Macroeconomic Consequences of Population Aging: A Simple Model with NTA Inputs

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Economic consequences of changing population age distributions

- Many developing countries have low or falling fertility, and benefit from the “demographic dividends”.
- Most rich countries and some at middle income are experiencing population aging.
- Here I use National Transfer Accounts to quantify economic effects in a unified framework.
- The “support ratio” is the work horse for this topic –effective workers divided by effective consumers.
- Here I will keep the ingredients of the support ratio but embed them, with capital, in a simple macro model to get some new results.

Starting point: NTA age profiles (see ntacounts.org)

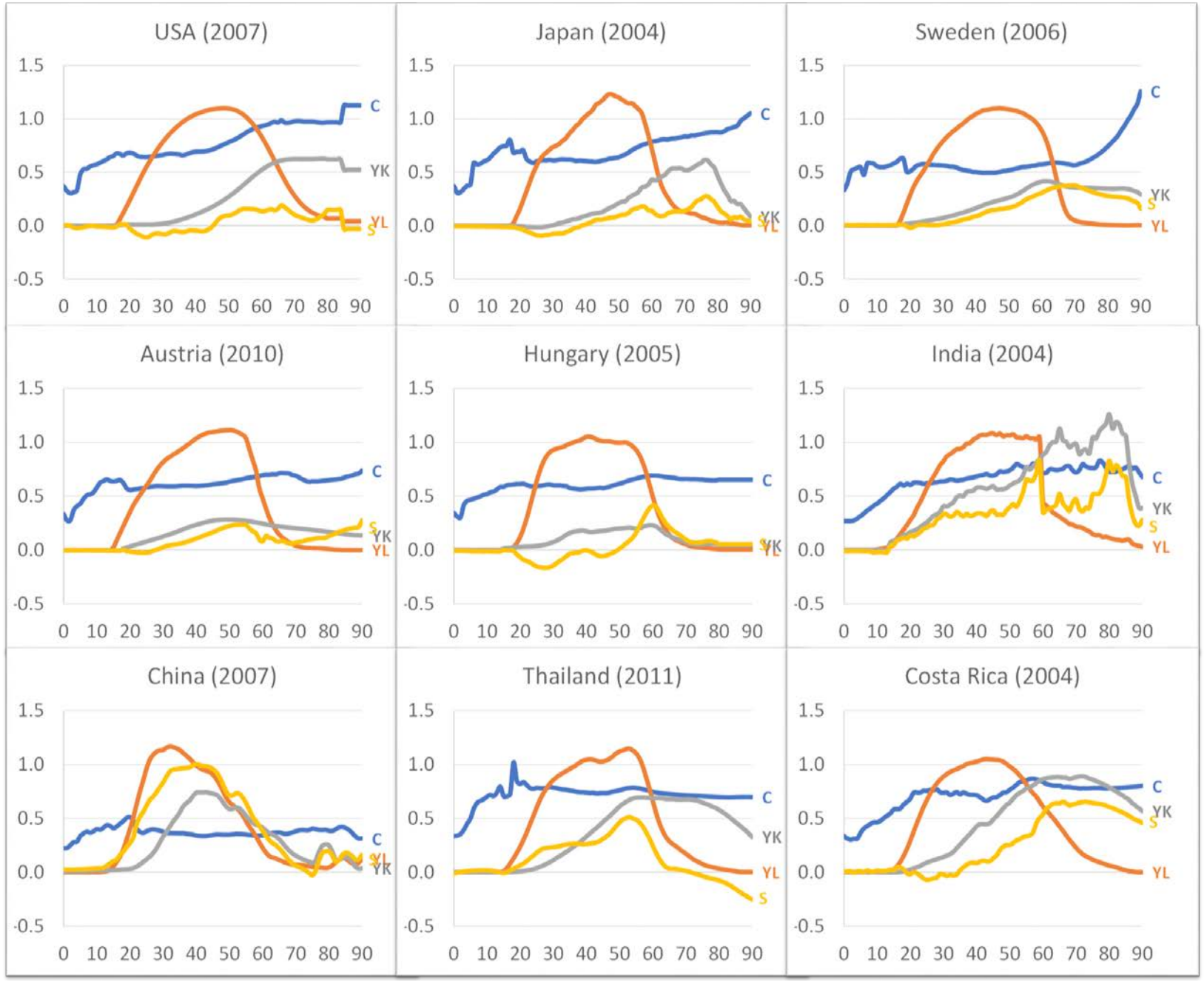
- Averages across the whole population by age, combining males and females.
- Consumption includes
  - Private expenditures, imputed to individuals within each household
  - Public in-kind transfers (e.g. education, health care, but not pensions which are income)
- Labor income includes
  - Wages, salaries, fringe benefits before tax
  - 2/3 of self employment income
  - Zeros
- Asset income includes
  - interest, dividends, rental value of owned home,
  - 1/3 of self-employment income, plus other property income.
- Saving includes both public and private, with corporate savings allocated to asset owners by age.
- Usually all age profiles are divided by average labor income ages 30-49 for comparison across countries.

Where are transfers?

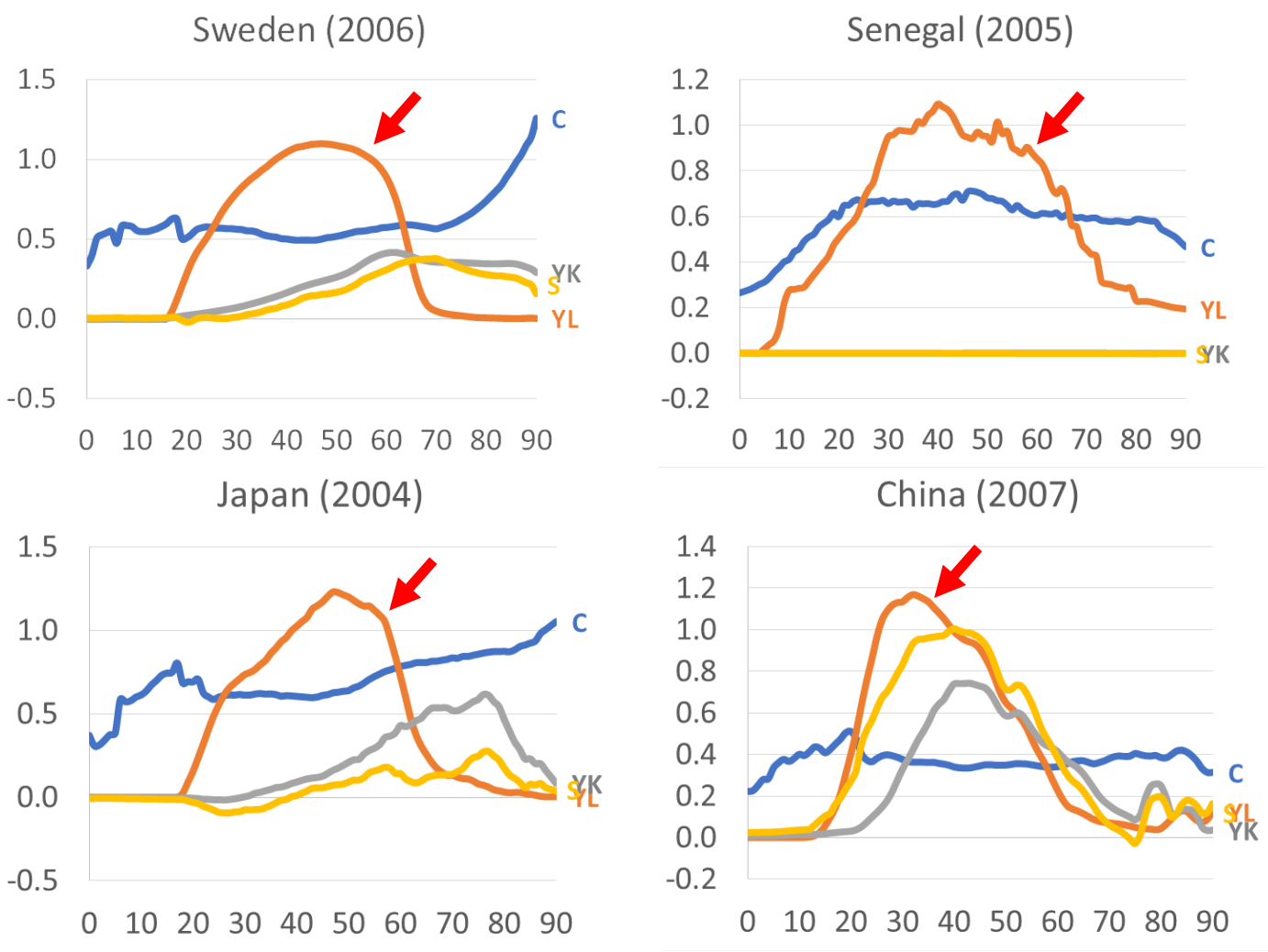
- They are included implicitly.
- Transfers make it possible for age patterns of consumption to differ from the age profile of income from assets and labor, minus savings.

Profiles for selected countries.

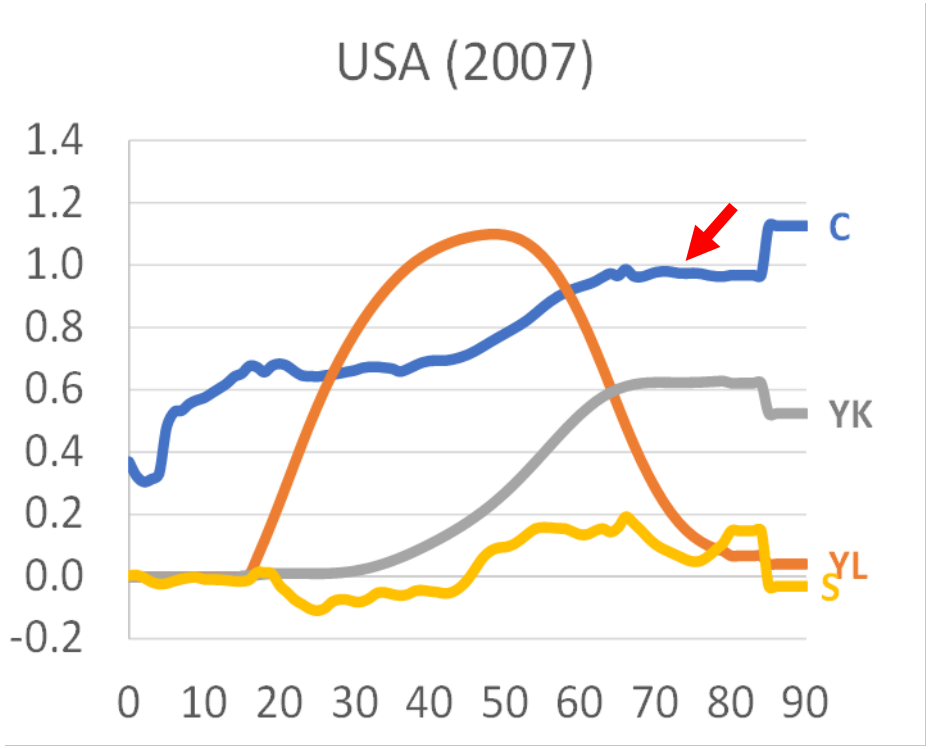
Shapes of age profiles differ widely.

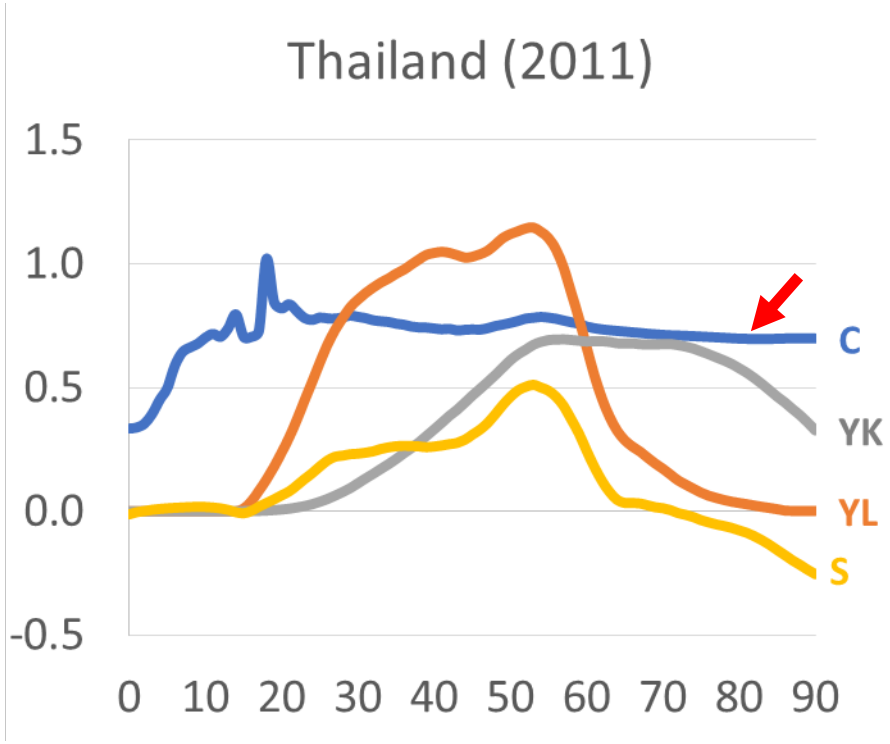


Compare labor income, yl, in Sweden, Japan, China, Senegal

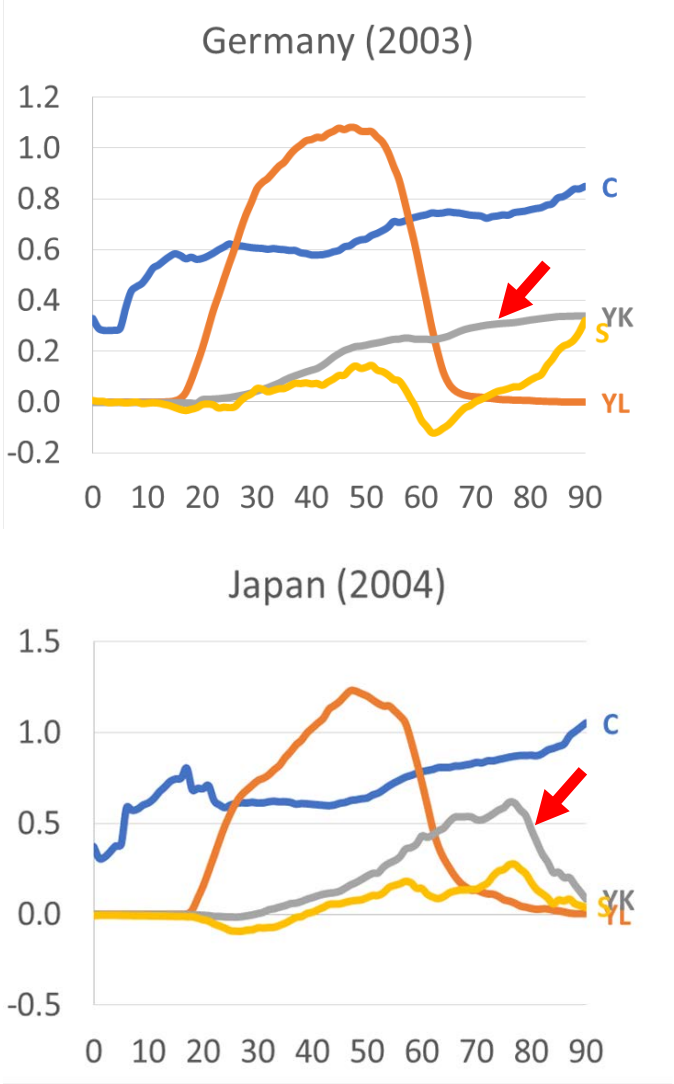


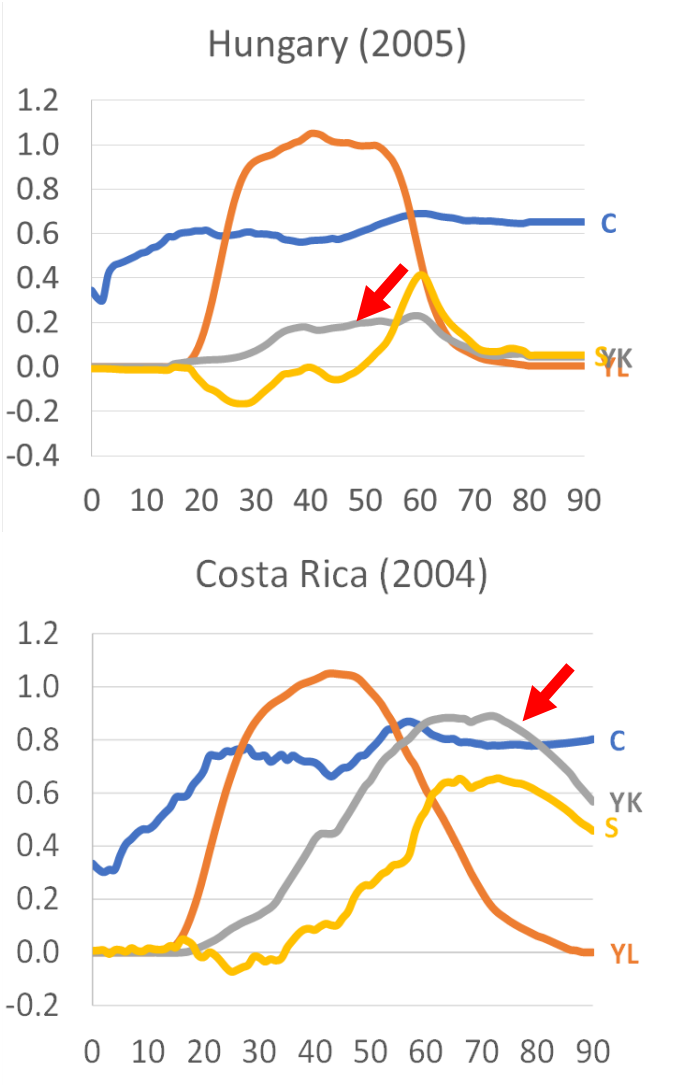
Compare Consumption, c, in US and Thailand





Compare asset income (yk) in Germany, Japan, Costa Rica and Hungary





Effective labor, consumers, assets and support ratios

- Calculate “effective” labor, effective consumers and effective capital
  - Multiply projected population age distributions times baseline NTA age profile and sum.
  - Assume asset holdings are proportional to asset income at each age.
  - “Effective” measures change with population size and age distribution.
- Notation:
  - L=Effective Labor
  - N=Effective Consumers
  - K=Effective Assets
- “Support ratio” (SR) is effective labor/effective consumers, or L/N.
  - I will use extensively as a benchmark for comparison later.

Basic strategy: Assume level, not shape, of age profiles changes over time in each country.

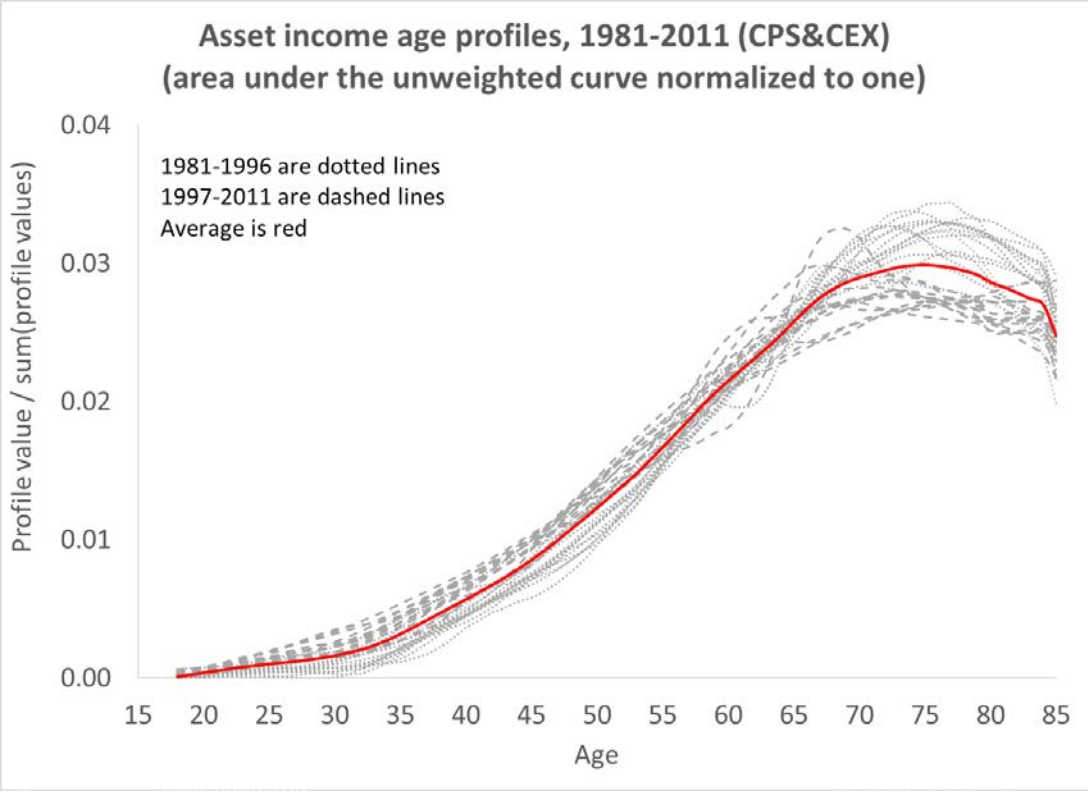
- There will surely be important changes in shape, some driven by policy – e.g. public pension retirement age.
- Consistent shape over time seems a reasonable working assumption.
- Allows us to isolate direct demographic impacts.

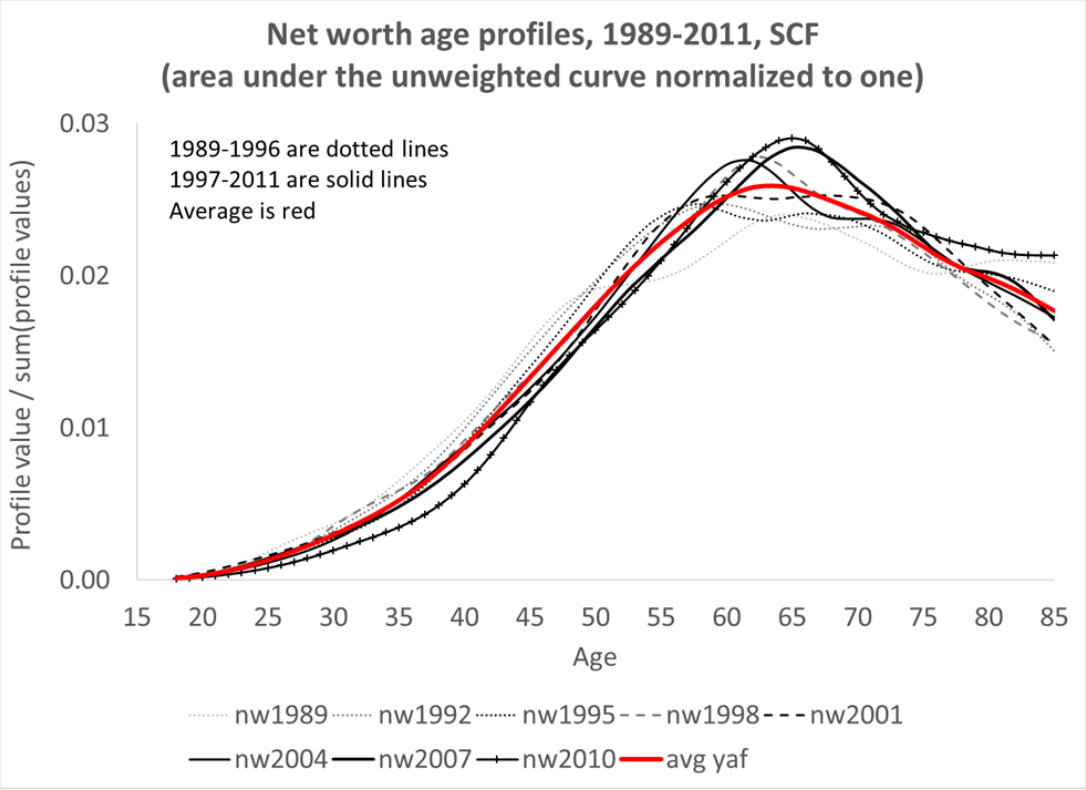
- So here find how changing population age distributions would affect the macroeconomy if individual behavior remains as it was at NTA baseline.

How does pop age distrib affect amount of capital?

- For capital, we could accumulate it longitudinally for cohorts based on age specific saving rates and age specific income each year.
  - But saving rates vary widely from year to year depending on macro economy.
- Private saving is influenced by many motives, difficult to model
  - life cycle saving (depends on public pensions, health care, long term care, etc.)
  - Precautionary savings (depends on safety net, expectations of family support, etc.)
  - Intended bequests (depends on number of children, spouse, etc.)
  - Inter vivos transfers vs bequests (depends on tax structures, cultural values, etc.)
- Actual asset holdings by age are accumulated through saving, but also by inheritance, taxation, and changing relative asset prices (e.g. housing market).
- All these influences are reflected in NTA asset age profiles.
- Here we calculate assets (capital) as a multiple of NTA asset income profiles, weighted by population age distribution and summed. “Effective capital”.

US: Similarity of age shape of asset income and net worth, and stable shapes from 1981-2011.





Closed economy case:
Assume Cobb-Douglas production $Y = AL^{\alpha}K^{1-\alpha}$

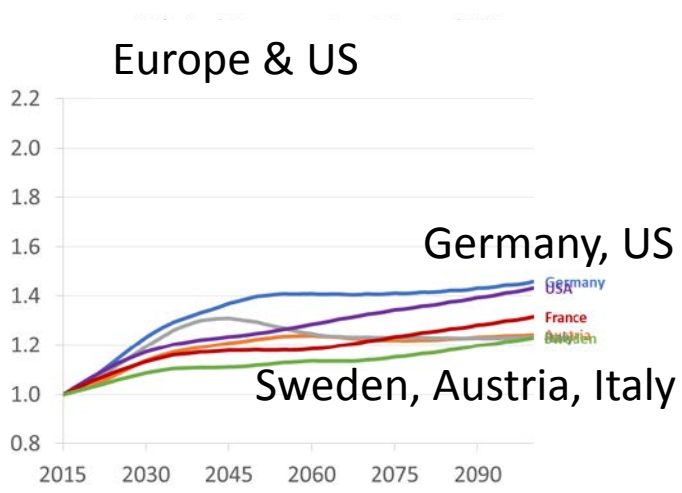
Y is National Income (includes income from investments abroad and excludes asset income going to foreign investors)

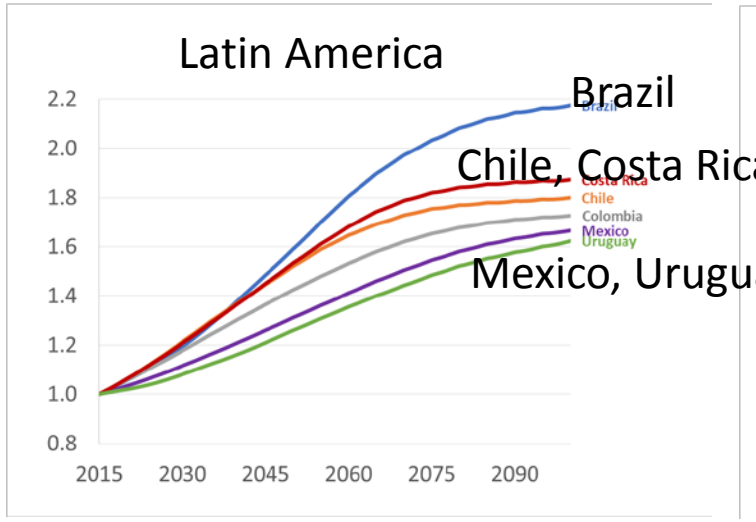
A reflects technology, assumed constant for simplicity.

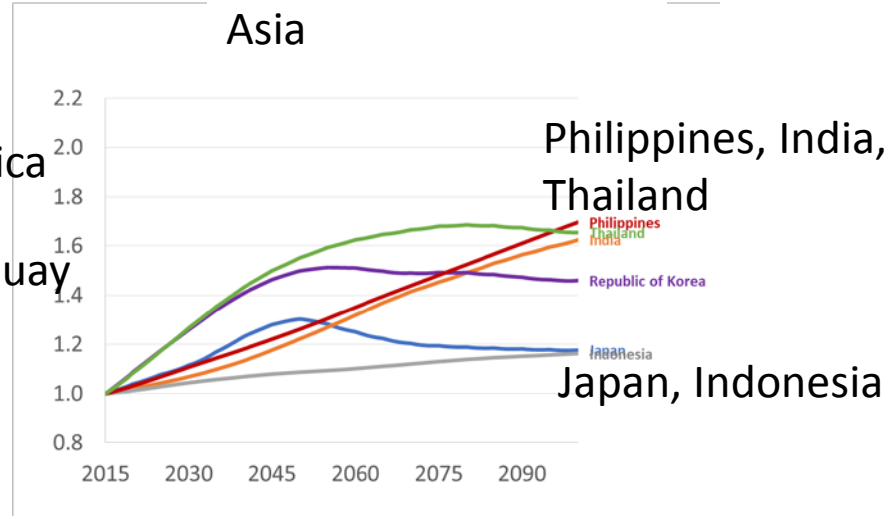
L and *K* are effective labor and capital.

Typically α is around 2/3 (often lower lately), value used here.

For closed economy case: Simulated change in ratios of capital to labor (K/L) and Wage to Interest Rate (w/r) relative to 2015







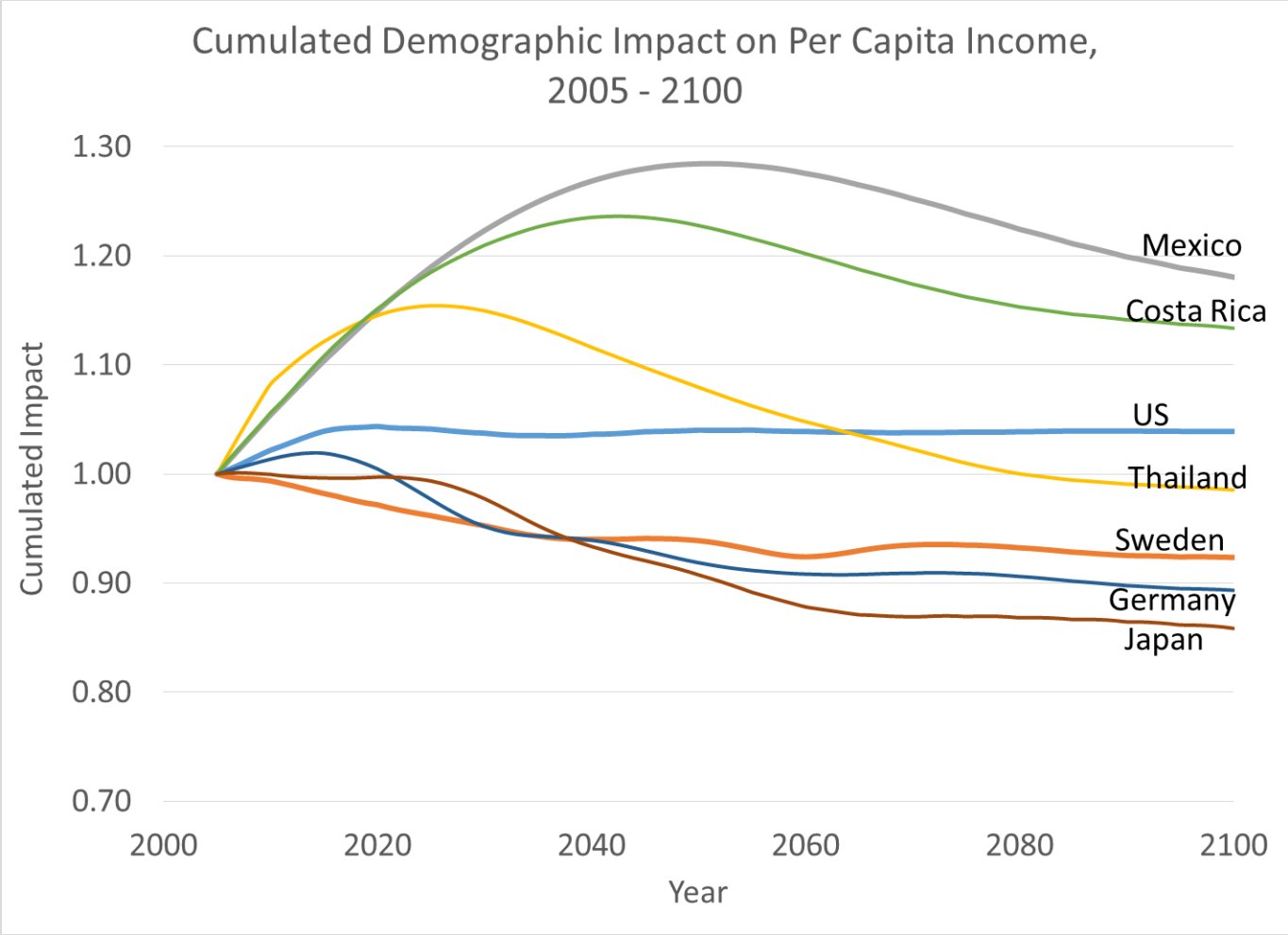
- If pop aging raises capital more than labor, the capital intensity of the economy rises.
- Labor productivity and wages rise, and interest rates fall.
- Countries with biggest increases are earlier in the demographic transition.
- Falling interest rates may be an issue; open financial markets will help rich countries.

Using K, L, and Pop size, we can calculate changes in per capita income (Y/P) for closed economy case (here relative to 2005)

Demographic dividend for developing countries -- +15 to 30%.

In aging countries, per capita inc falls modestly (about 10%).

But per capita income does not reflect age pattern of consumption or proportion of output saved.



Our usual NTA measure of wellbeing is Consumption per Effective Consumer, C/N

- Like per capita income
- Also reflects
  - Age pattern of consumption by age, e.g. elderly consume more than kids
  - Age pattern of saving by age, e.g. people tend to save more after 50
- From here on, I will be talking about Consumption per Effective Consumer, C/N, as the outcome of interest.

The impact of pop age distrib in a closed economy (CII)

- The "Closed Impact Index" (CII) shows how pop age distr affects Consumption per Effective Consumer in closed economy.
- Let ' indicate derivative of each variable with respect to pop age distr.
- Proportional change in C/N due to pop age distr change is:

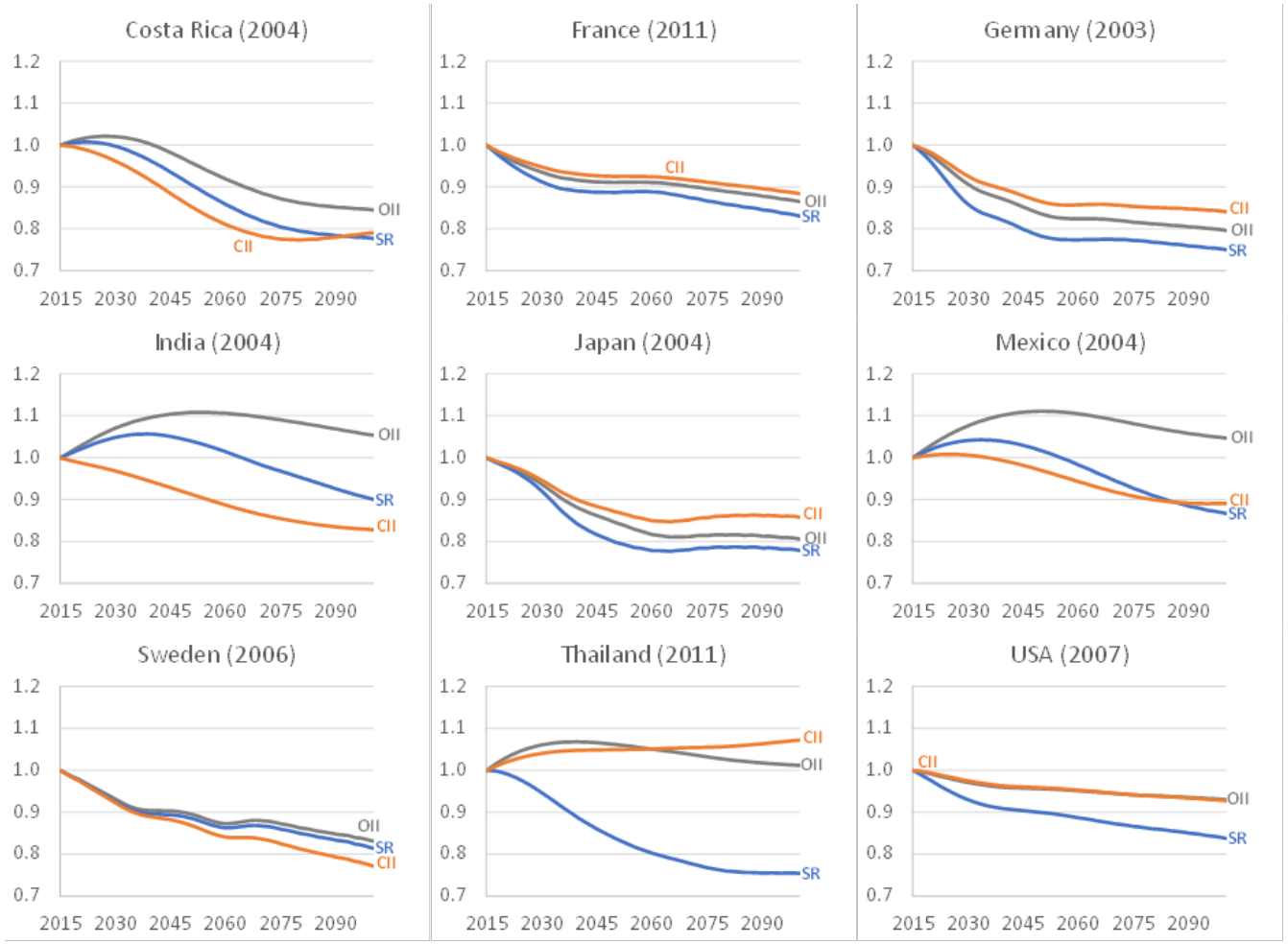
$$\frac{C'}{C}-\frac{N'}{N}=-\frac{s'}{1-s}+\alpha\frac{L'}{L}+(1-\alpha)\frac{K'}{K}-\frac{N'}{N}$$

- Result depends on how pop age distr affects
  - labor
  - capital
  - consumption needs
  - amount saved.

The “Open Impact Index” (OII) shows the same outcome for a small open economy

- Wages and interest rate, w and r, do not depend on capital and labor in the domestic economy.
- w and r are set on the international market and not affected by the national population age distribution.
- Pop age distr affects L and K, leading either to asset investments in foreign countries, or in foreign investment in this country.

Comparison of Support Ratio (SR), Closed Impact Index (CII) and Open Impact Index (OII) for nine countries (all indexed to 1.0 in 2015)



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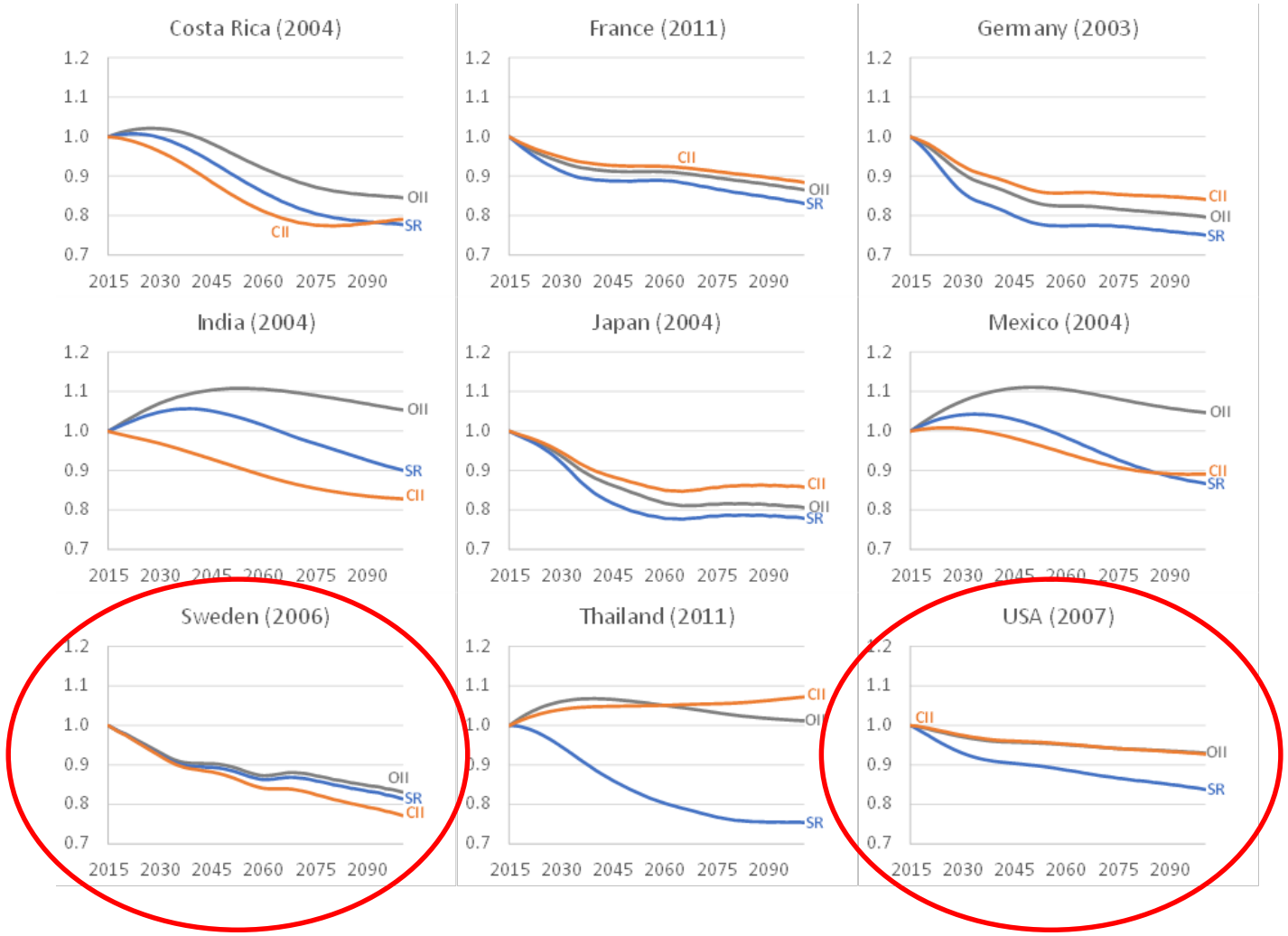
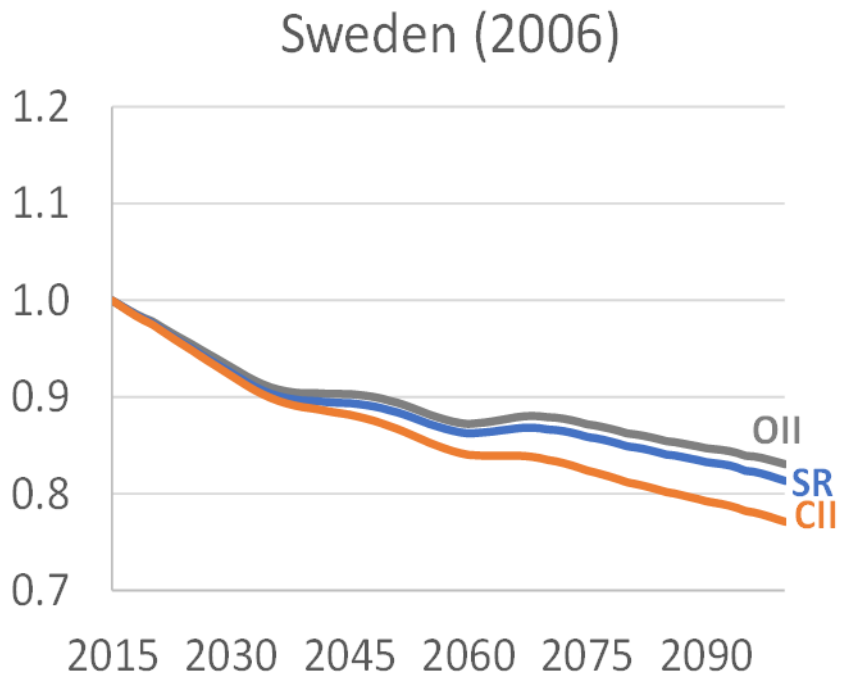
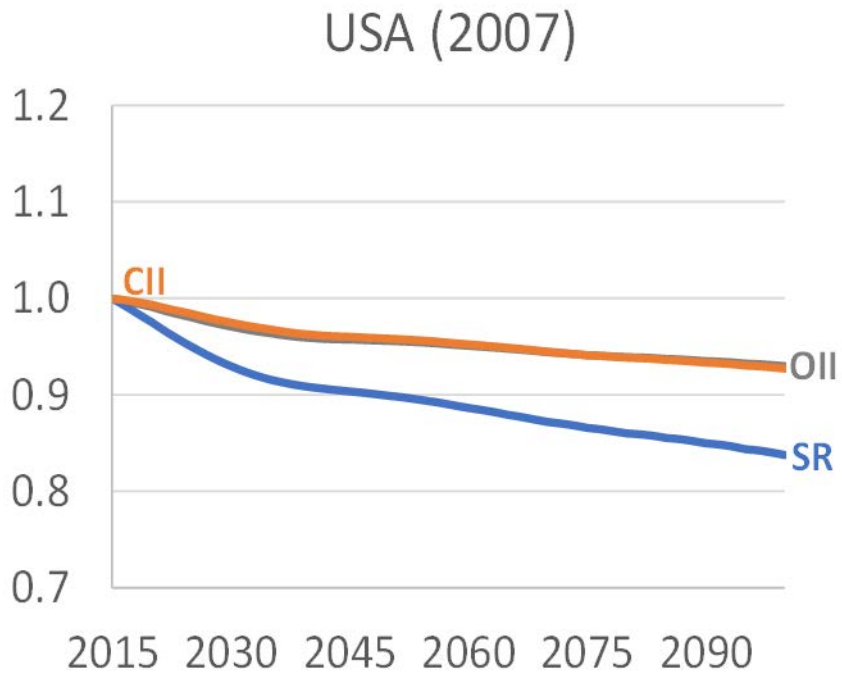


Institutions matter: Heavy reliance by elderly on public transfers in Sweden vs smaller pension system in US combined with heavy reliance on assets.



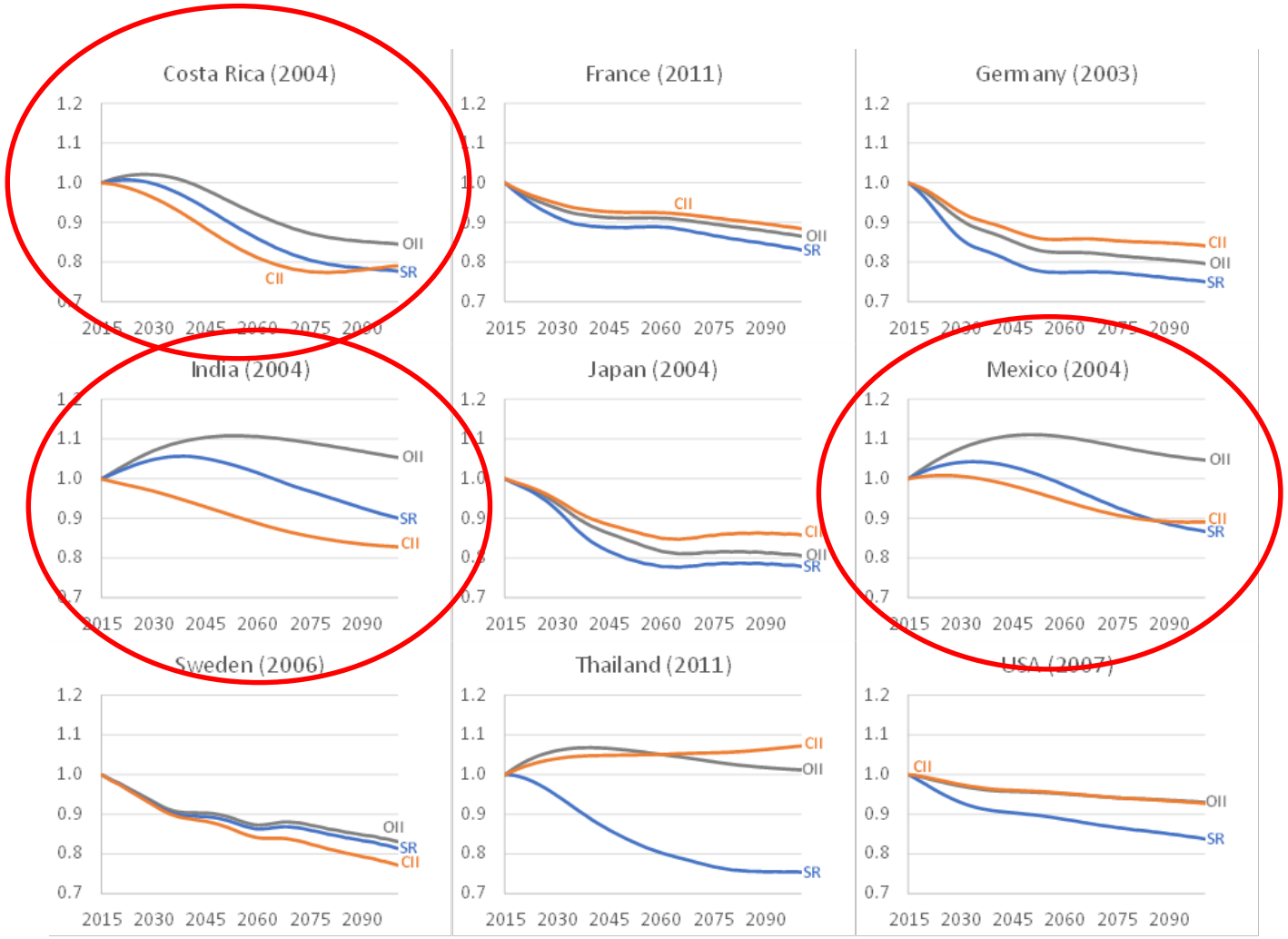


US: Strong capital intensification; CII and OII are very similar; modest effect of aging relative to SR.

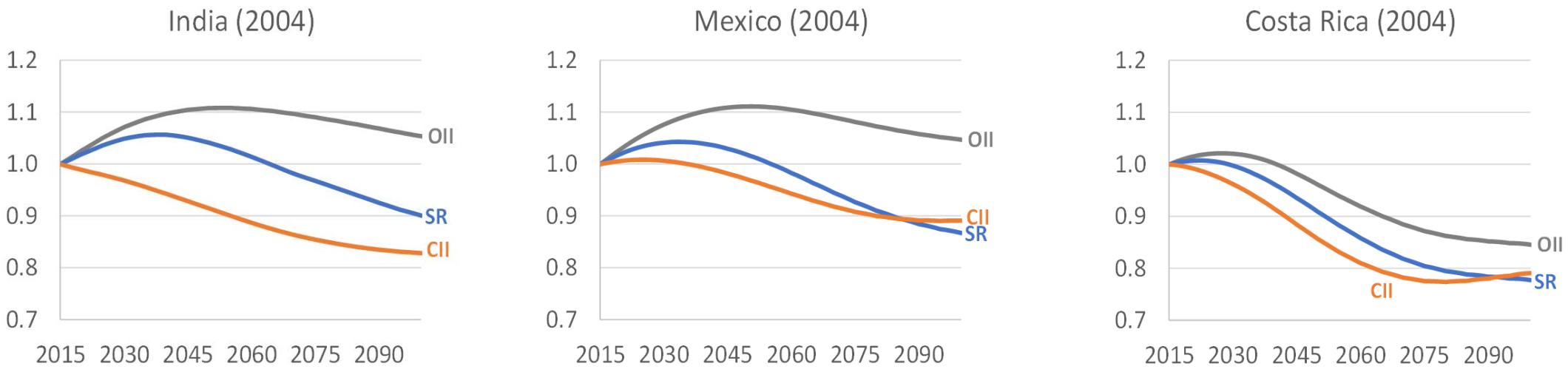
Sweden: Heavy reliance on public transfers means low saving and few assets. Little capital intensification. All indices show similar big impact of aging.

In developing countries, capital inflows may soften the eventual effects of population aging in open economies.

Costa Rica, Mexico and India: Under open economy, all benefit from capital inflows that offset capital dilution in demog dividend phase.

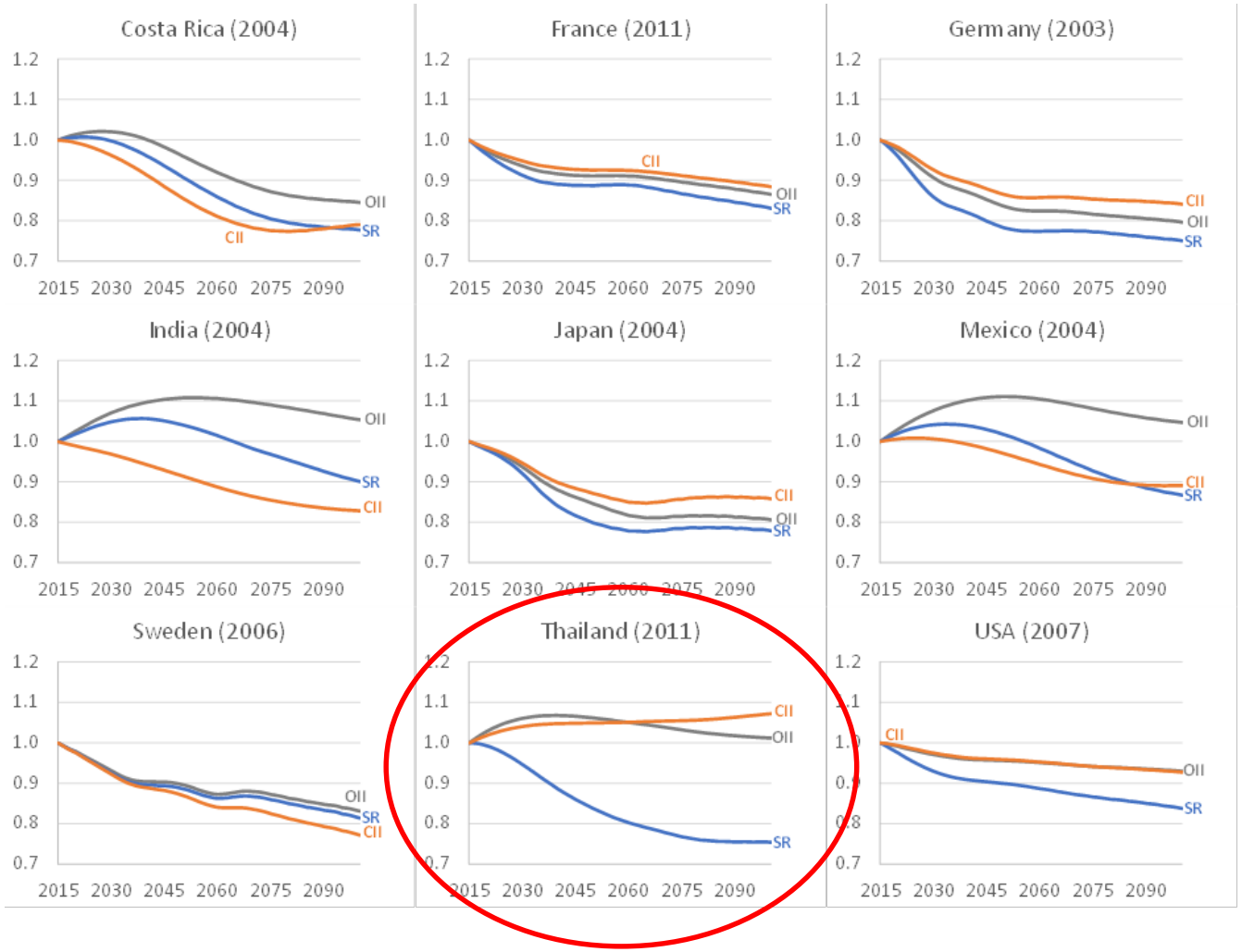


During demographic dividend phase, it can matter a lot whether economy is closed or open.



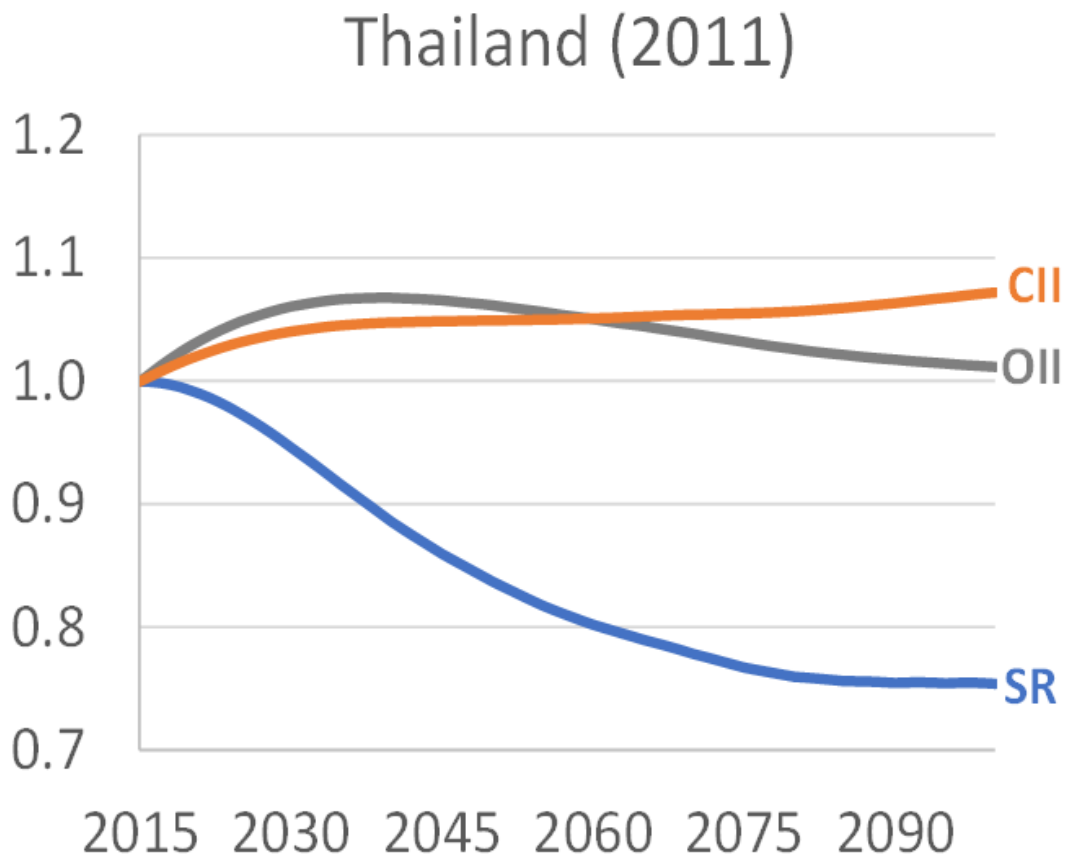
- With closed economy, Mexico, India and Costa Rica experience slower growth of capital during dividend phase, offsetting some of the support ratio benefits (CII<SR).
- With open economy, all countries benefit from capital inflows that offset capital dilution in demog dividend phase. (OII>SR).
- Human capital might change this outcome.

Comparison of Support Ratio (SR), Closed Impact Index (CII) and Open Impact Index (OII) for nine countries (all indexed to 1.0 in 2015)



Thailand:

- Early fert decline means rapid aging now so SR drops sharply
- Elderly rely heavily on assets so pop aging brings capital intensification.
- CII and OII show little effect of aging.



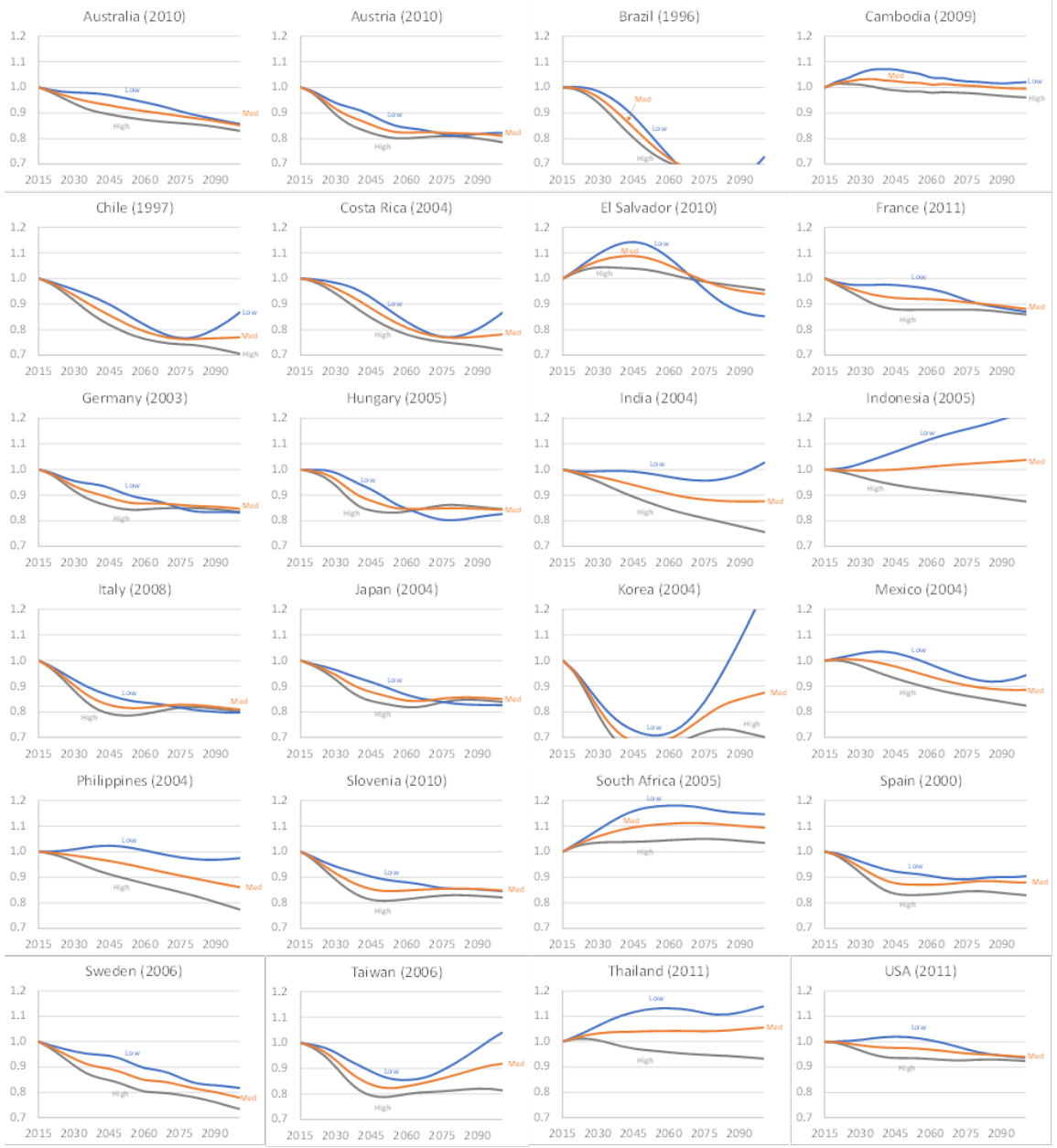
How does fertility affect outcome in *closed* economies?

Use UN Fertility Variants (plus or minus .5 births per woman)

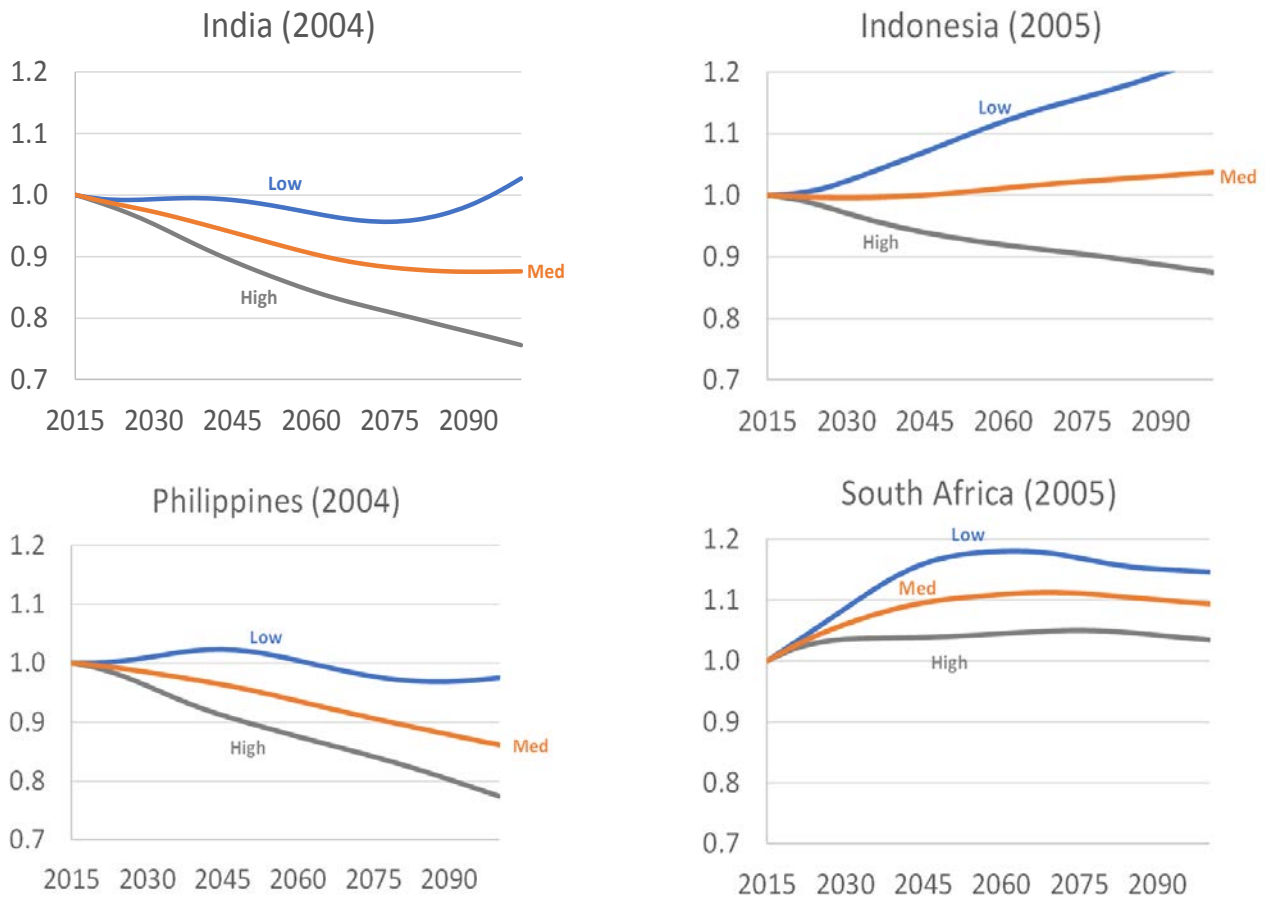
Typically “low” in 2100 is c1.25 instead of c1.75

Lower fertility mostly brings better outcomes

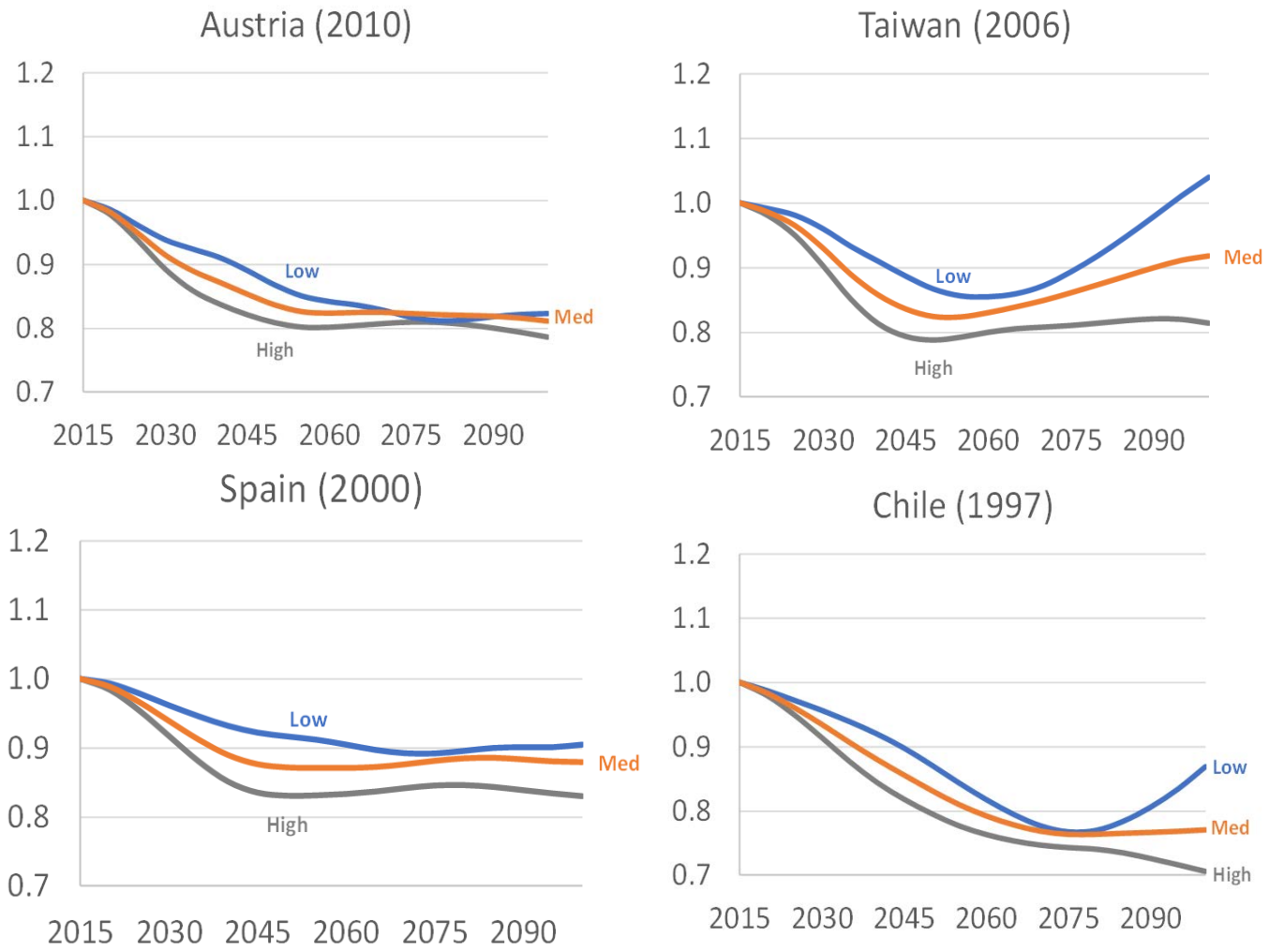
- Reduces child dependency for many decades.
- Raises capital intensity, labor productivity, wages.
- But eventually deeper aging is costly.



In closed economy, low fertility is very beneficial in high to moderate fertility countries.

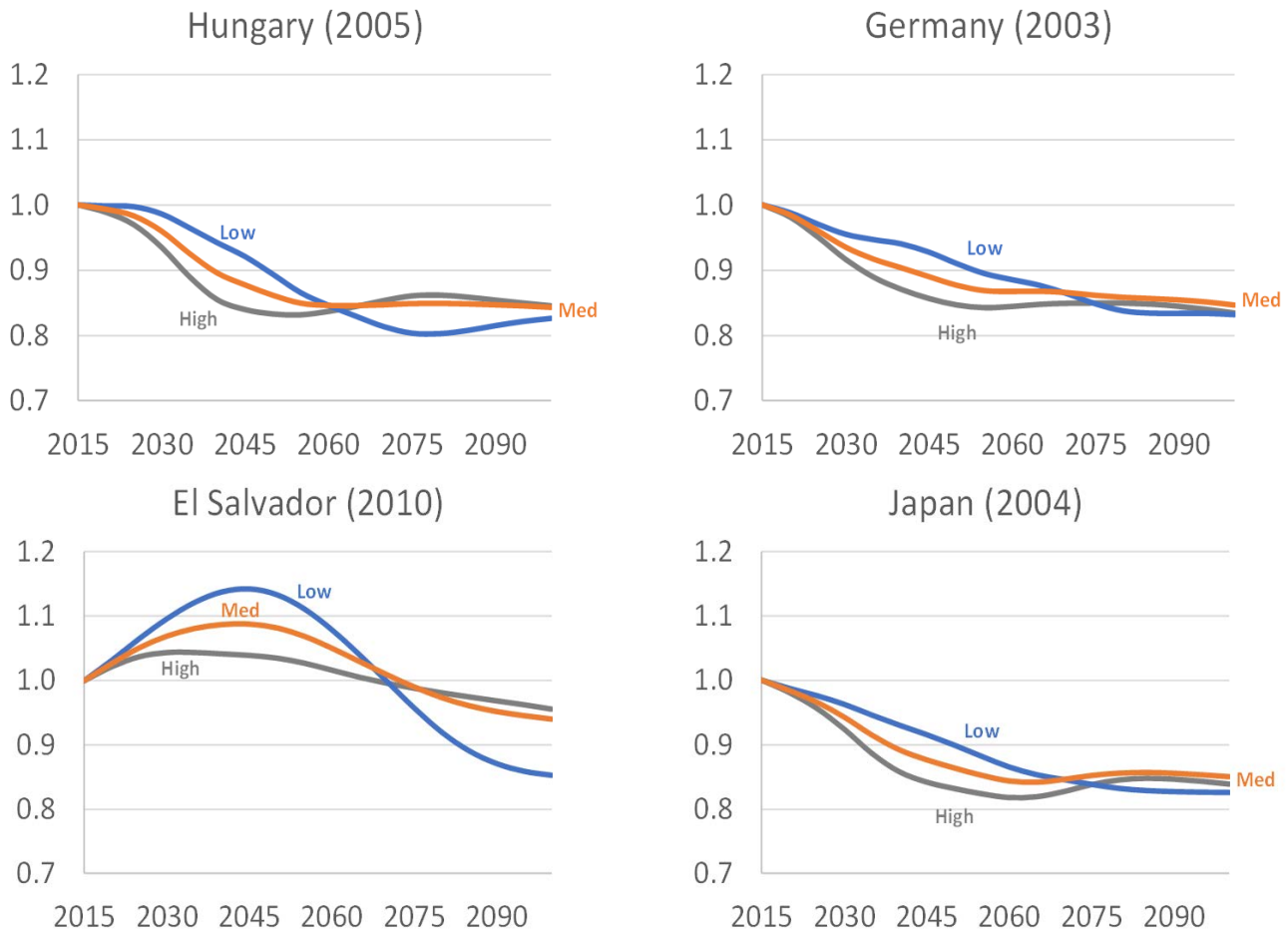


In closed economy, low fertility might be beneficial even in low fertility countries like Austria, Spain, Chile, or Taiwan.



In some other countries (e.g. Japan, Italy, Germany, Hungary, and El Salvador), low fertility is better for first 40 to 50 years, but worse thereafter as pop aging deepens.

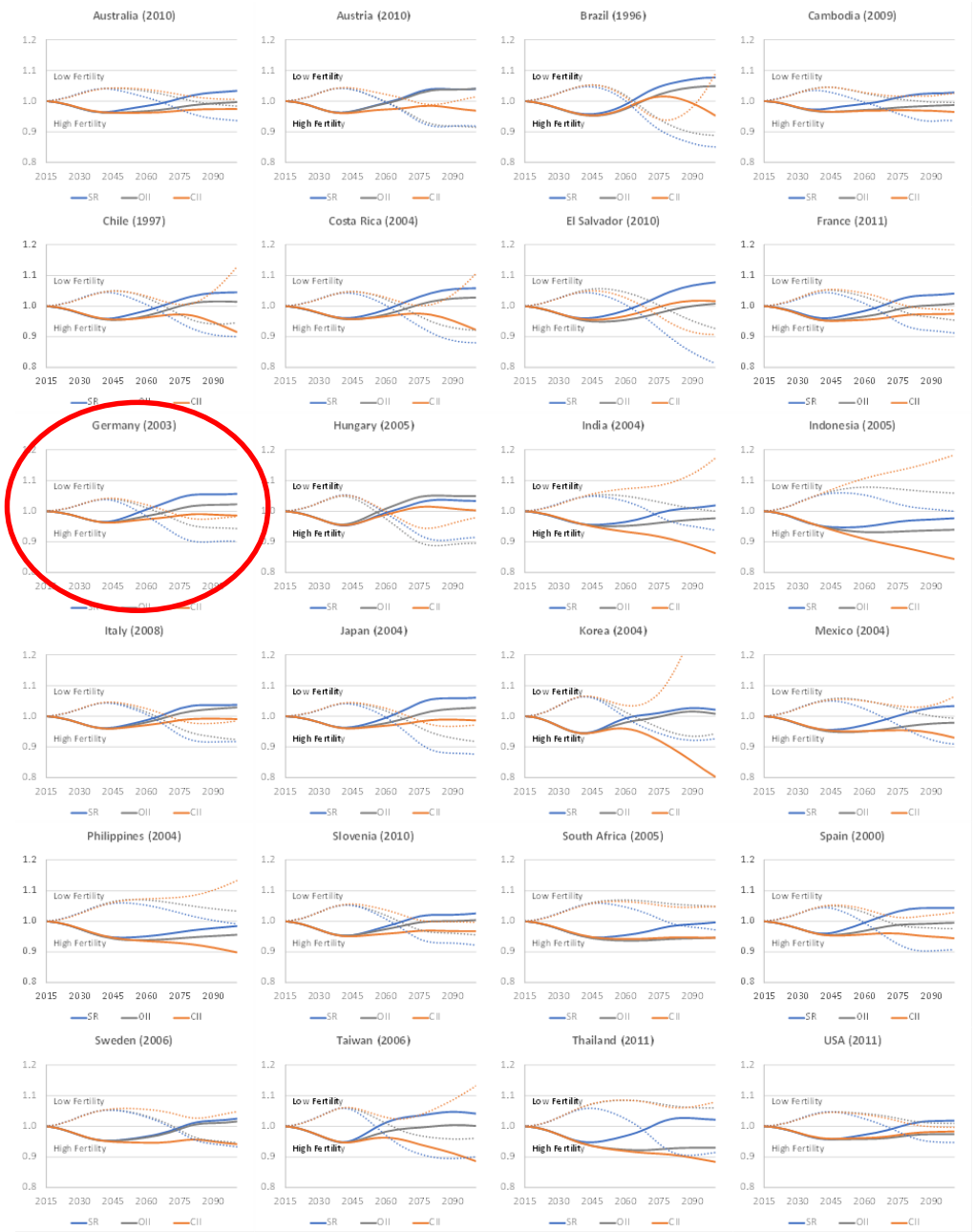
When countries already have low fertility today, a half child more or fewer does not make much difference.



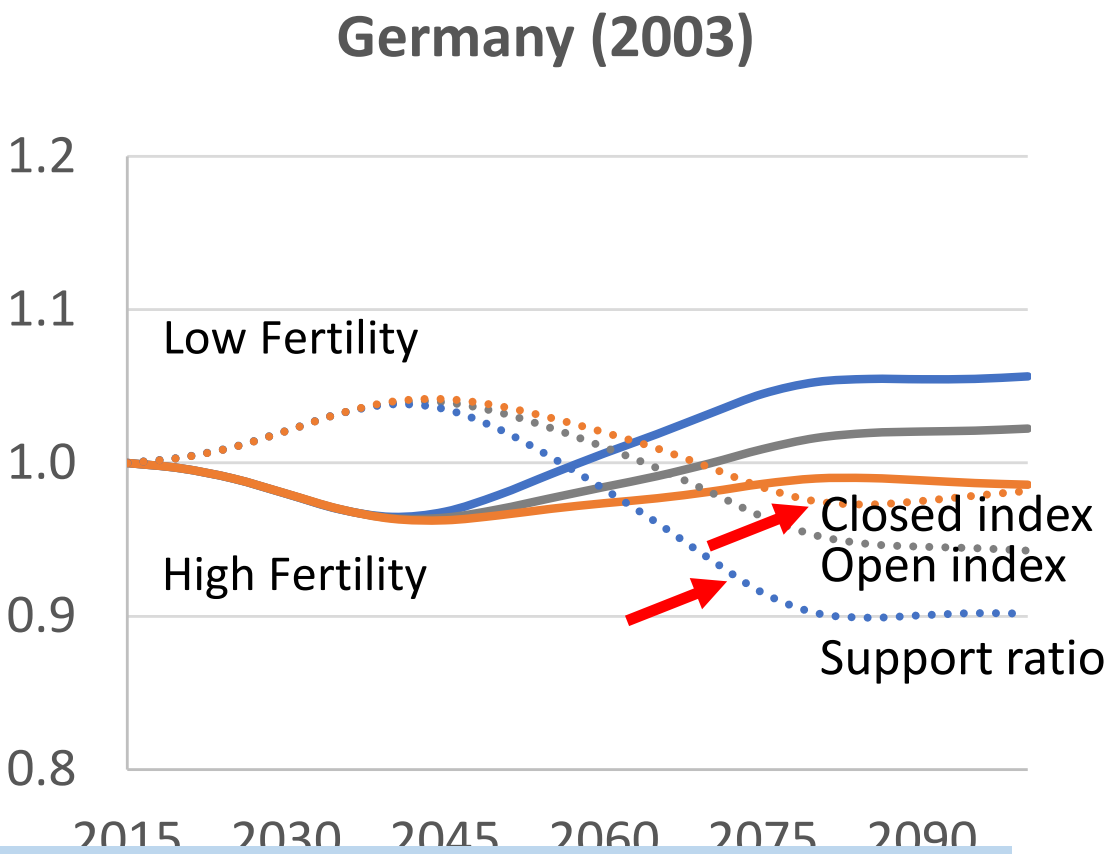
Each Measure?

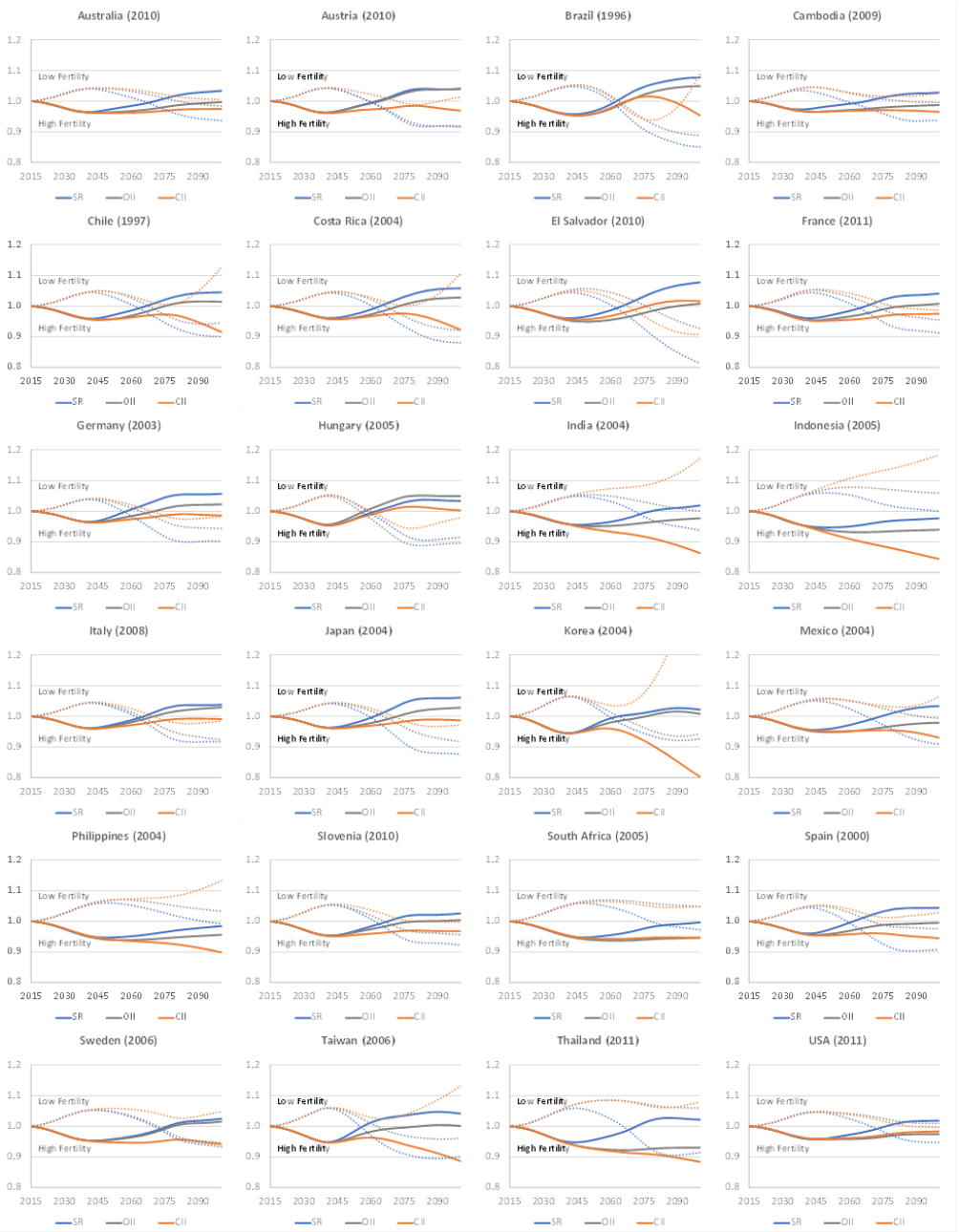
Chart shows ratio of High or Low Fertility outcomes to Medium variant for each measure:

- Support Ratio
- Closed Economy index
- Open Economy index



Result for Germany is typical of most rich countries.

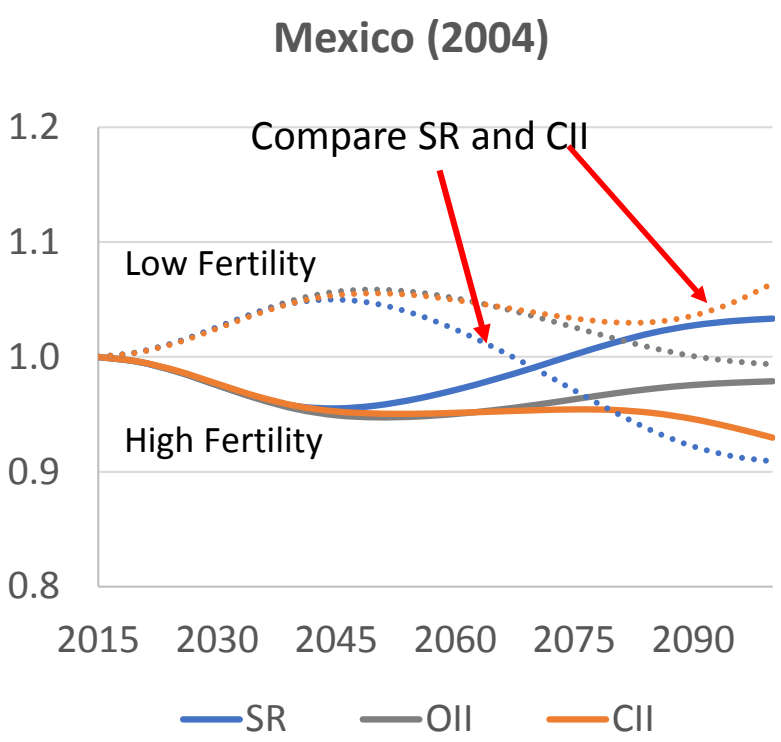




Similarly, support ratio benefits of higher fertility are offset by capital dilution, whether open or closed.

Mexico is typical of developing countries.

The demographic dividend becomes larger and lasts longer when we take capital into account in either open or closed cases.



Some limitations of this analysis

- Rising public debt could crowd out capital.
- Capital accumulation could be modeled in other ways, perhaps with other results – although most would show intensification.
- Global population aging will cause capital intensification in open economies also.
- Analysis at this aggregate national level masks massive adjustments that will be necessary for individuals, markets, policies, institutions, and technologies.
- I ignored human capital and time costs, both of which would reinforce the conclusions.
- Behavior is already changing in ways that alter the NTA profiles that are the basis of this analysis.

Conclusions – taking capital into account makes population aging look less costly.

- Capital intensity will rise in all countries. Wages rise relative to interest rates.
- Taking capital into account indicates greater benefits than the support ratio from reducing fertility in both developing and rich economies.
- Lower fertility boosts consumption for all 25 countries by all measures, at least for the first 40 years, while higher fertility is costly, raising questions about pro-natalist policies .
- In many countries low vs high fertility makes little difference in long run. Perhaps these are in “optimal” fertility range identified in Lee, Mason et al (2014).
- Population aging presents many challenges, but the overall picture is encouraging.