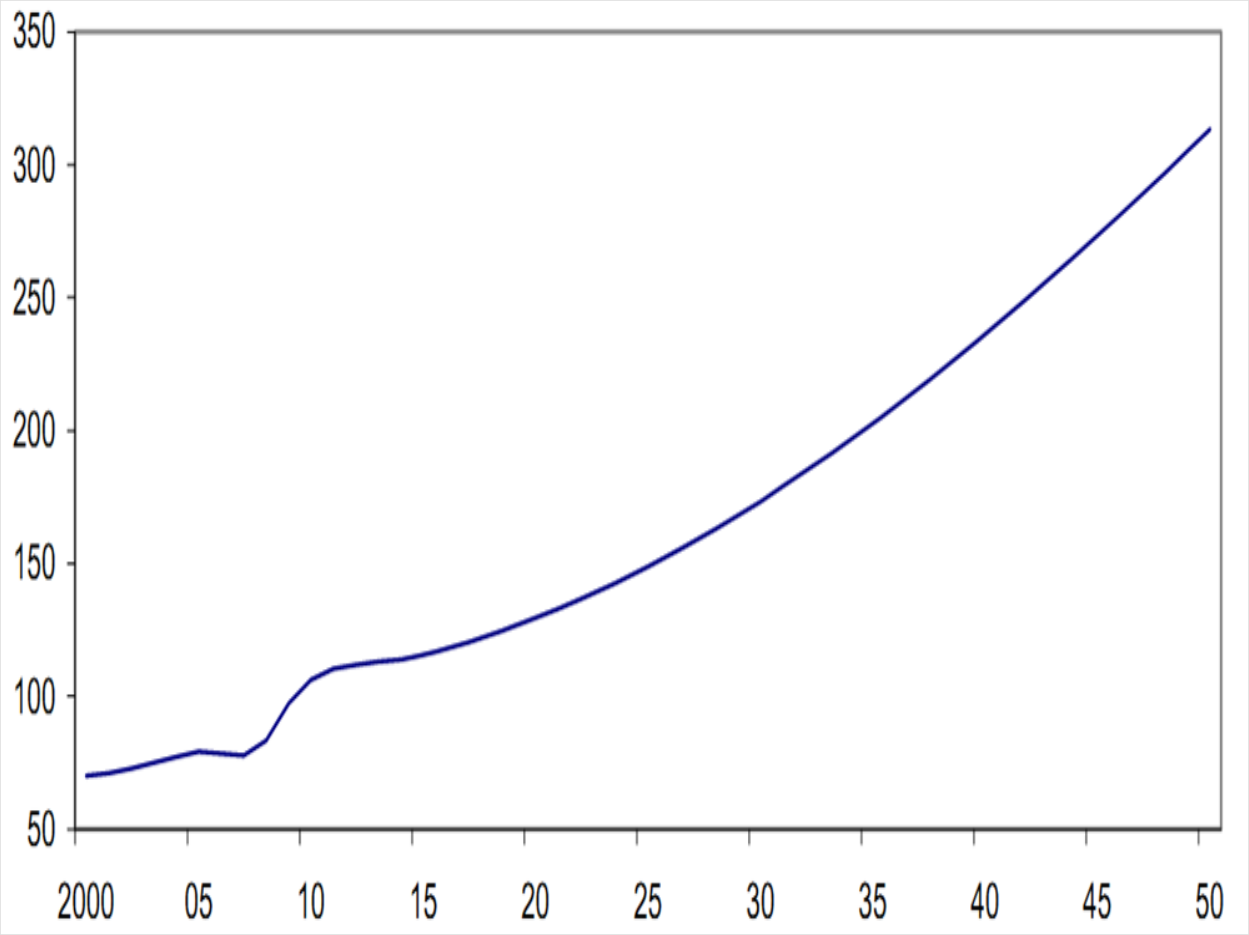


Figure 8: Government Debt to GDP in Advanced G-20 Countries by IMF 2011

Future Work

- Sustainable pension with means-testing
- Optimal design of tax-transfer systems in ageing economies