

Low Fertility and Economic Growth

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Societies

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- We are grateful to the 23 NTA research teams which have constructed accounts presented here.
- Thanks also to Diana Wongkaren for her assistance with calculations.



Main Points

- Question: How does fertility affect standards of living?
 - Support ratio
 - Lifetime consumption
- Answer:
 - Large transitory changes in the support ratio
 - In the long run, above replacement fertility would maximize the support ratio in most countries.
 - But below replacement fertility would maximize lifetime consumption in most countries in the long run.

Main Points

- Question: Does the effect of fertility depend to a significant degree on observed differences in the economic lifecycle?
Differences susceptible to policy?
- Answer: Observed differences in the age patterns of consumption and labor income have substantial effects on the support ratio, lifetime consumption, and the fertility rate that will maximize them.

Simple Growth Identity

$$\frac{Y}{N} = \frac{Y}{L} \frac{L}{N}, \text{ or}$$

$$\text{gr}[Y/N] = \text{gr}[Y/L] + \text{gr}[L/N]$$

Y – Income

N – Population or effective number of consumers

L – Effective number of workers

L/N - Support ratio

$\text{gr}[\]$ - Growth rate

Support Ratio Defined

$$SR_t = \frac{L}{N} = \frac{\sum_x y_l(x, t_0) P(x, t)}{\sum_x c(x, t_0) P(x, t)}$$

y_l – Age index of labor productivity

c – Age index of consumption

P – Population.

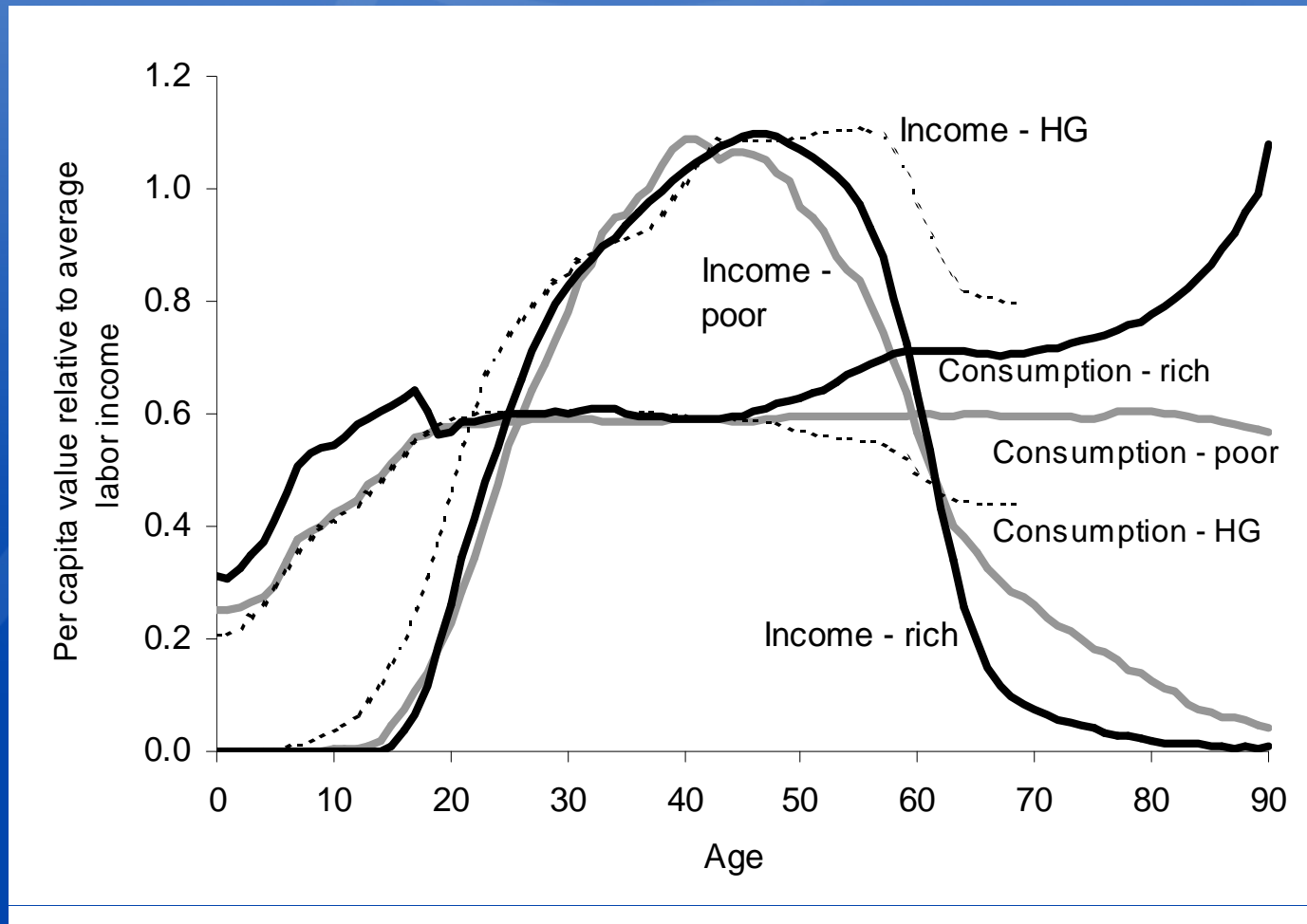
Data

- Population – World Population Prospects except for Taiwan
- Consumption and labor income profiles
 - National Transfer Account estimates
 - Labor income profile is based on estimated age profile combining earnings, employer provided benefits, self-employment labor income, and the value of the labor of unpaid family workers.
 - Consumption includes all public and private consumption

NTA Estimates

- Constructed by research teams in each country using a common methodology.
- Accounts are consistent with National Income and Product Accounts.
- Age profiles based on household surveys of wages, income, and consumption and administrative records on taxes collected and benefits paid by public programs.
- Estimates are currently being constructed in 35 countries. Estimates have been completed and reviewed for 23 economies used here.
- Details are available at www.ntaccounts.org and in Lee and Mason, lead authors and editors, forthcoming. *Population and the Generational Economy: A Global Perspective* (Cheltenham, UK: Edward Elgar).

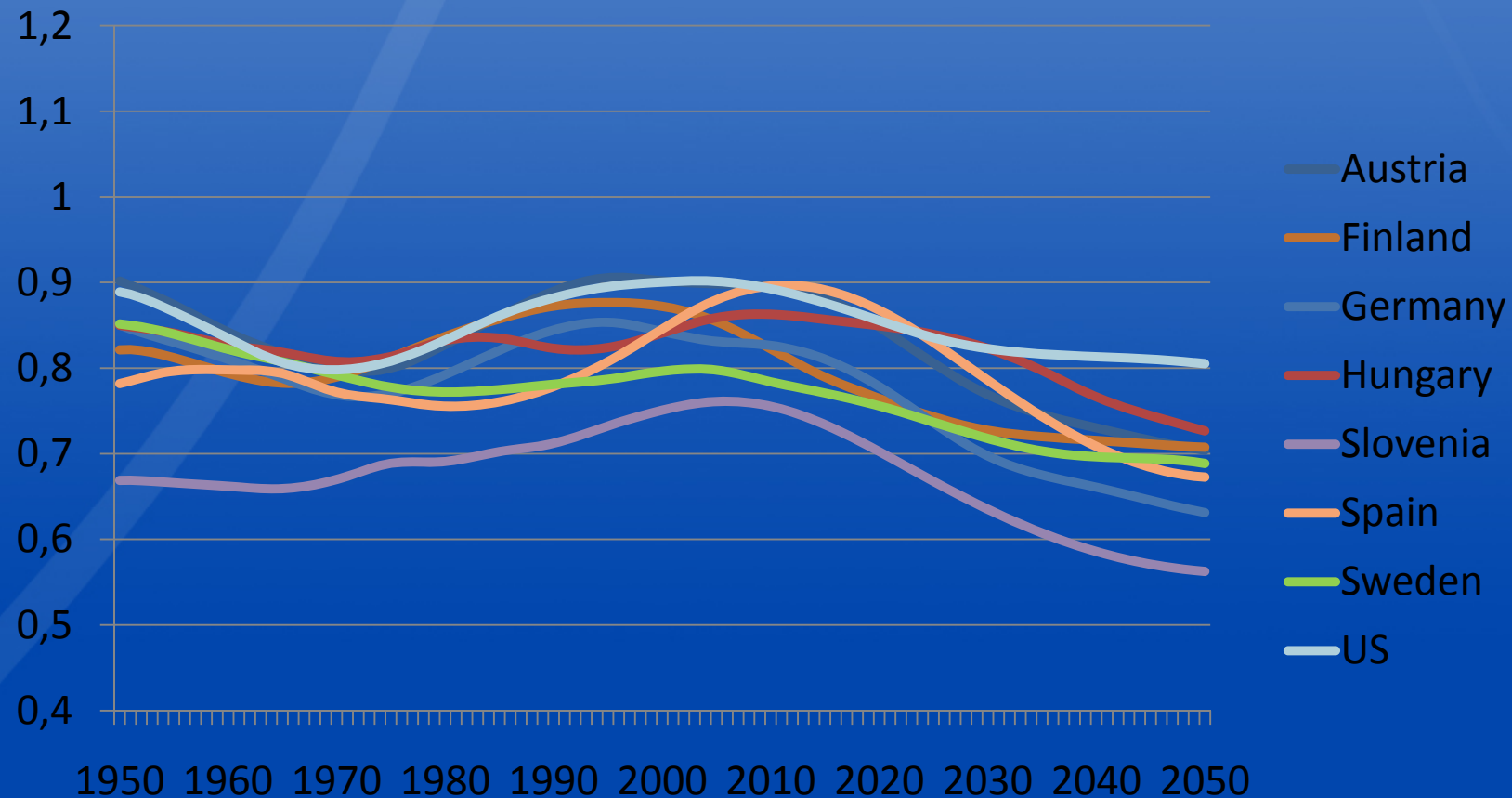
Profiles of labor income and consumption High and low-income countries



Source: Lee and Mason forthcoming.

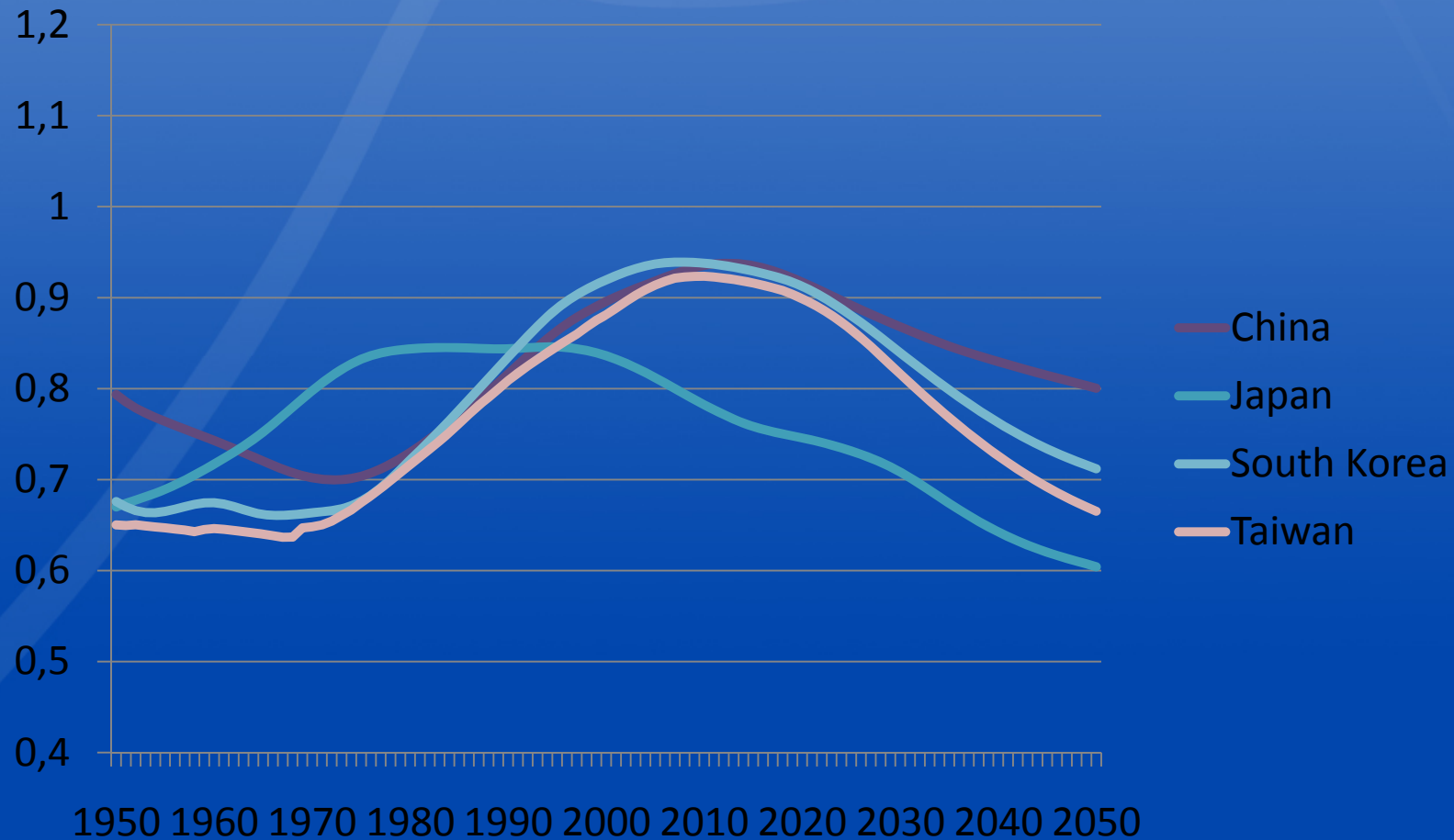
Support Ratio, 1950-2050

Europe and the US



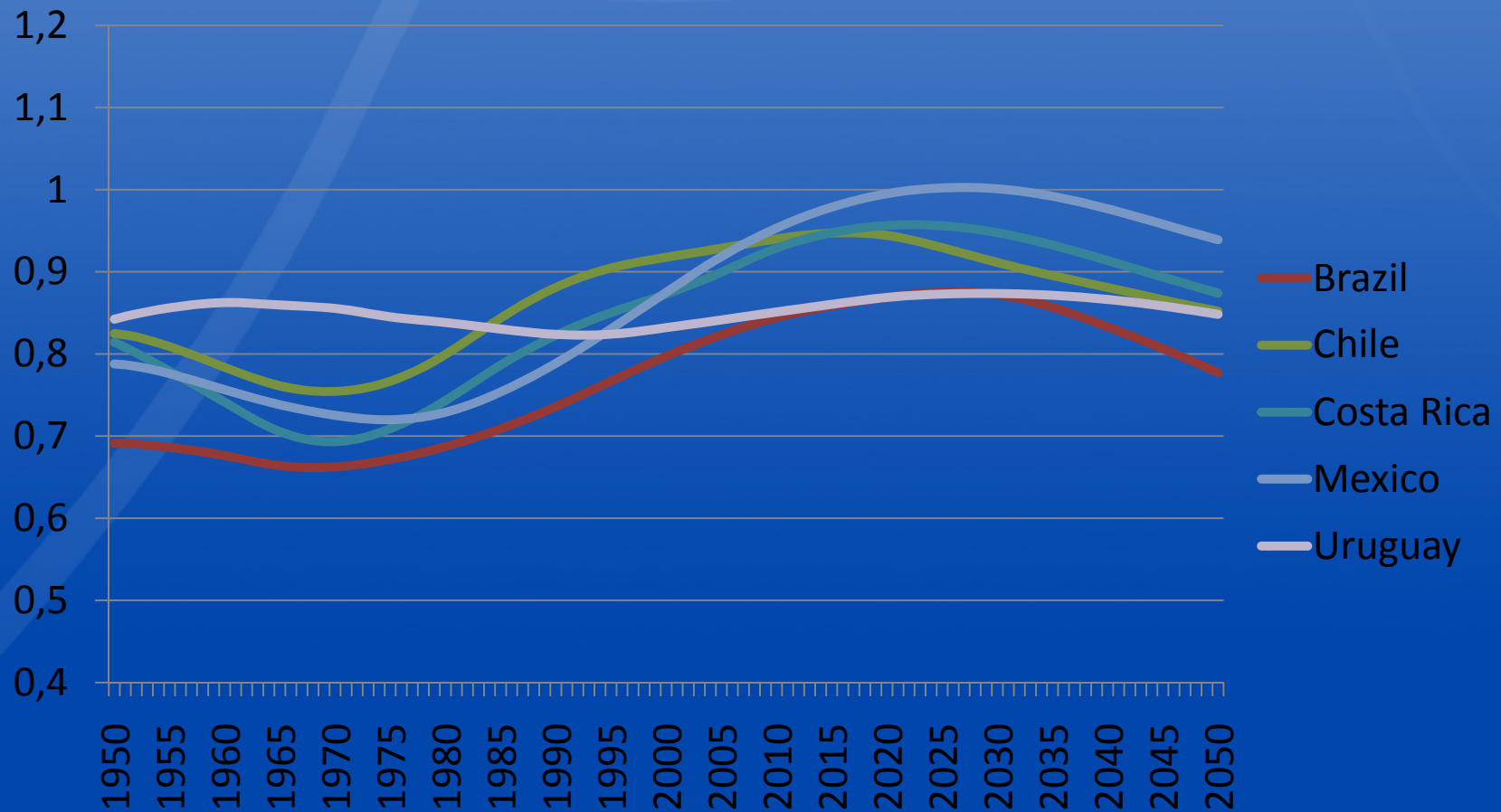
Support Ratio, 1950-2050

East Asia NTA economics



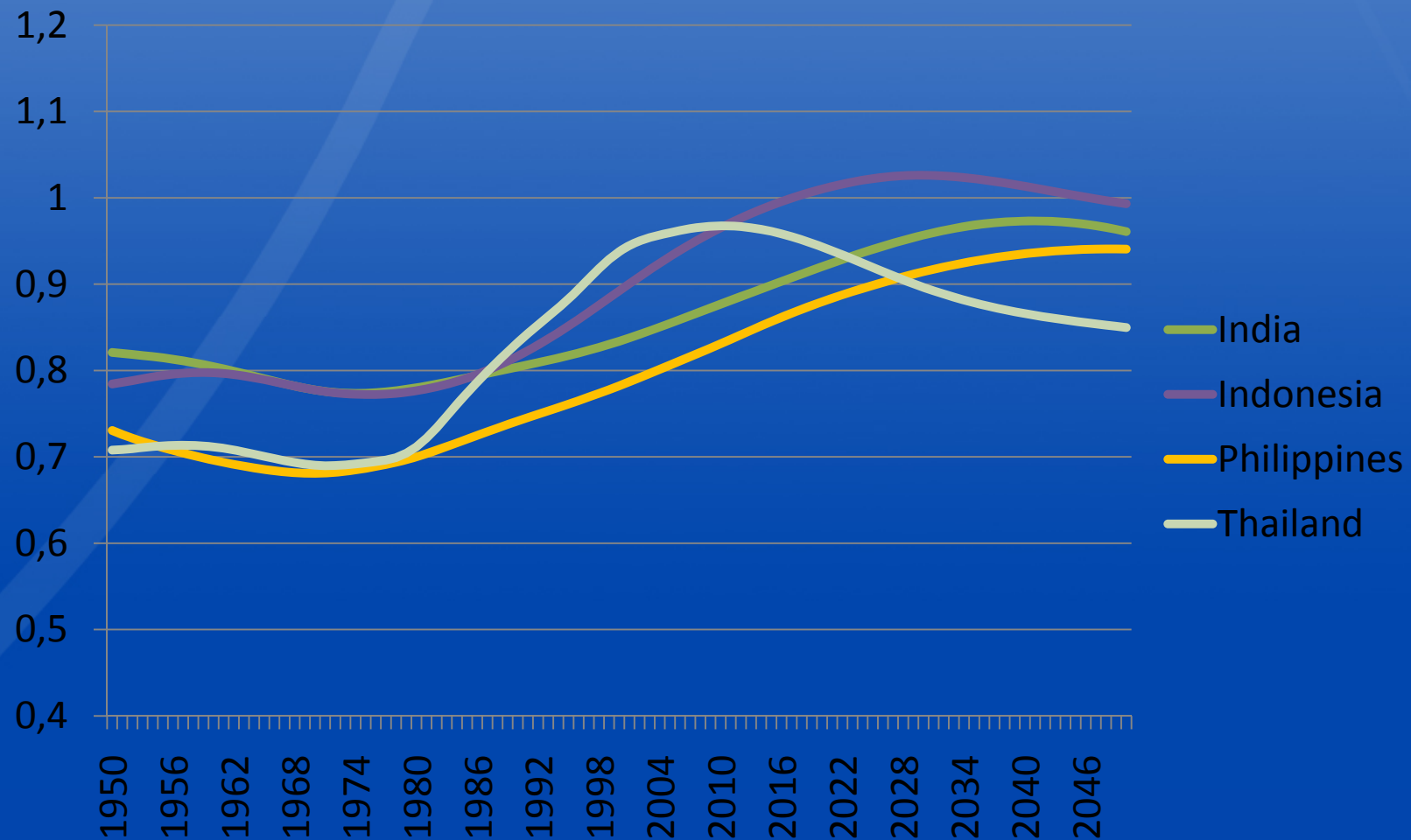
Support Ratio, 1950-2050

Latin America NTA Countries



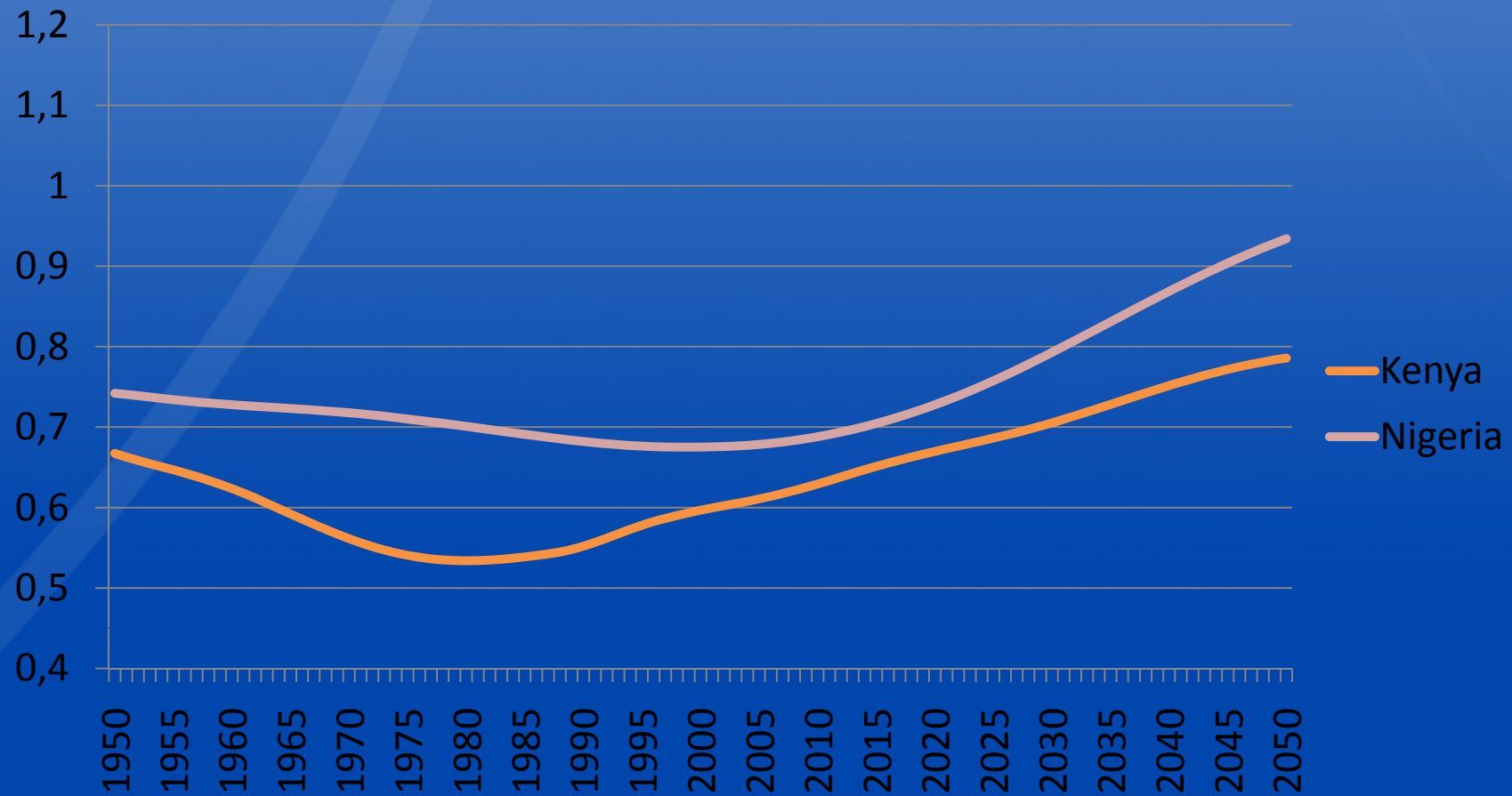
Support ratio, 1950-2050

South and SE Asia NTA Countries



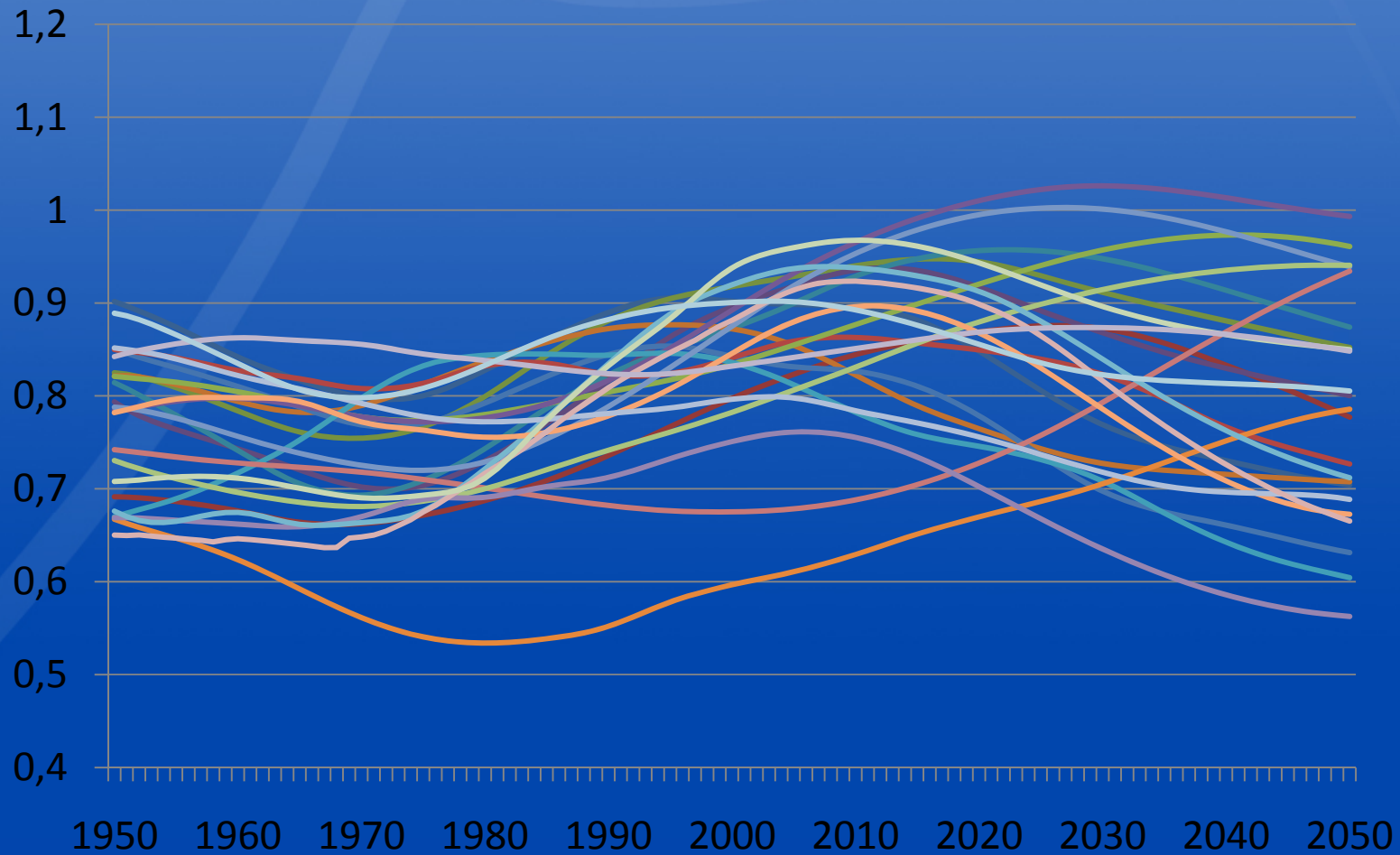
Support Ratio, 1950-2050

African NTA countries



Support ratio, 1950-2050

23 NTA Countries



Demographic Dividend

Increase in SR – trough to peak

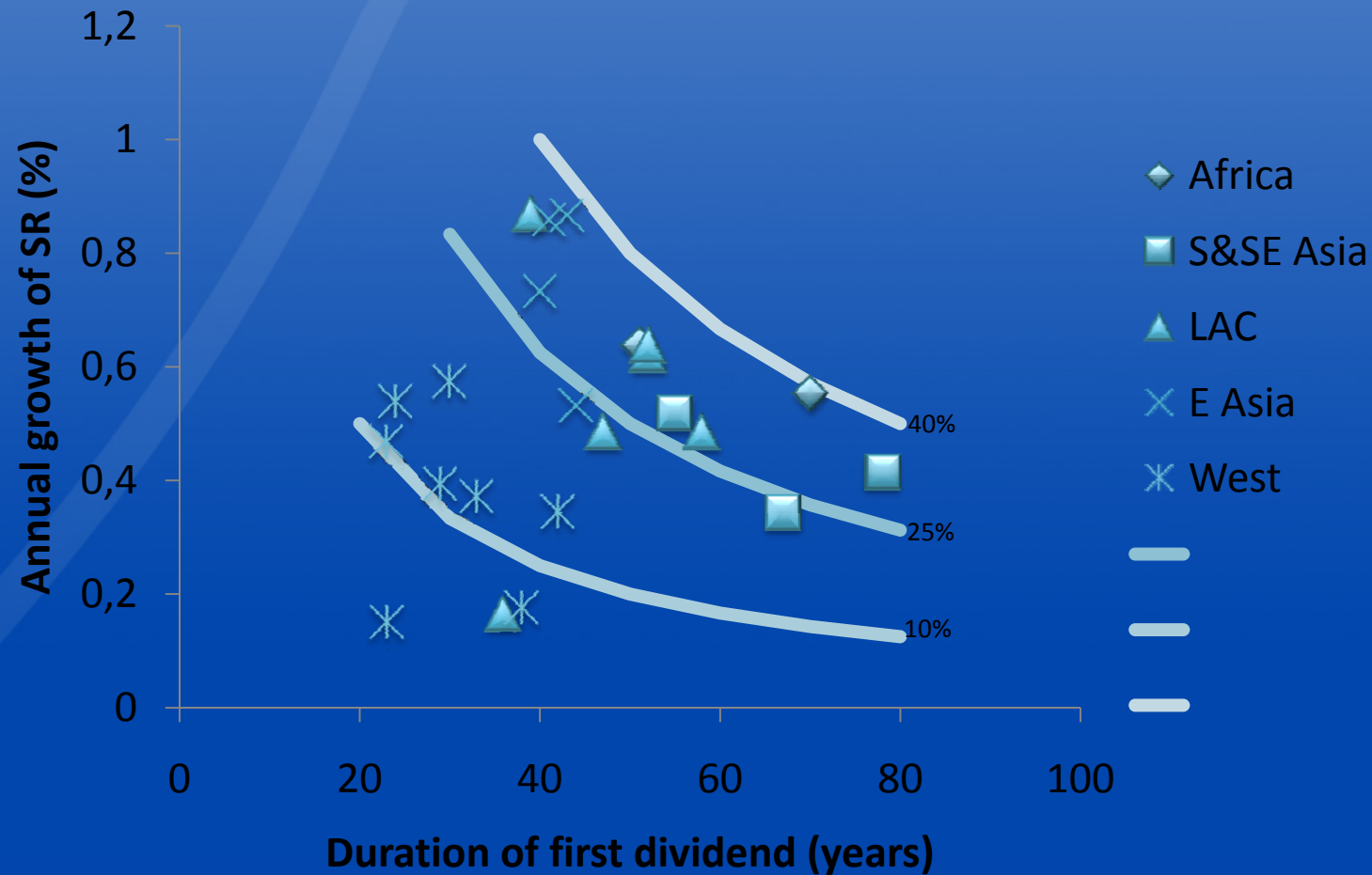
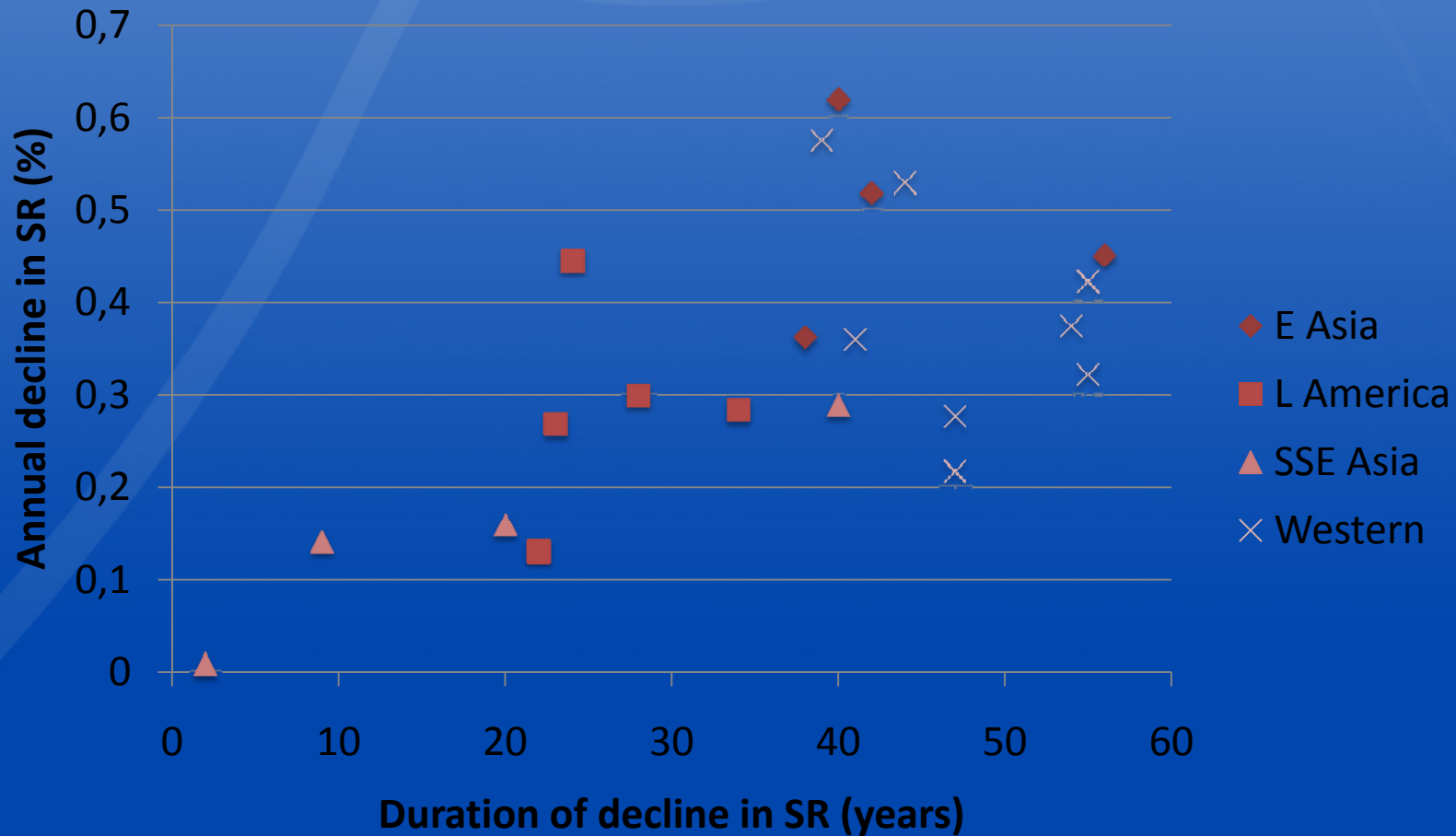


Table 1. Support ratios for aging populations.

Country	Support Ratios		Maximum value	Year	Decline to 2010 [1]			Decline to 2050 [1]		
	2010	2050	Support ratio		Duration	Decline (%)	Annual decline (%)	Duration	Decline (%)	Annual decline (%)
Kenya	0.63	0.79	0.79	2050	-	-	-	-	-	-
Nigeria	0.69	0.93	0.93	2050	-	-	-	-	-	-
Africa	0.66	0.86	0.86	2050	-	-	-	-	-	-
China	0.94	0.80	0.94	2012	-	-	-	38	14.6	0.36
Japan	0.78	0.60	0.85	1994	16	7.5	0.45	56	28.6	0.45
South Korea	0.94	0.71	0.94	2008	2	0.1	0.06	42	24.2	0.52
Taiwan	0.92	0.67	0.92	2010	-	-	-	40	28.0	0.62
East Asia	0.89	0.70	0.91	2006	5	1.9	0.13	44	23.8	0.49
Brazil	0.84	0.78	0.88	2026	-	-	-	24	11.3	0.45
Chile	0.94	0.85	0.95	2016	-	-	-	34	10.1	0.28
Costa Rica	0.93	0.87	0.96	2022	-	-	-	28	8.7	0.30
Mexico	0.95	0.94	1.00	2027	-	-	-	23	6.3	0.27
Uruguay	0.85	0.85	0.87	2028	-	-	-	22	2.9	0.13
Latin America	0.90	0.86	0.93	2024	-	-	-	26	7.9	0.28
India	0.88	0.96	0.97	2041	-	-	-	9	1.3	0.14
Indonesia	0.97	0.99	1.03	2030	-	-	-	20	3.2	0.16
Philippines	0.83	0.94	0.94	2048	-	-	-	2	0.0	0.01
Thailand	0.97	0.85	0.97	2010	-	-	-	40	12.2	0.29
S & SE Asia	0.91	0.94	0.98	2032	-	-	-	18	4.2	0.15
Austria	0.90	0.70	0.91	1996	14	1.2	0.08	54	22.3	0.37
Finland	0.82	0.71	0.88	1995	15	6.2	0.40	55	19.3	0.32
Germany	0.83	0.63	0.85	1995	15	3.2	0.21	55	26.0	0.42
Hungary	0.86	0.73	0.86	2009	1	0.0	0.03	41	15.8	0.36
Slovenia	0.76	0.56	0.76	2006	4	0.7	0.19	44	26.1	0.53
Spain	0.90	0.67	0.90	2011	-	-	-	39	25.0	0.57
Sweden	0.78	0.69	0.80	2003	7	1.9	0.27	47	13.8	0.28
US	0.89	0.81	0.90	2003	7	1.1	0.15	47	10.7	0.22
Europe & US	0.84	0.69	0.86	2002	8	1.8	0.16	48	19.9	0.38

Population Aging

Decline in Support Ratio to 2050



Decline in the support ratio Peak to 2050

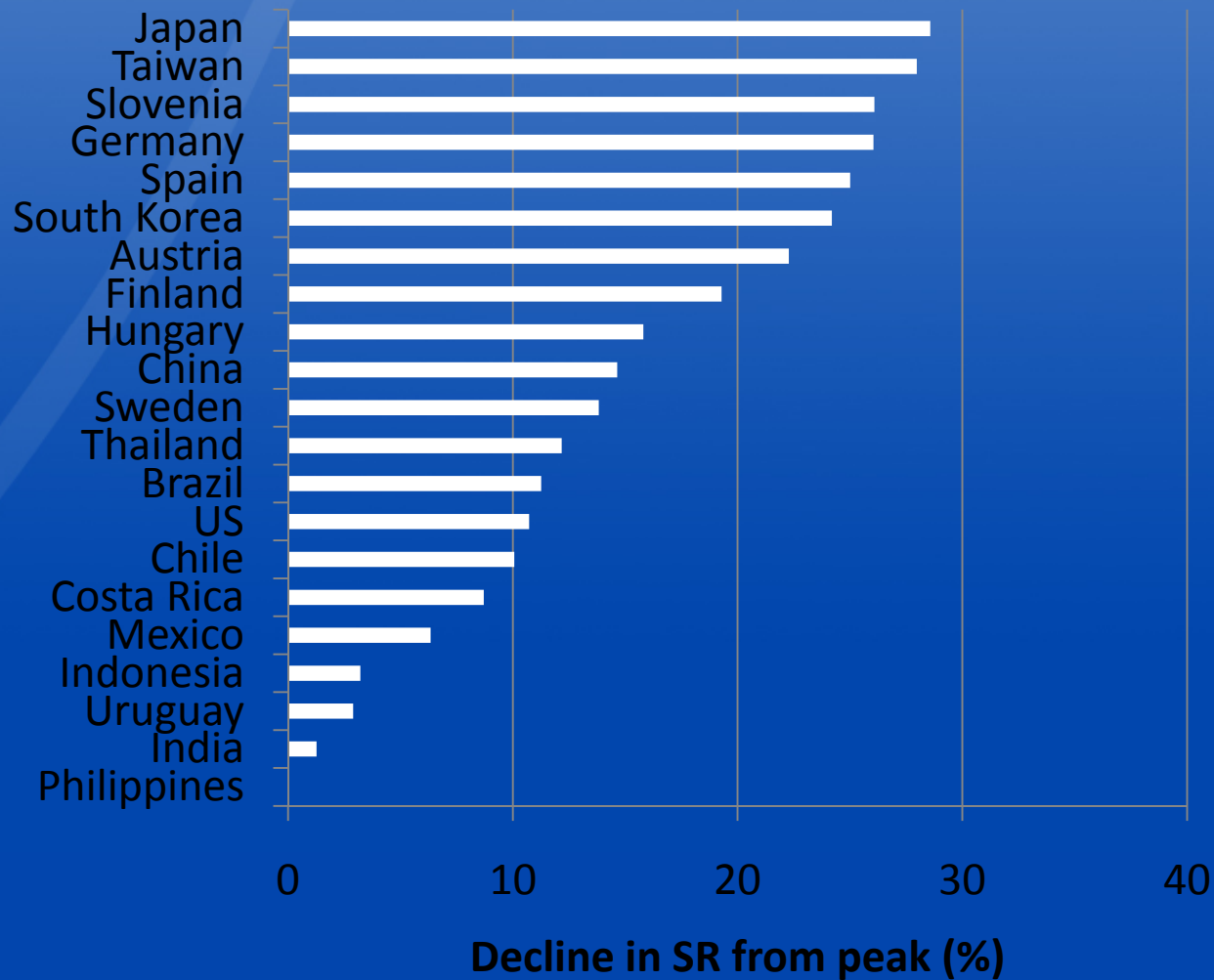


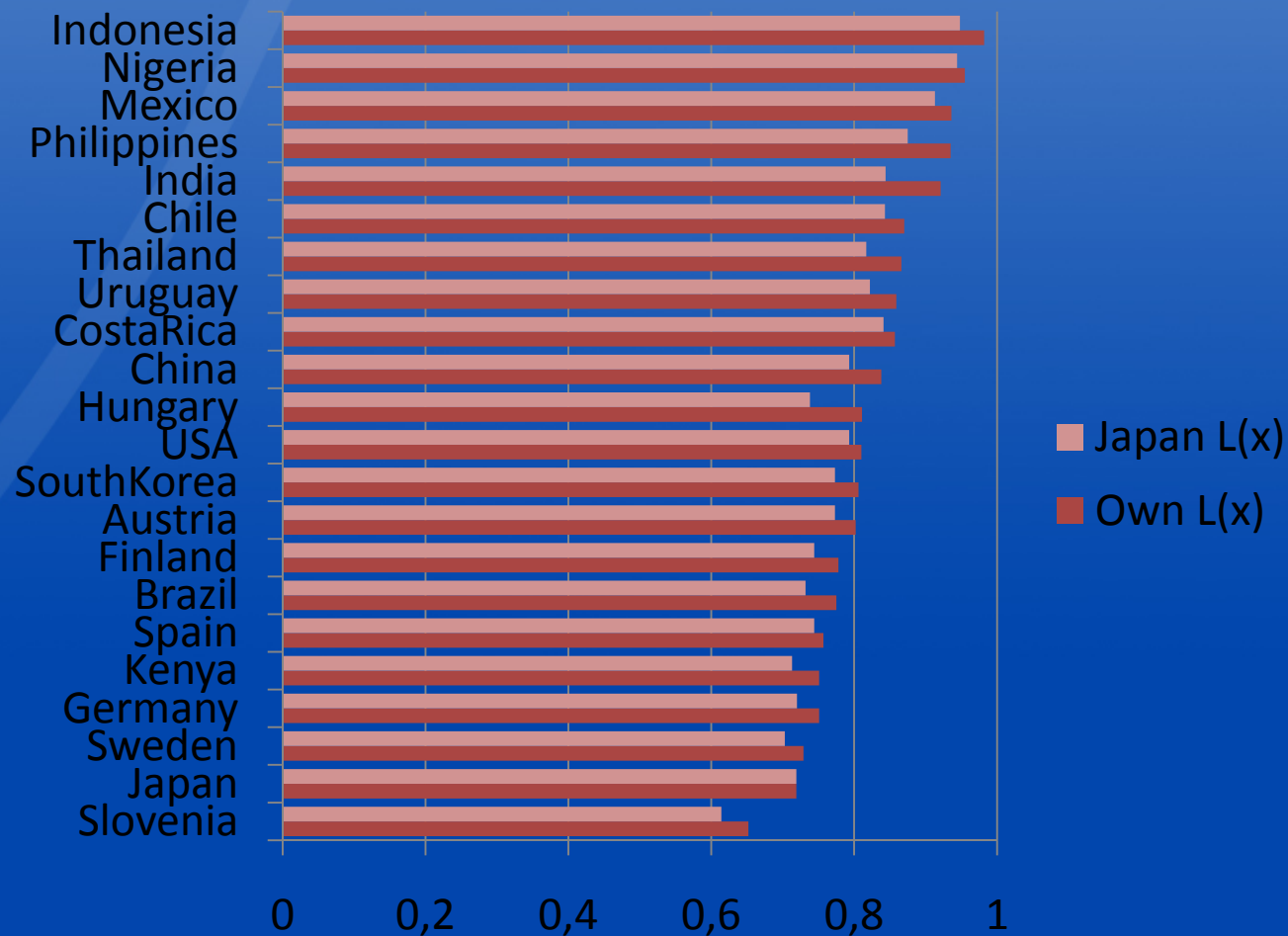
Table 2 . Mean ages of consumption and labor income, support ratios given replacement fertility and own survival schedule or survival schedule for Japan.

	Own survival schedule					Japan survival schedule			
Country	A _C	A _{YI}	Ac-Ayl	Support ratio	A _C	A _{YI}	Ac-Ayl	Support ratio	
Slovenia	39.9	40.5	-0.6	0.652	42.7	40.7	2.0	0.614	
Japan	45.8	45.1	0.7	0.719	45.8	45.1	0.7	0.719	
Sweden	44.4	43.9	0.5	0.729	45.9	44.0	2.0	0.703	
Germany	44.3	42.6	1.8	0.751	46.1	42.7	3.5	0.72	
Kenya	37.6	40.5	-2.9	0.751	44.4	42.1	2.3	0.713	
Spain	42.5	42.8	-0.3	0.757	43.4	42.8	0.5	0.744	
Brazil	43.7	43.3	0.3	0.775	47.1	44.1	3.0	0.732	
Finland	42.6	42.6	0.0	0.778	44.8	42.8	2.0	0.744	
Austria	42.8	39.7	3.1	0.802	44.4	39.8	4.6	0.773	
S. Korea	39.7	41.7	-2.0	0.806	42.1	42.1	0.0	0.773	
US	46.2	45.3	1.0	0.81	47.4	45.5	1.9	0.793	
Hungary	40.4	42.5	-2.0	0.811	45.1	43.0	2.0	0.738	
China	40.0	42.0	-2.0	0.838	43.3	42.8	0.5	0.793	
Costa Rica	44.7	43.7	0.9	0.857	45.7	43.9	1.8	0.841	
Uruguay	41.9	43.8	-1.9	0.859	44.3	44.2	0.1	0.822	
Thailand	39.1	41.6	-2.5	0.866	43.5	42.5	1.0	0.817	
Chile	43.2	43.2	0.0	0.87	45.0	43.6	1.4	0.843	
India	40.1	43.0	-3.0	0.921	45.9	44.4	1.5	0.844	
Philippines	40.2	44.0	-3.9	0.935	44.5	45.1	-0.5	0.875	
Mexico	42.4	43.7	-1.2	0.936	44.2	44.2	0.1	0.913	
Nigeria	38.0	46.8	-8.8	0.955	46.2	49.4	-3.1	0.944	
Indonesia	38.3	43.4	-5.1	0.982	42.5	45.2	-2.7	0.948	
Averages	41.7	43.0	-1.27	0.825	44.7	43.6	1.1	0.791	

How important are differences across countries in profiles of consumption and labor income?

- Calculate the support ratio for each country
 - Own countries consumption and labor income profiles
 - Replacement fertility
 - Two mortality schedules
 - $L(x)$ for 1995-2000 for each country
 - $L(x)$ for 1995-2000 for Japan
 - No migration

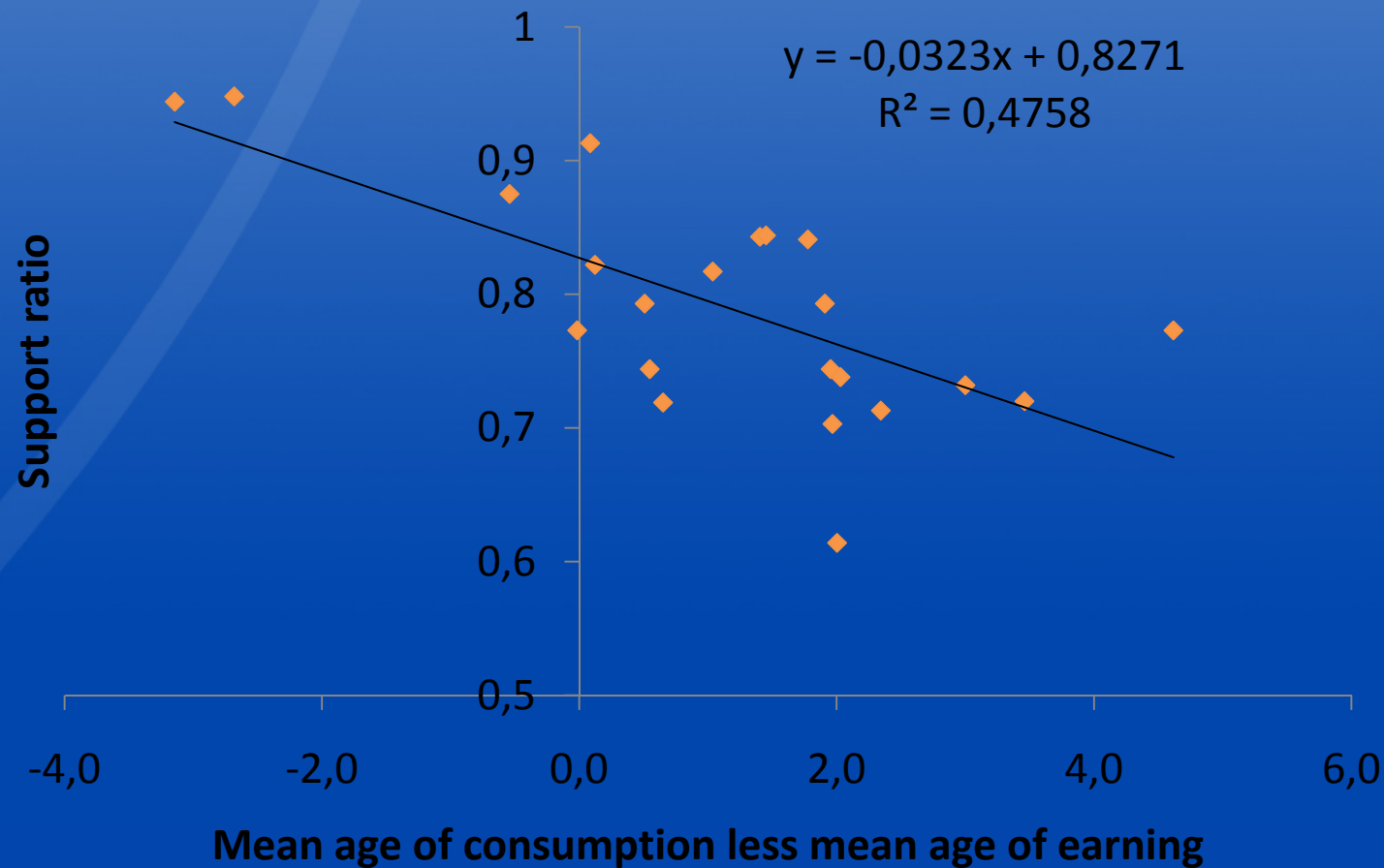
Support ratio (replacement TFR) Own L(x) and Japan L(x)



Observations

- Variation in survival has a pretty small effect
- Low income countries have a much higher support ratio. Elderly consume less and produce more.
- Even within the industrialized countries there is significant variation
 - US is 0.8, Japan is 0.72, and Slovenia is 0.65.
- The effect of the lifecycle on the support ratio can be summarized using the difference between the average age of effective consumers and producers.

Support ratio (replacement TFR) vs Ac - Ayl



Note: Japan survival schedule.

Maximum Support Ratio

First order Conditions

$$\frac{\partial \ln SR}{\partial n} = A_C - A_{Y_l},$$

where

$$A_C = \int_0^{\omega} x e^{-nx} l(x) \gamma(x) dx \Bigg/ \int_0^{\omega} e^{-nx} l(x) \gamma(x) dx$$

$$A_{Y_l} = \int_0^{\omega} x e^{-nx} l(x) Y_l(x) dx \Bigg/ \int_0^{\omega} e^{-nx} l(x) Y_l(x) dx.$$

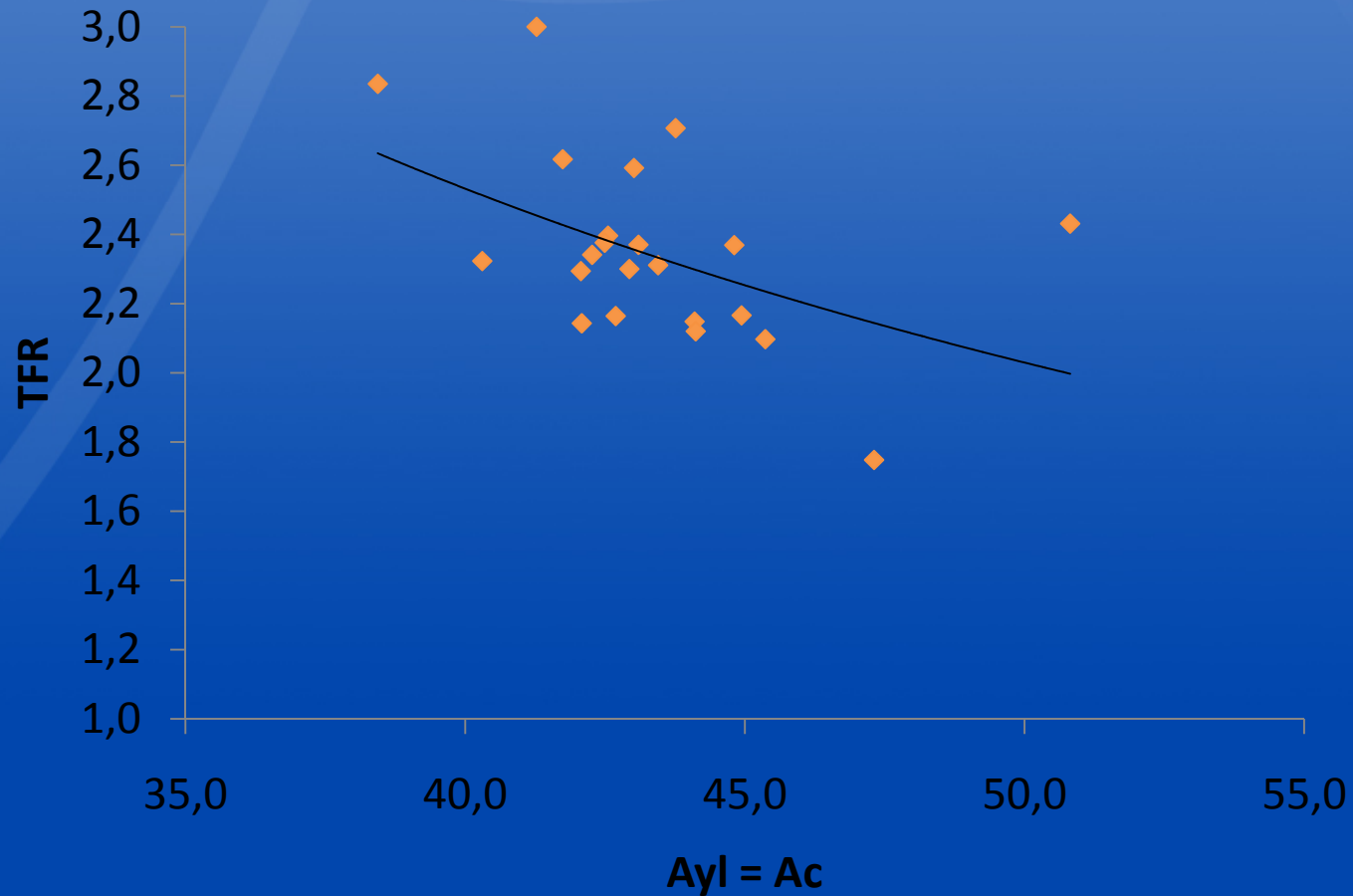
Table 3. Maximum support ratio and corresponding mean ages, TFR, and population growth rates conditional on age profiles of consumption and labor income, own survival rates for 2010.

Region	Country	Ac	Ayl	TFR	Support ratio	Pop growth rate (%)
Africa	Kenya	41.6	41.6	2.0	0.76	-0.820
Africa	Nigeria	51.6	51.6	1.3	1.10	-3.121
E Asia	China	43.0	43.0	2.0	0.84	-0.610
E Asia	Japan	44.9	44.9	2.2	0.72	0.133
E Asia	South Korea	42.6	42.6	1.8	0.81	-0.554
Europe/US	Austria	38.7	38.7	2.6	0.81	0.753
Europe/US	Finland	42.6	42.6	2.1	0.78	0.000
Europe/US	Germany	42.1	42.1	2.4	0.75	0.414
Europe/US	Hungary	43.1	43.1	1.8	0.82	-0.534
Europe/US	Slovenia	40.7	40.7	2.0	0.65	-0.136
Europe/US	Spain	42.9	42.9	2.0	0.76	-0.061
Europe/US	Sweden	43.8	43.8	2.1	0.73	0.091
Europe/US	US	44.9	44.9	2.2	0.81	0.229
Latin America	Brazil	43.2	43.2	2.2	0.78	0.085
Latin America	Chile	43.2	43.2	2.1	0.87	0.003
Latin America	Costa Rica	43.3	43.3	2.2	0.86	0.261
Latin America	Mexico	44.4	44.4	1.9	0.94	-0.386
Latin America	Uruguay	44.5	44.5	1.8	0.86	-0.483
SSE Asia	India	44.7	44.7	1.9	0.94	-0.998
SSE Asia	Indonesia	47.4	47.4	1.3	1.04	-2.021
SSE Asia	Philippines	46.4	46.4	1.5	0.96	-1.295
SSE Asia	Thailand	42.7	42.7	1.7	0.88	-0.734

Table 4 . Maximum support ratio and corresponding mean ages, TFR, and population growth rates conditional on age profiles of consumption and labor income, Japan survival rates for 2010.

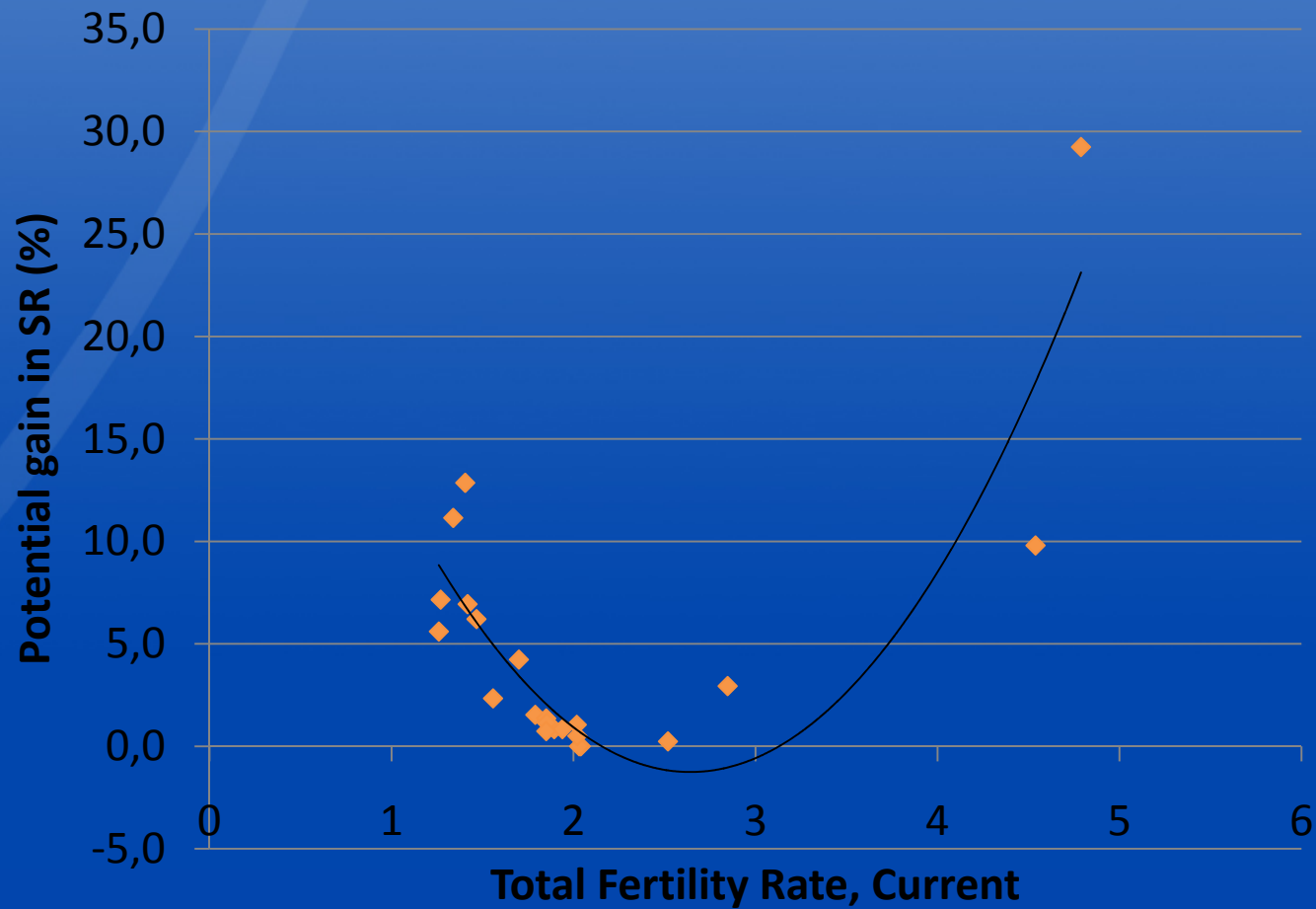
Region	Country	Ac	Ayl	TFR	Support ratio	Pop growth rate (%)
Africa	Kenya	41.3	41.3	2.4	0.72	0.553
Africa	Nigeria	50.8	50.8	1.6	0.96	-0.844
E Asia	China	42.6	42.6	2.3	0.79	0.132
E Asia	Japan	44.9	44.9	2.2	0.72	0.133
E Asia	South Korea	42.1	42.1	2.1	0.77	-0.004
Europe/US	Austria	38.4	38.4	2.4	0.79	1.045
Europe/US	Finland	42.3	42.3	2.3	0.75	0.404
Europe/US	Germany	41.7	41.7	2.6	0.73	0.751
Europe/US	Hungary	42.5	42.5	2.4	0.74	0.436
Europe/US	Slovenia	40.3	40.3	2.3	0.62	0.378
Europe/US	Spain	42.7	42.7	2.2	0.74	0.120
Europe/US	Sweden	43.4	43.4	2.3	0.71	0.347
Europe/US	US	44.8	44.8	2.3	0.80	0.435
Latin America	Brazil	43.0	43.0	2.4	0.74	0.700
Latin America	Chile	42.9	42.9	2.3	0.85	0.361
Latin America	Costa Rica	43.1	43.1	2.4	0.84	0.473
Latin America	Mexico	44.1	44.1	2.1	0.91	0.025
Latin America	Uruguay	44.1	44.1	2.1	0.82	0.029
SSE Asia	India	43.8	43.8	2.3	0.85	0.383
SSE Asia	Indonesia	47.3	47.3	1.6	0.96	-0.865
SSE Asia	Philippines	45.4	45.4	2.0	0.88	-0.144
SSE Asia	Thailand	42.1	42.1	2.2	0.82	0.254

SR Maximizing TFR



Note: Japan survival schedule.

Percentage Difference in SR Current TFR vs Max SR



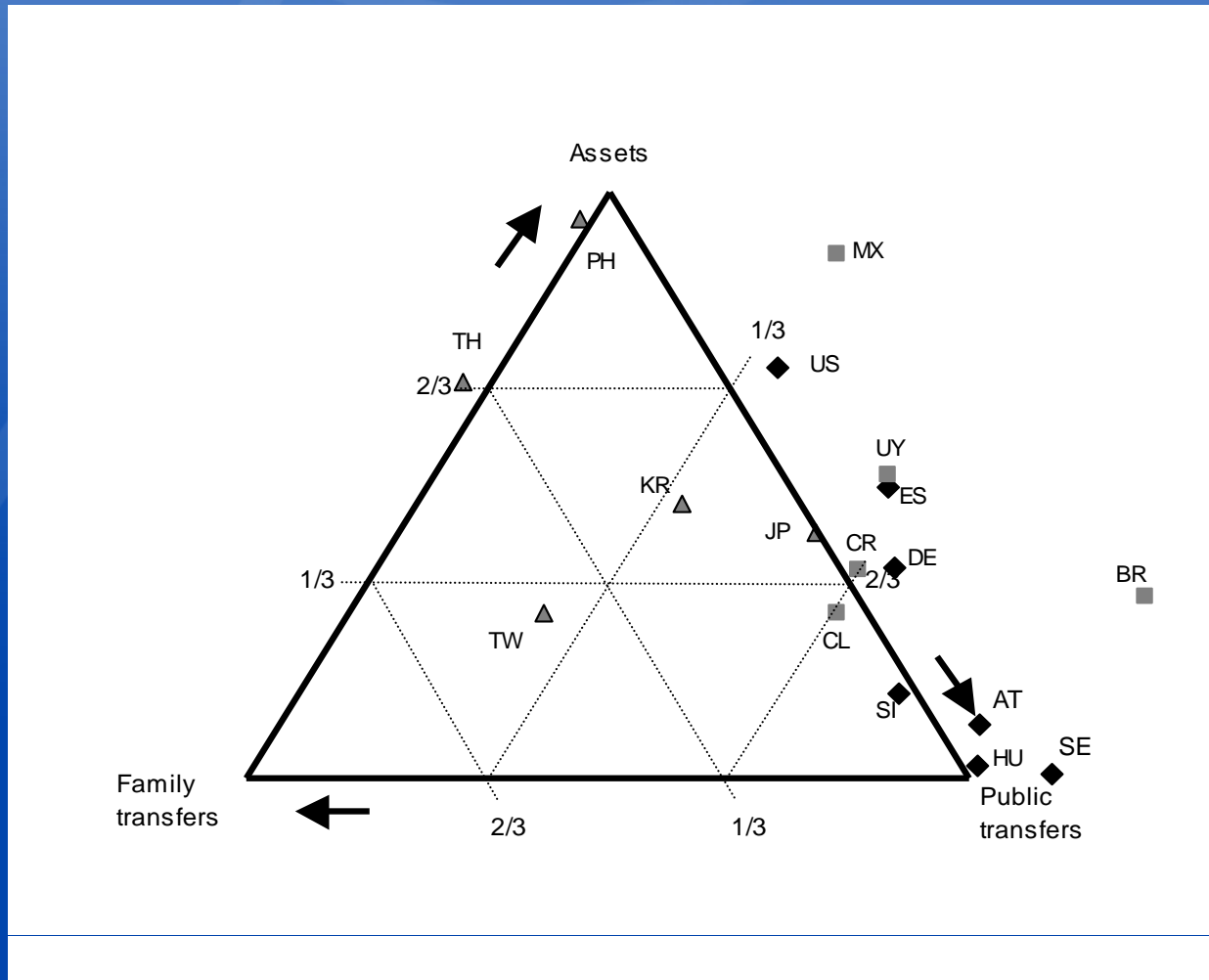
Maximum lifetime consumption

First order conditions

$$dC(n)/dn = C(n)(A_c - A_{yl}) - K \quad \text{or}$$

$$\frac{dC(n)/dn}{C(n)} = A_c - A_{yl} - \frac{K}{C(n)}.$$

Source: Arthur and McNicoll (1978)



Source: Mason and Lee forthcoming.

Comparison of SR maximizing and C maximizing TFR ($K/C = 4$)



Table 5. Summary measures given fertility rate that maximizes lifetime consumption, given age-profiles of consumption and labor income and current Japanese survival rates; $K/C = 4.0$.

Country	AC	Ayl	TFR	Support ratio	Population growth rate (%)
Kenya	46.7	42.7	1.8	0.71	-0.4
Nigeria	56.9	52.9	1.2	0.94	-2.0
China	48.5	44.5	1.7	0.78	-0.9
Japan	50.1	46.1	1.7	0.71	-0.7
S Korea	47.6	43.6	1.6	0.76	-1.0
Austria	43.6	39.6	2.2	0.78	0.1
Finland	47.4	43.4	1.8	0.74	-0.4
Germany	46.8	42.8	2.0	0.72	-0.1
Hungary	47.6	43.6	1.8	0.73	-0.4
Slovenia	45.1	41.1	1.9	0.61	-0.4
Spain	47.8	43.8	1.7	0.73	-0.7
Sweden	48.5	44.5	1.9	0.70	-0.4
US	50.3	46.3	1.8	0.78	-0.5
Brazil	48.5	44.5	1.9	0.73	-0.2
Chile	48.7	44.7	1.7	0.83	-0.7
Costa Rica	49.0	45.0	1.8	0.83	-0.6
Mexico	50.4	46.4	1.5	0.89	-1.1
Uruguay	49.6	45.6	1.6	0.81	-0.9
India	49.7	45.7	1.8	0.83	-0.7
Indonesia	55.0	51.0	1.1	0.94	-2.3
Philippines	51.5	47.5	1.5	0.86	-1.2
Thailand	47.6	43.6	1.7	0.80	-0.7

Bottom Line

- Low fertility may require painful adjustments on the part of governments.
- Low fertility could lead to substantial depopulation which may be viewed as undesirable on a number of grounds.
- Low fertility should not lead to lower standards of living as long as transfers to the elderly are kept in check and capital accumulation is not undermined.
- Very low fertility seems undesirable on all grounds.

Mahalo