How Low Should Fertility Go? Capital, Transfers and Consumption: Population aging and Its macroeconomic Consequences

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Work is fully joint by Andy and me. I just happen to be presenting.
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Global population aging

- Due mainly to low fertility; also to long life.
- Fertility is falling almost everywhere or is already low.
- 42% of world population lives in countries where fertility is below replacement level (UN 2011).
- Current TFR
  - Europe 1.6
  - China might be 1.5 to 1.8 (?)
  - Japan 1.4
  - Brazil 1.8
  - Taiwan .9

Government attitudes toward fertility in 2009 (UN 2011)

- 56 countries: viewed as **too high**
- 51 countries: viewed as **too low**

- What level of fertility is “best” for minimizing dependency and maximizing the support ratio?

Support ratios

Our labor income and consumption profiles are:

$c_0(x)$ = consumption by age measured in NTA base year

$y_{l0}(x)$ = labor income by age measured in NTA base year

- Consider a simple economy
  - all income is labor income
  - all income is consumed each year.
- Then the population-weighted sum of consumption and labor income must be equal.

- Let β be the multiplier for the level of consumption .
- The basic identity for simple economy in which labor is the only source of income is:

$$\beta(t)\int_0^{\omega} Pop(x,t)\,c_0(x)\,dx = \int_0^{\omega} Pop(x,t)\,y_{l0}(x)\,dx$$

- Solve this for β(t), relative level of consumption at t:

$$\beta(t) = \frac{\int_0^{\omega} Pop(x,t)\,y_{l0}(x)\,dx}{\int_0^{\omega} Pop(x,t)\,c_0(x)\,dx} = \text{Support Ratio}(t)$$

III. Is post-transition fertility too low?

- Falling fertility over the demographic transition causes big fluctuations in age distribution generating the dividends.
- Post-transition low fertility will change less. Populations will grow older.
- Constant fertility would lead to an approximately stable population age distribution
  - Depends on mortality too, but less so

- Each level of constant fertility generates a different stable population age distribution and different support ratio.
- The stable population age distribution is:

$$Pop(x) \text{ proportional to } e^{-nx} l(x)$$

- Here we ask: What level of n above would minimize dependency and maximize support?
- When we know this value of n we can calculate the level of fertility that would generate it.

The level of the consumption profile is given by β

For a stable population with growth rate n we have:

$$\beta = \frac{\int_0^{\omega} e^{-nx} l(x) y_{l0}(x) dx}{\int_0^{\omega} e^{-nx} l(x) c_0(x) dx}$$

To find the n that maximizes β we differentiate β with respect to n:

$$d\beta(n)/dn = A_c - A_{y_l}$$

Where A_c, A_{yl} are the average ages of consumption and labor income in the stable population.

- If on average people consume later in the life cycle than they earn (if $A_c > A_{yl}$), then the average dollar is transferred upwards from younger to older.
- Then it is advantageous to have more younger givers of transfers and fewer older receivers of transfers.
  - This happens with higher fertility and higher n.
  - Conversely when $A_c < A_{yl}$

- The condition for optimal growth is that the derivative is 0, which requires that $A_c = A_{yl}$. As we vary n, the average ages change, and we find n that makes them equal.

- For each country we can find this n numerically, given the age profiles of consumption and labor income.

- Once we find n, we can find the corresponding fertility using the approximation:

$$n \approx \frac{\ln\left(TFR/2.05\right)}{\text{Av Age of Childbearing}}$$

Steady-state support ratios, and TFR that maximizes SR for current survival rates.

In almost all countries, "optimal" fertility is at near replacement or below.

Exceptions are Austria and Germany (2.6, 2.4) where work starts at young age and elderly retire early and are costly.

In Nigeria, Indonesia, Philippines, "optimal" is very low, 1.3 to 1.5, where elderly keep working and have low net cost. In Nigeria young earn very little.

Country	Current TFR	Intrinsic support ratio	TFR for Max Supp ratio		Replacement support ratio
			TFR	Support ratio	
Kenya	4.5	0.67	**2.0**	0.76	0.75
Nigeria	4.8	0.81	**1.3**	1.10	0.96
China	1.8	0.84	**2.0**	0.84	0.84
Japan	1.3	0.67	**2.2**	0.72	0.72
South Korea	1.3	0.79	**1.8**	0.81	0.81
India	2.5	0.92	**1.9**	0.94	0.92
Indonesia	2.0	1.00	**1.3**	1.04	0.98
Philippines	2.8	0.89	**1.5**	0.96	0.94
Thailand	1.9	0.87	**1.7**	0.88	0.87
Brazil	1.7	0.76	**2.2**	0.78	0.78
Chile	1.9	0.87	**2.1**	0.87	0.87
Costa Rica	1.9	0.85	**2.2**	0.86	0.86
Mexico	2.0	0.94	**1.9**	0.94	0.94
Uruguay	2.0	0.86	**1.8**	0.86	0.86
Austria	1.4	0.74	**2.6**	0.81	0.80
Finland	1.9	0.78	**2.1**	0.78	0.78
Germany	1.3	0.70	**2.4**	0.75	0.75
Hungary	1.4	0.81	**1.8**	0.82	0.81
Slovenia	1.5	0.64	**2.0**	0.65	0.65
Spain	1.6	0.75	**2.0**	0.76	0.76
Sweden	1.9	0.73	**2.1**	0.73	0.73
USA	2.0	0.81	**2.2**	0.81	0.81

Median = 2.0

We can do something very similar for the fiscal support ratio

- What fertility rate and pop gr rate would maximize the ratio of effective tax payers to effective beneficiaries?
- This is the level of fertility that would permit the lowest level of taxes or the highest level of benefits.

Optimal TFR for the public sector, maximizes ratio of tax base to costs of benefits

Result is driven by whether public transfers to elderly for pensions, health care, long term care outweigh public transfers to children for education and health care.

In most countries transfers to elderly dominate., so "optimal" fertility for public sector is typically substantially higher, way above replacement levels.

True for rich industrial nations, Latin America, East Asia. Brazil: 5.5!

Not true for South and Southeast Asia, where public programs for elderly are mostly tiny and for children are relatively larger.

Where public transfers to elderly are very low, it is beneficial to have very low fertility to economize on transfers to children.

Table 6. Public support ratios relative to base year values.

Country	Base year TFR	Intrinsic support ratio	Maximum support ratio		Replacement support ratio
			TFR	Support ratio	
China	1.64	0.84	2.53	0.88	0.87
Japan	1.27	0.79	2.64	0.90	0.89
South Korea	1.26	0.83	2.08	0.86	0.86
Taiwan	1.10	0.80	1.85	0.84	0.83
India	2.52	1.00	2.04	1.01	1.01
Indonesia	2.02	1.07	0.90	1.19	1.05
Philippines	2.85	1.09	1.21	1.21	1.16
Thailand	1.85	1.03	0.66	1.24	0.97
Brazil	1.70	0.67	5.52	0.93	0.74
Chile	1.89	0.76	3.70	0.86	0.78
Costa Rica	1.94	0.72	3.90	0.83	0.74
Mexico	2.04	0.87	2.84	0.89	0.87
Uruguay	2.03	0.93	3.16	0.99	0.94
Austria	1.41	0.80	3.76	0.95	0.89
Finland	1.85	0.90	2.88	0.95	0.92
Germany	1.34	0.80	3.36	0.94	0.90
Hungary	1.42	0.85	2.50	0.93	0.92
Slovenia	1.47	0.77	3.20	0.89	0.85
Spain	1.56	0.79	2.73	0.84	0.83
Sweden	1.85	0.89	3.51	0.97	0.92
US	2.02	0.88	2.12	0.88	0.88

Median = 2.6

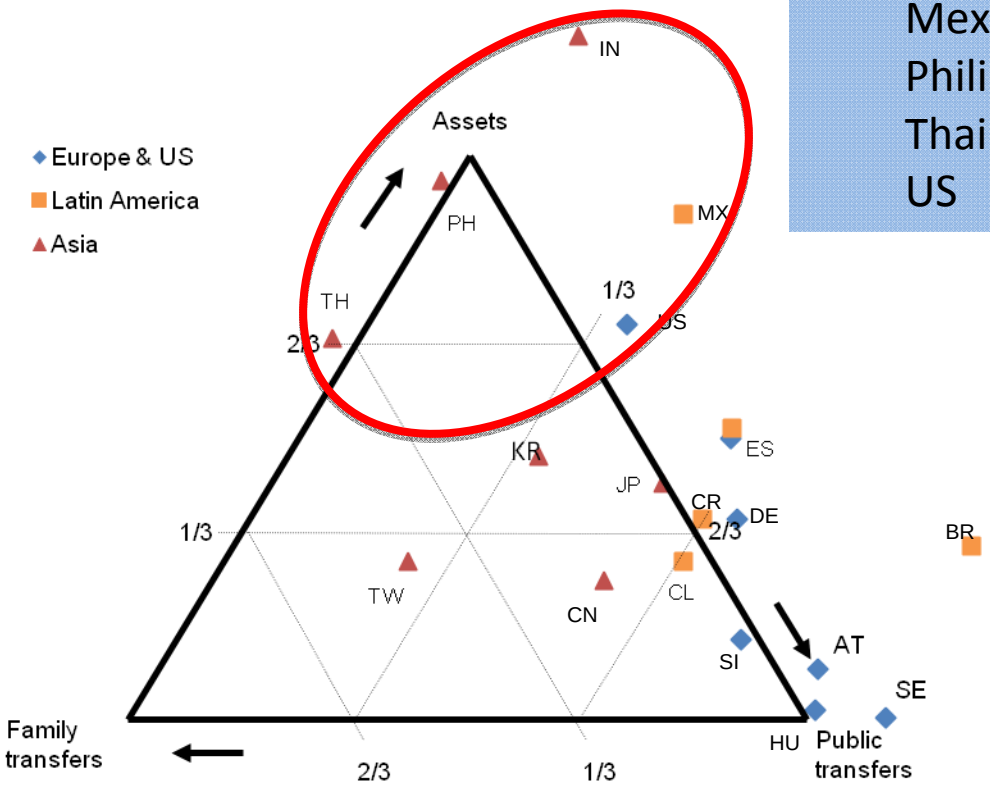
Conclusions so far

1. For most countries, fertility near replacement level maximizes the support ratio.
2. In most cases, the support ratio is almost the same if fertility is set at replacement level.
3. If we focus on the public sector alone, we find that the fertility that maximizes the fiscal support ratio is about half a child higher, around 2.6 births per woman.
4. There are a few exceptions: Indonesia, Philippines, Nigeria, Austria and Germany.

VI. Are the elderly *dependent*? Depends on how their consumption is funded.

- They are dependent only to the extent that they finance their consumption out of public or private transfers.
- When consumption of the elderly is funded mainly out of public or private transfers, then population aging just raises the transfer burden on workers.

In some countries, elders rely mainly on assets.



India
Mexico
Philippines
Thailand
US

VII. A generalized support ratio reflects elders' reliance on assets

- In US, old age consumption is funded 2/3 from assets, either principal or interest.
- Assume that future elderly will have saved and prepared similarly and will rely on assets and on transfers to the same degree as in current NTA measures at each age.
- Then recalculate the support ratio including only necessary support from transfers, either public or private.

The "generalized support ratio", GSR

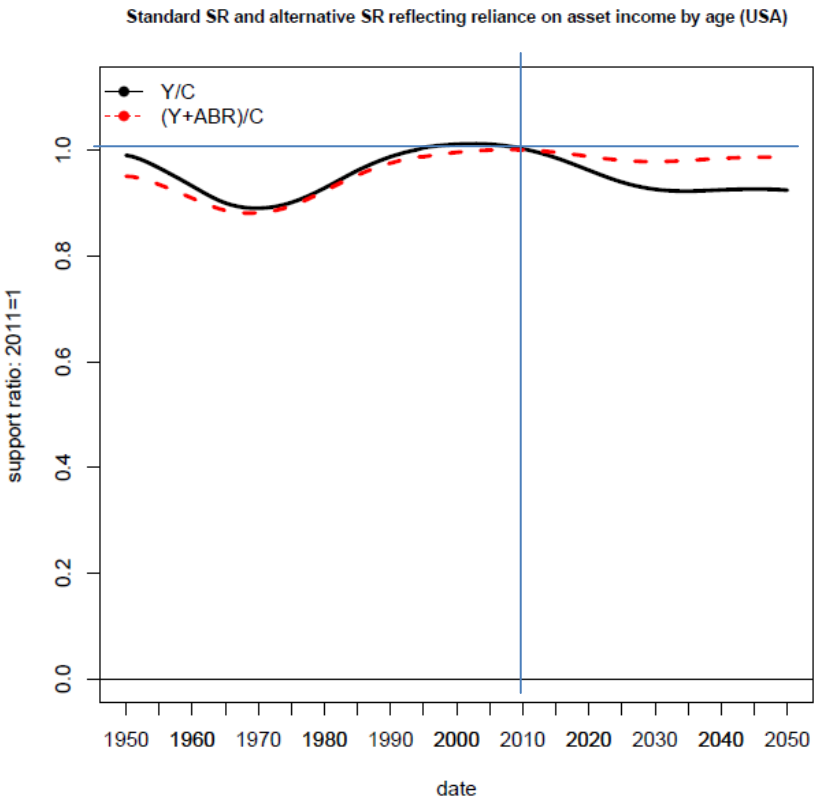
- Numerator of General Support Ratio is now the age-weighted sum of all income other than transfers that is used to pay for consumption

$$y_l(x) + rA(x) - s(x)$$

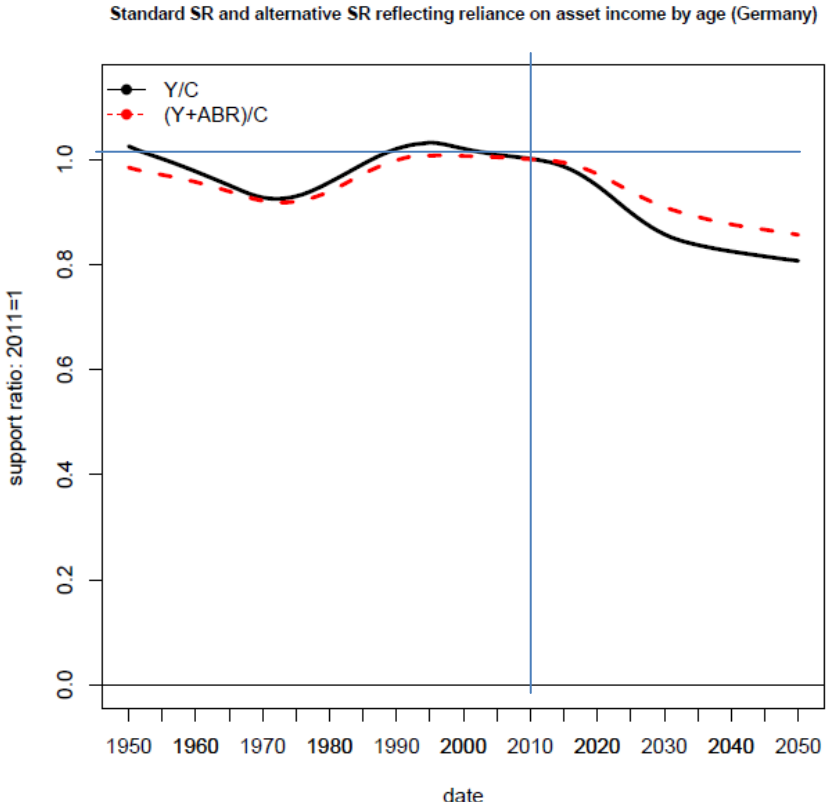
instead of $y_l(x)$ as in the standard ratio.

Standard support ratios (black) and Generalized support ratios (red); 2011=1.0.

US: General ratio does not decline from 2011 to 2050.

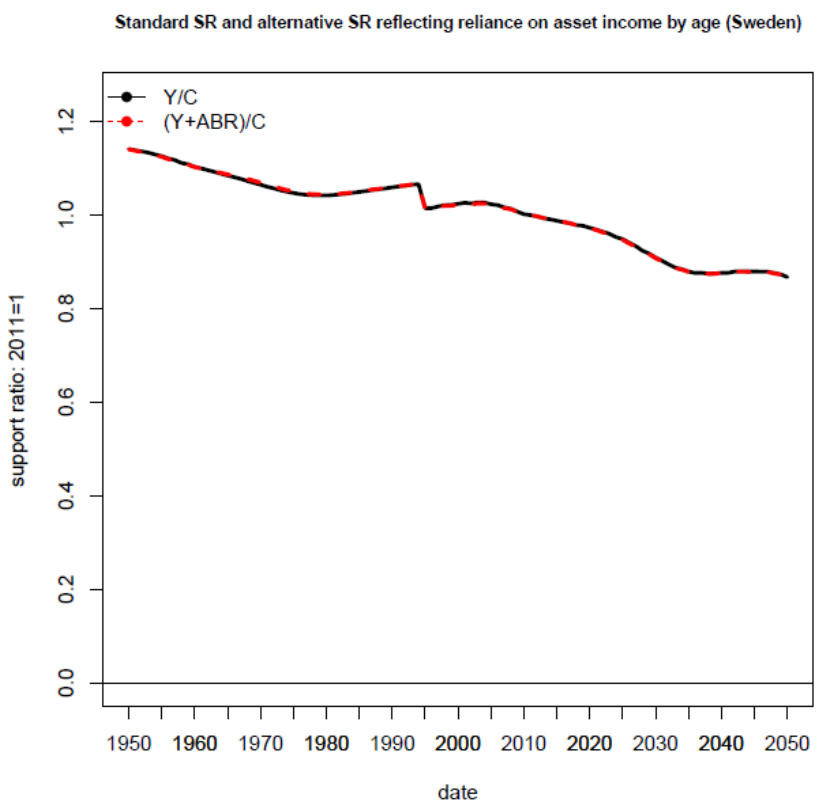


Germany: General ratio does decline 2011-2050, but a bit less

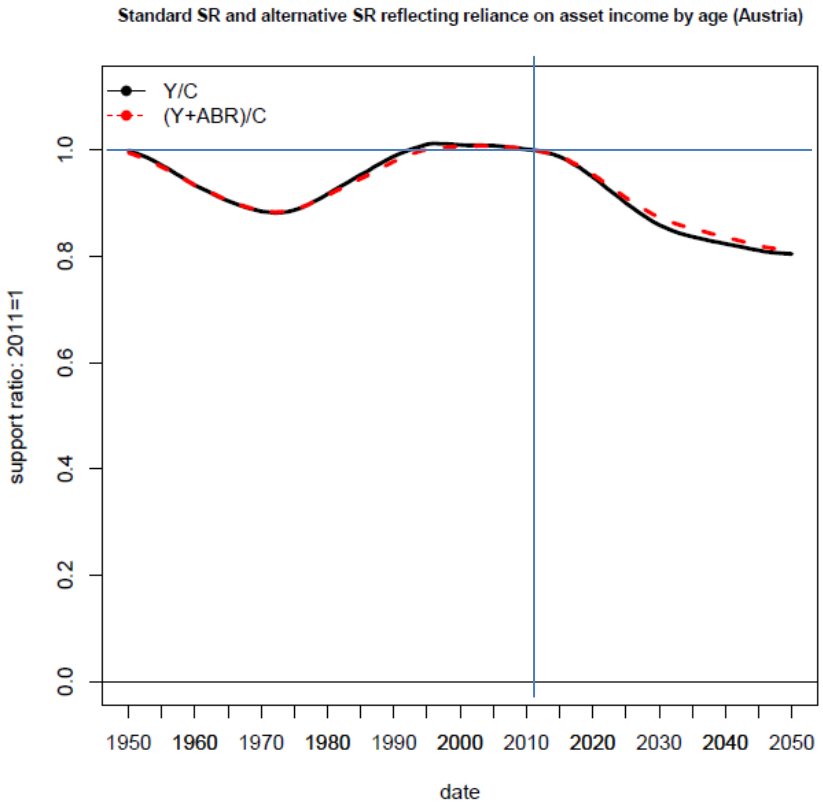


Standard support ratios (black) and Generalized support ratios (red); 2011=1.0.

Sweden: General ratio is same as standard ratio because all transfers.

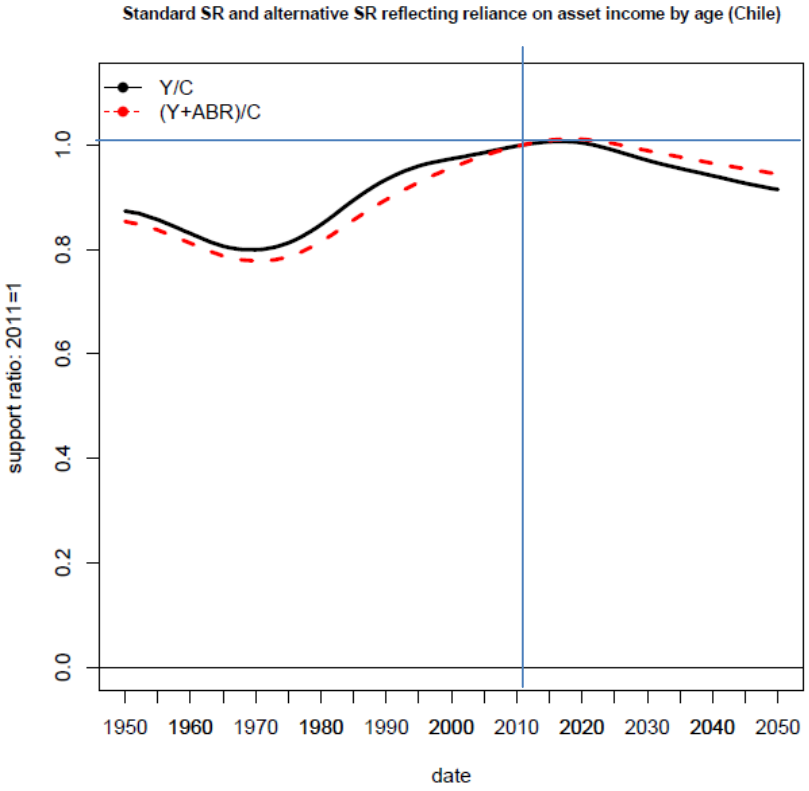


Austria: same story; no difference because all transfers

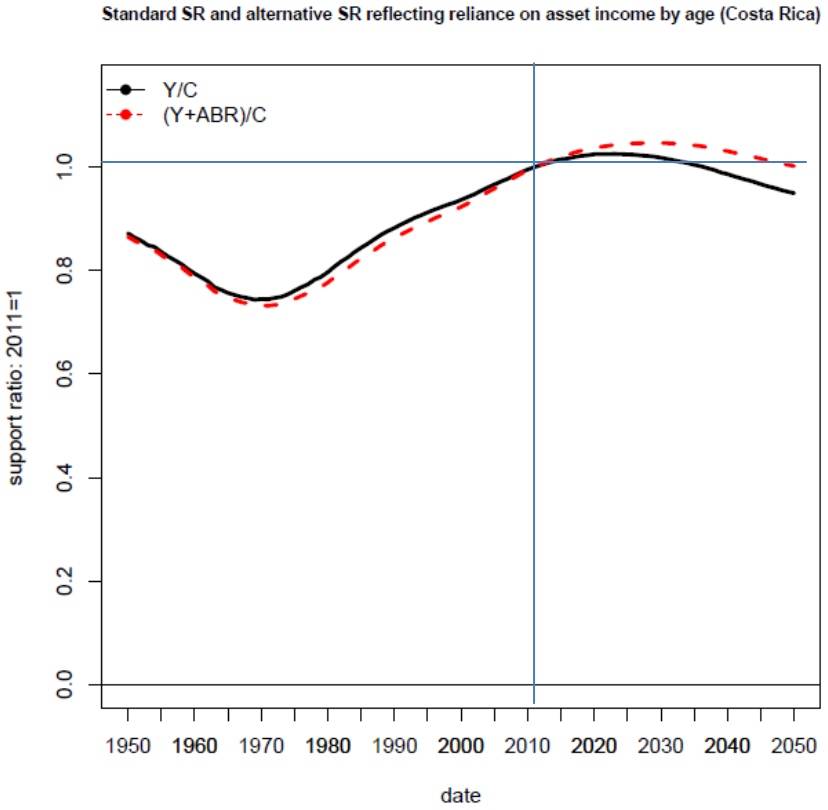


Standard support ratios (black) and Generalized support ratios (red); 2011=1.0.

Chile: GSR declines only a bit less; despite privatized pension.

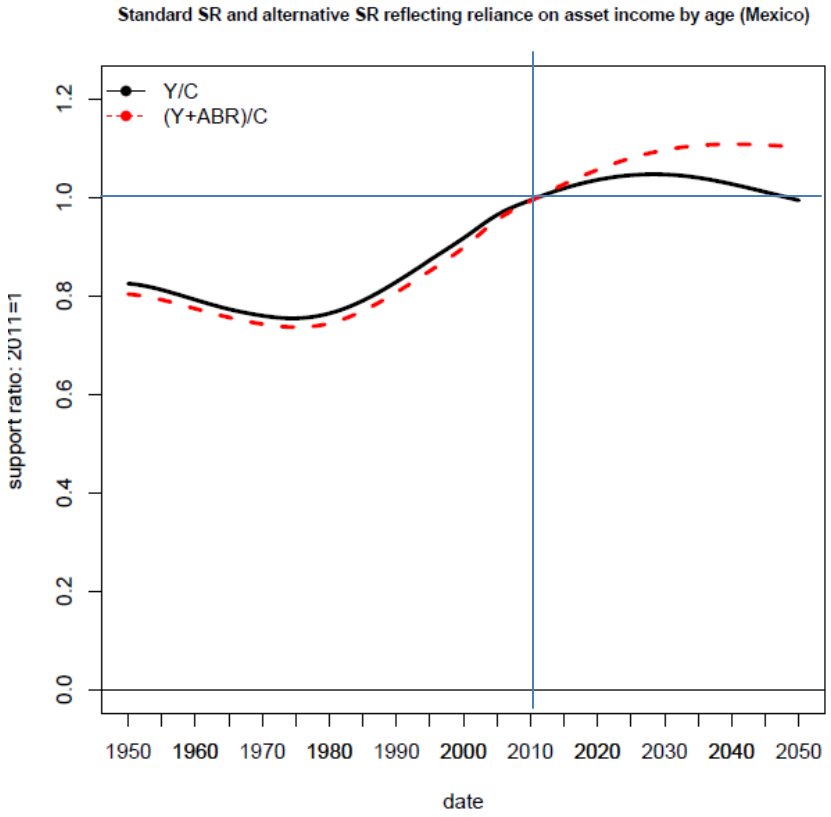


Costa Rica: GSR is more substantially higher

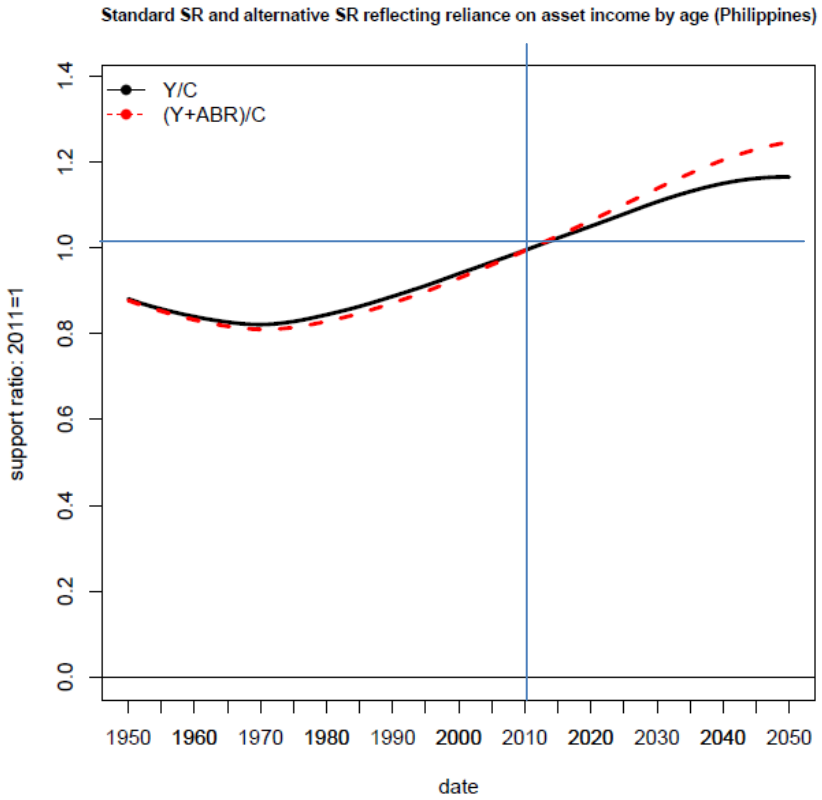


Standard support ratios (black) and Generalized support ratios (red); 2011=1.0.

Mexico: A big difference. Assets are very important. But why?



Philippines: Matters here too.



We could calculate the TFR that would maximize this General Support Ratio

- Have not yet done this.
- Below we try another approach to the role of capital.

What is the best TFR when there is capital?

- More capital per worker, K/L
  - Raises productivity of labor, $y_l(x)$
  - Requires higher savings to equip growing labor force (particularly if pop gr rate is higher)
- Higher TFR and population growth rate means lower old age dependency, but also means higher saving rate is needed (particularly to maintain higher capital per worker).

Analytically (see Arthur and McNicoll, 1978)

$$d\left[\ln\left(\text{lifetime consumption}\right)\right]/dn = A_c - A_{y_l} - K/C$$

This expression reflects the effect of more rapid population growth on both the support ratio ($A_c - A_{yl}$) and on the need to save to maintain the capital labor ratio.

Now the optimum requires that $A_c > A_{yl}$ and that will require that the population growth rate and fertility be lower.

We will find optimal fertility (maximizes consumption) under two different conditions

1. What fertility and population growth rate are best if the capital labor ratio is fixed at some realistic level?
2. Which are best if we also pick the best amount of capital per worker? This is closely related to Samuelson's "goldenest golden rule".

TFR for case of K/L=4.0 is not quite right.

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 or at golden rule level, as indicated.

			K/L = 4.0			K/L = Golden Rule		
Country	AC	Ayl	TFR	Support ratio	Population growth rate (%)	TFR	Support ratio	Population growth rate (%)
Kenya	49.3	43.7	1.3	0.74	-0.025	----	----	----
Nigeria	62.2	56.1	0.6	1.00	-0.057	----	----	----
China	50.3	44.7	1.3	0.77	-0.019	----	----	----
Japan	52.3	46.4	1.6	0.68	-0.008	1.3	0.65	-1.5
S Korea	50.3	44.6	1.3	0.75	-0.016	----	----	----
Austria	45.8	40.2	1.9	0.77	-0.003	1.6	0.74	-0.9
Finland	49.7	44.0	1.6	0.73	-0.009	1.2	0.69	-1.7
Germany	49.1	43.4	1.7	0.70	-0.006	1.4	0.67	-1.3
Hungary	50.4	44.8	1.3	0.77	-0.017	----	----	----
Slovenia	47.2	41.7	1.6	0.62	-0.009	1.3	0.58	-1.7
Spain	50.0	44.3	1.5	0.72	-0.011	1.1	0.67	-2.1
Sweden	50.9	45.1	1.7	0.69	-0.007	1.4	0.67	-1.3
US	53.0	47.1	1.6	0.77	-0.010	1.1	0.70	-2.2
Brazil	51.1	45.3	1.6	0.73	-0.011	1.0	0.64	-2.8
Chile	51.4	45.6	1.5	0.82	-0.013	----	----	----
Costa Rica	51.8	46.0	1.5	0.81	-0.012	----	----	----
Mexico	53.7	47.9	1.2	0.89	-0.020	----	----	----
Uruguay	52.6	46.8	1.3	0.82	-0.018	----	----	----
India	54.1	48.3	1.2	0.90	-0.027	----	----	----
Indonesia	60.8	54.7	0.5	0.93	-0.049	----	----	----
Philippines	56.3	50.4	0.8	0.89	-0.032	----	----	----
Thailand	50.9	45.2	1.1	0.83	-0.023	----	----	----
Taiwan	48.3	42.7	1.5	0.73	-0.012			

TFR that maximizes steady state age adjusted consumption or govt. budget, ranked from highest to lowest

1. Public sector only (**Median=2.6**)
2. Overall Support Ratio (**Median=2.0**)
3. Maximizing consumption while maintaining given capital/labor ratio (**Median=1.5**)
4. (Pseudo "goldenest golden rule": choosing both best fertility and best capital/labor ratio. Interior optimum exists for only about half the countries. (**Median=1.3**)

IX. Conclusions

- For countries that have already reached low fertility, and are moving rapidly toward an old population, we ask:
  - Is fertility too low?
  - What population growth and age distribution are desirable?
- LIMITATIONS OF THE ANALYSIS
- In low income countries, ***public programs and private consumption and labor will change*** so much that little can be said now.
- In rich countries public transfers will doubtless change in response to population aging (e.g. later retirement, reduced public benefits). So ***exercise is a bit artificial***.
- Also, ***we do not consider direct satisfaction parents get from children***. Only their effects on pop age structure and growth. Big piece is missing.

But…for rich industrial nations

- Fertility above replacement would ease fiscal pressures on pensions, health care and long term care by reducing population aging.
- That advantage evaporates if we include private transfers. Then replacement fertility would be roughly optimal.
- If we include capital and adjust saving to keep K/L constant, then fertility between 1.5 and 2.0 is best.
- If we optimize both K/L (golden rule) and n, the best TFR is 1.0-1.5 (unrealistic).
- **Conclude**: rich industrial nations should not be too concerned about below replacement fertility, at least not on economic grounds.

Actual versus optimal fertility predicts national policy in 18 out of 22 cases (optimal based on support ratio criterion)

- All five countries with actual fertility more than .2 above optimal have policies in place to reduce fertility.
- Seven of eight countries with fertility within .2 of optimal have no policies to change fertility
- Six of nine countries with actual fertility more than .2 below optimal have policies to raise fertility.

END