The quantum and tempo of life cycle events

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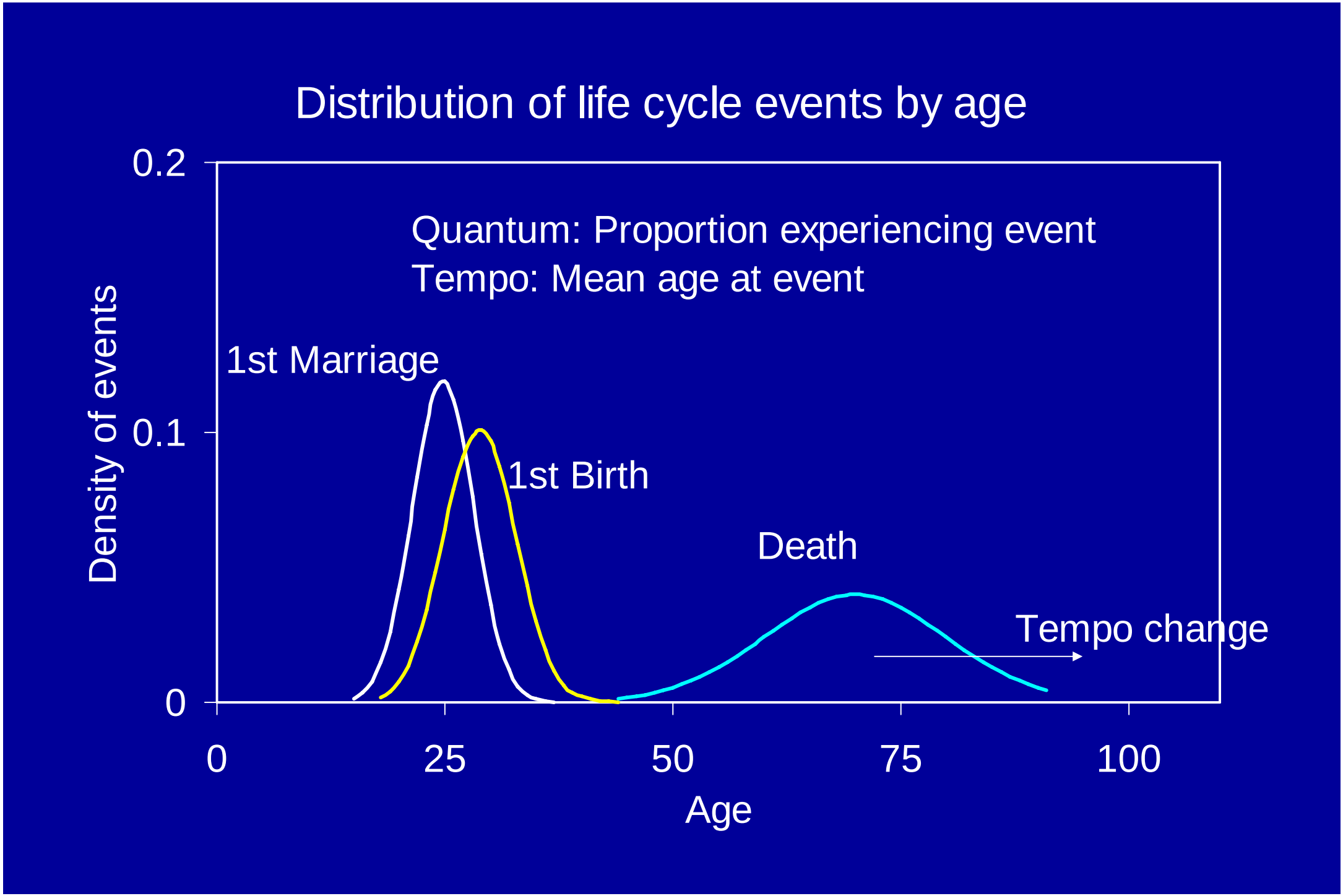
Population Council


Distribution of life cycle events by age
Quantum: Proportion experiencing event
Tempo: Mean age at event
1st Marriage
1st Birth
Death
Tempo change
Density of events
0.2
0.1
0
0
25
50
75
100
Age

Period measures of quantum and tempo (2nd kind)

	QUANTUM	TEMPO
Birth	Total fertility rate *TFR(t)*	Mean age at birth *MAB(t)*
Marriage	Total marriage rate *TNR(t)*	Mean age at marriage *MAM(t)*
Death	Total mortality rate *TMR(t)*	Mean age at death *MAD(t)*

a. Tempo distortions in the total fertility rate

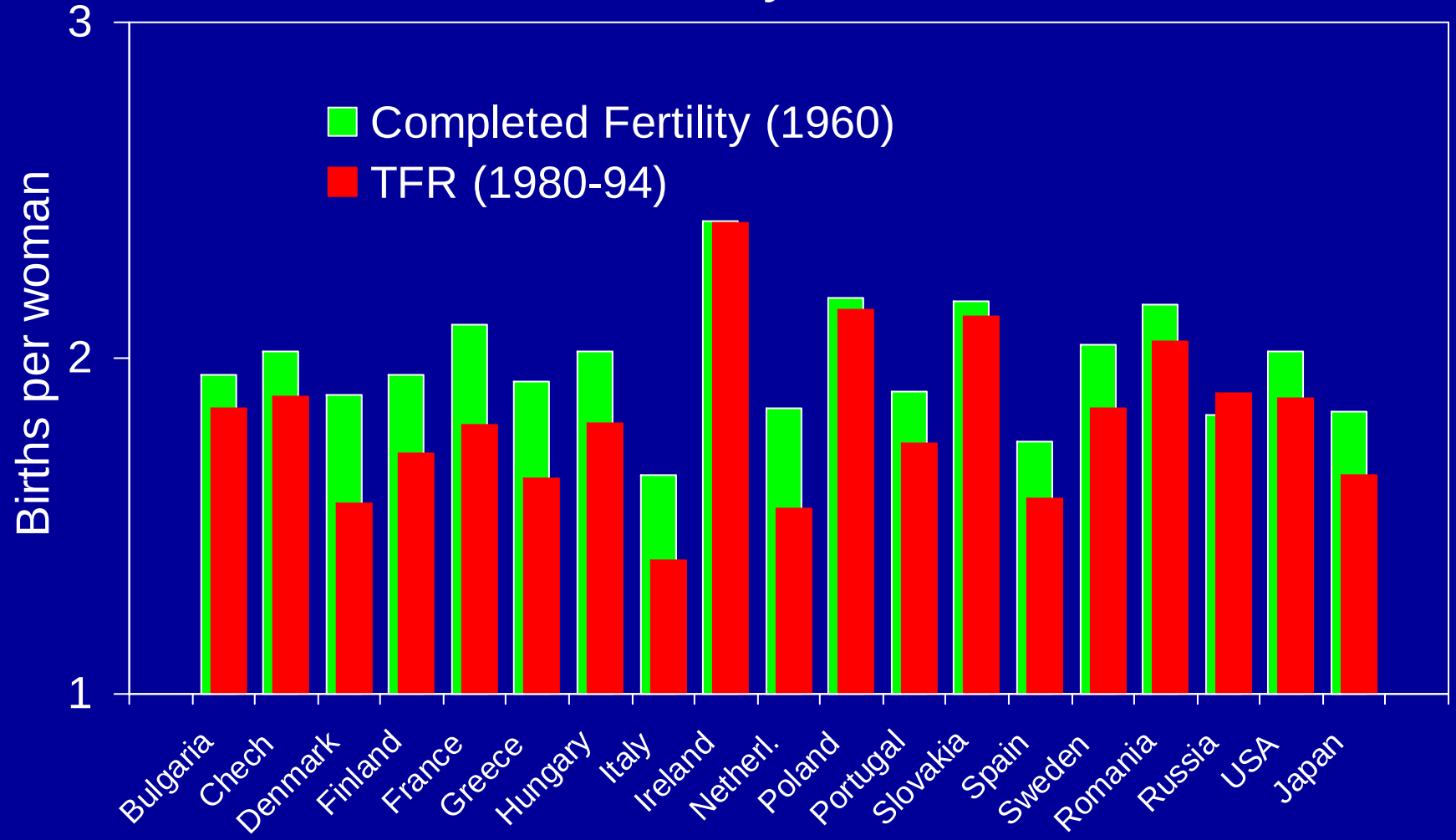
Total fertility rate, France 1975-2000

Period	TFR (births per woman)
1975-80	1.86
1980-85	1.87
1985-90	1.81
1990-95	1.71
1995-00	1.73
Average 1975-2000	1.80
Completed fertility of 1960 cohort	?

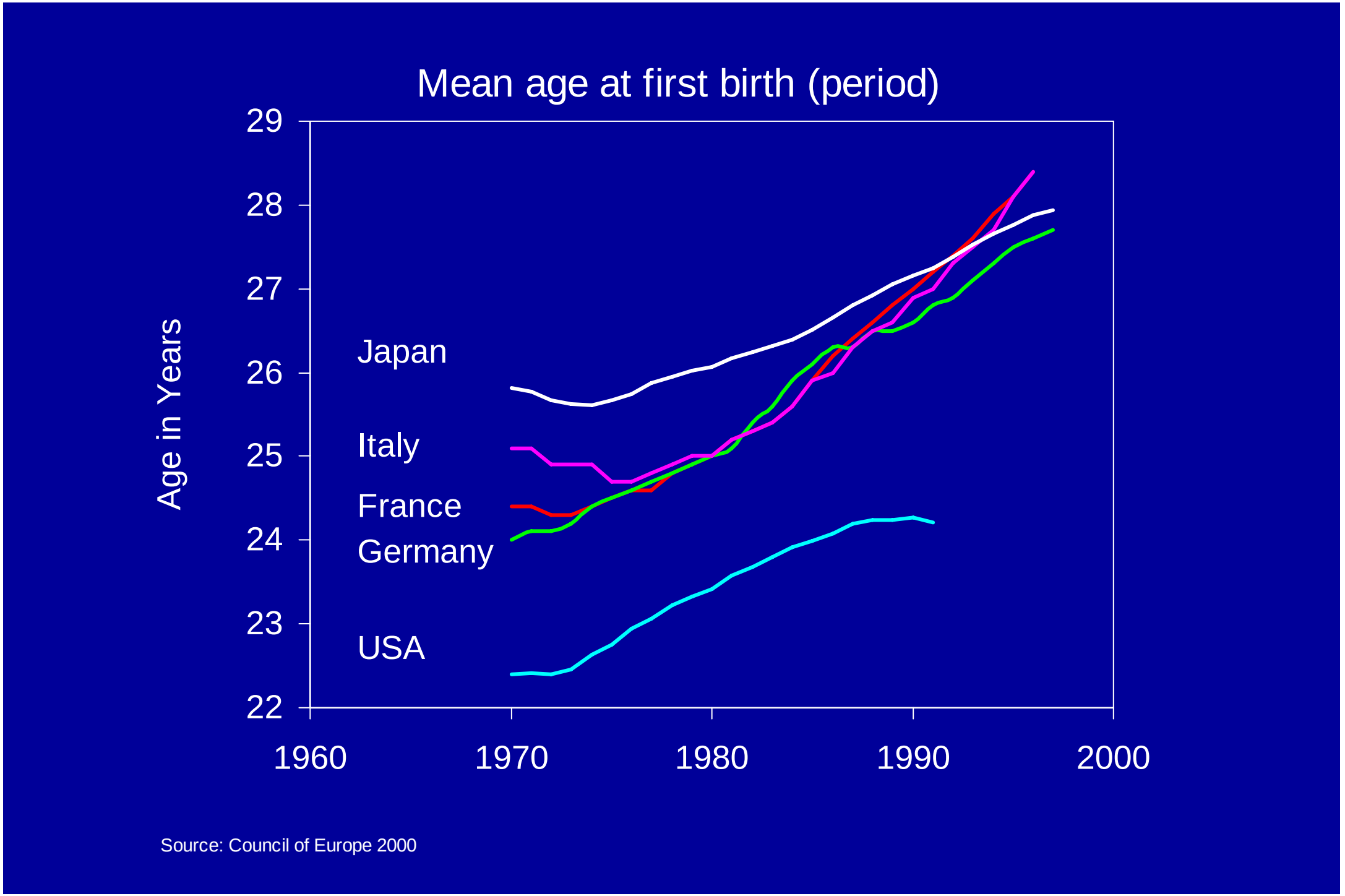
Total fertility rate, France 1975-2000

Period	Observed TFR	Undistorted TFR
1975-80	1.86	?
1980-85	1.87	?
1985-90	1.81	?
1990-95	1.71	?
1995-00	1.73	?
Average 1975-2000	1.80	?
Completed fertility 1960 cohort	2.10	

Completed fertility (1960 cohort) and total fertility rate 1980-94

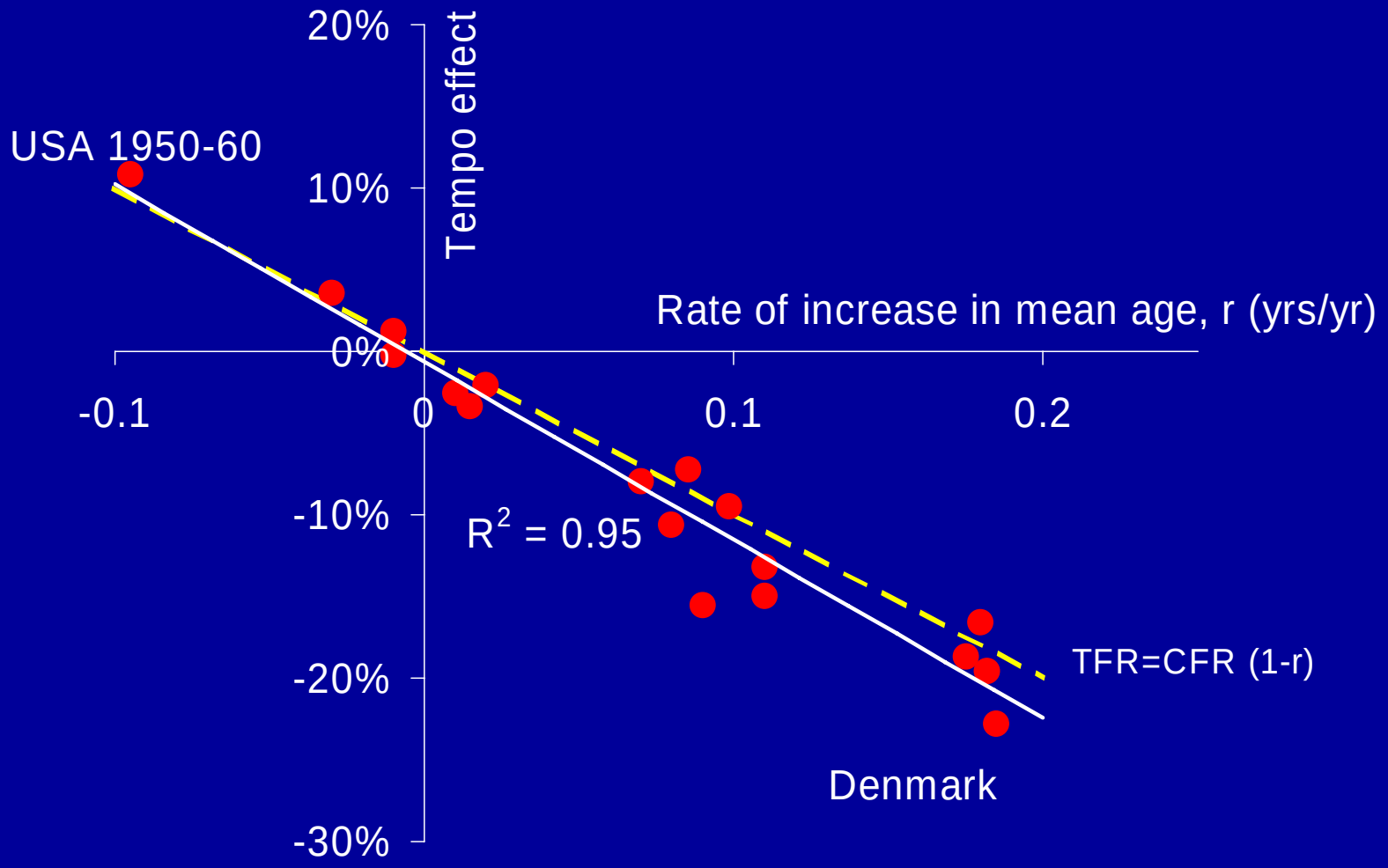


Source: UN 1999, Council of Europe 2000



Source: Council of Europe 2000

Tempo effect (TFR/CFR-1) at birth order one by increase in mean age at first birth, 1980-90



Source: Council of Europe, 2000; Sardon, 2000, 2001; Sato, 2001; Bongaarts and Feeney, 1998

Correction of tempo distortion

Tempo adjusted TFR:

$$TFR^*(t) = \frac{TFR(t)}{1 - r(t)}$$

$$r(t) = \frac{dMAB(t)}{dt}$$

Source: Bongaarts and Feeney 1998

Fertility in France

TFR (1980-1995) = 1.80

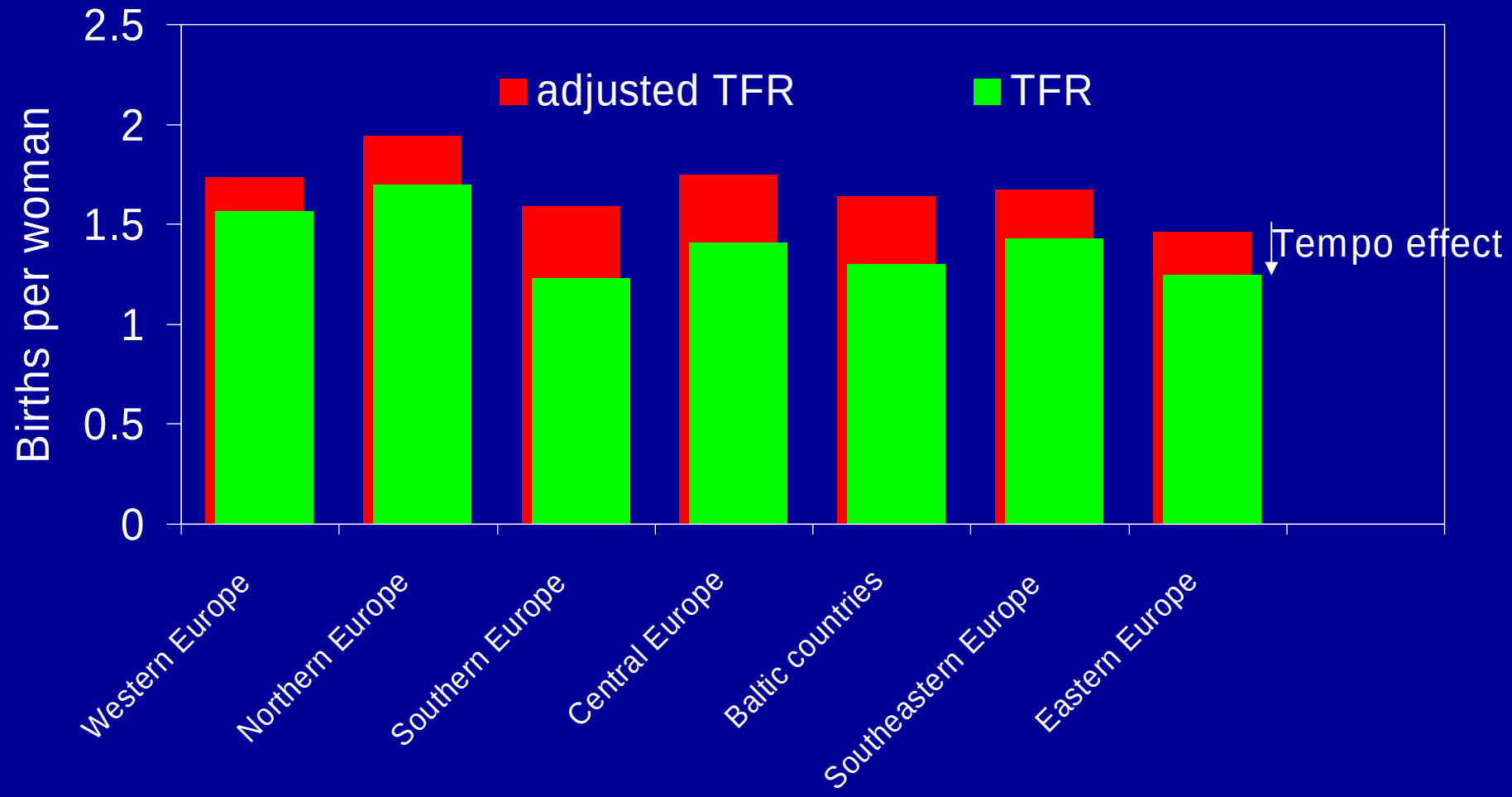
Cohort fertility (1960) = 2.10

Rate of increase in mean age (r) = 0.15/year

Distortion index (1-r)=0.85

Tempo adjusted TFR*=1.8/0.85 = 2.11

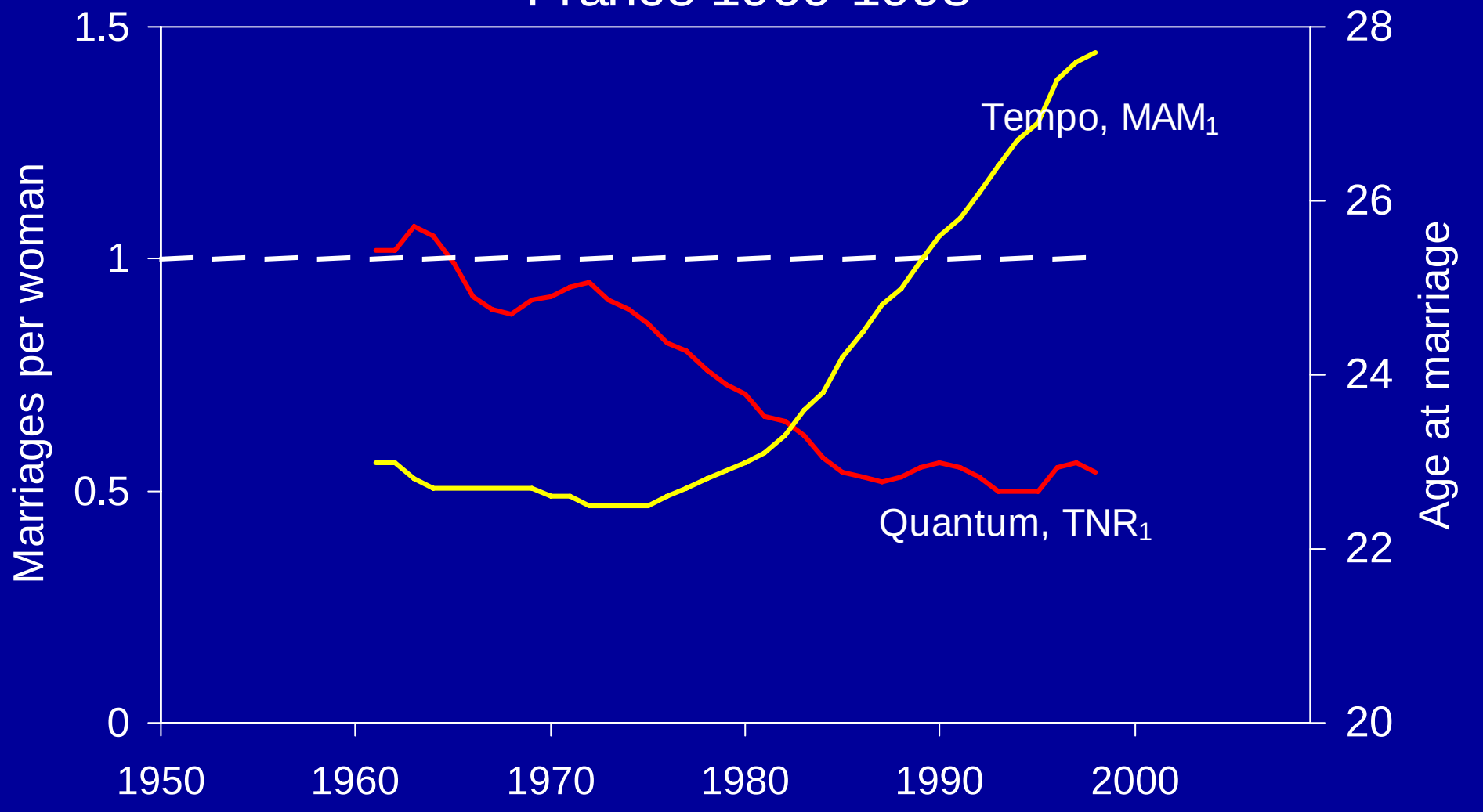
Total fertility rate with an without the tempo effect 1995-2000



Source: Sobotka 2004

b. Tempo distortions in the total marriage rate

Quantum and tempo of first marriage, France 1960-1998



Source: Council of Europe 2002

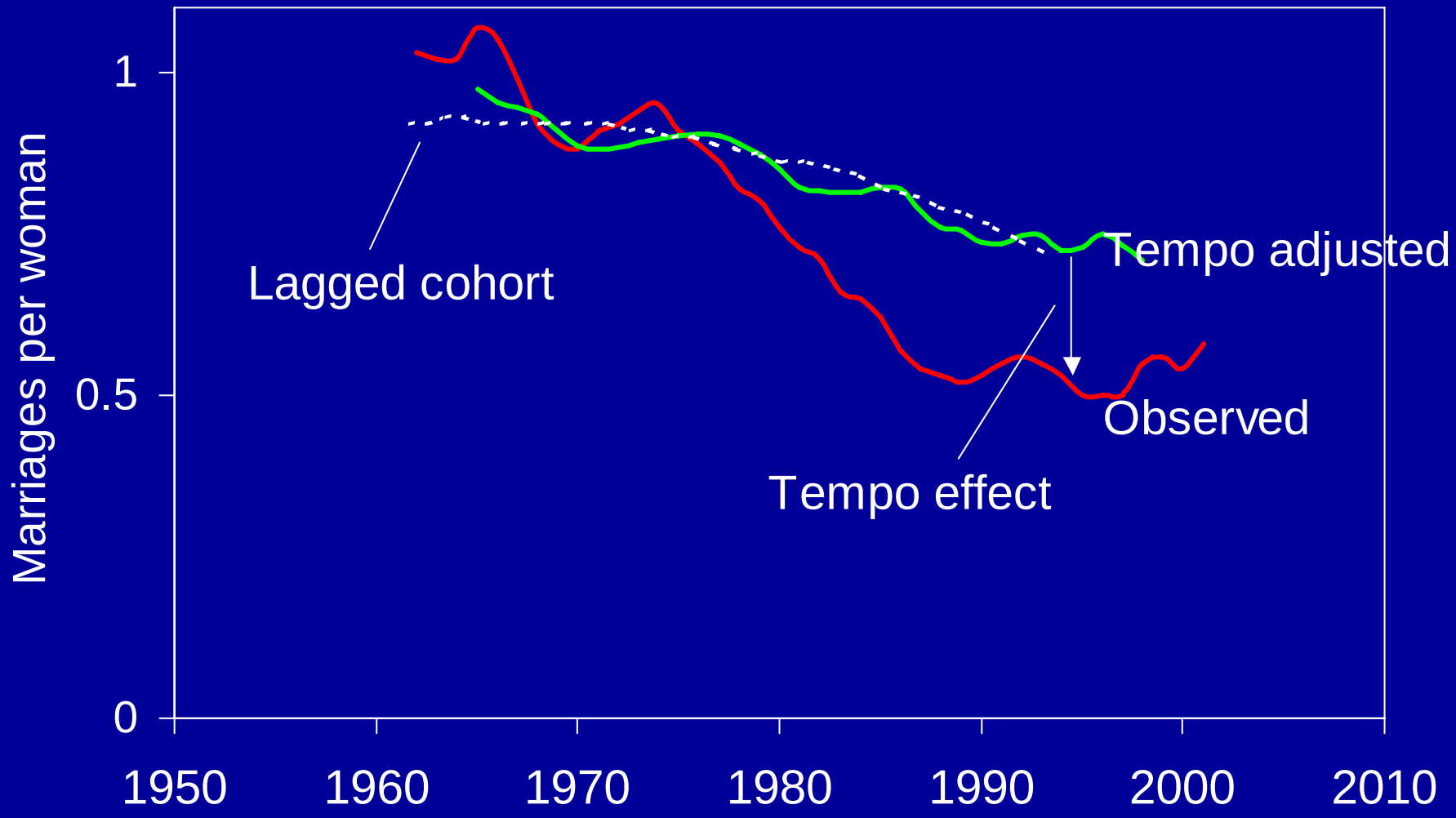
Removing tempo distortion in total marriage rate

Tempo adjusted *TNR*:

$$TNR^*(t) = \frac{TNR(t)}{1 - r(t)}$$

$$r(t) = \frac{dMAM(t)}{dt}$$

Total first marriage rate, observed and adjusted, France



Source: Council of Europe 2002

c. Tempo distortions in the total mortality rate

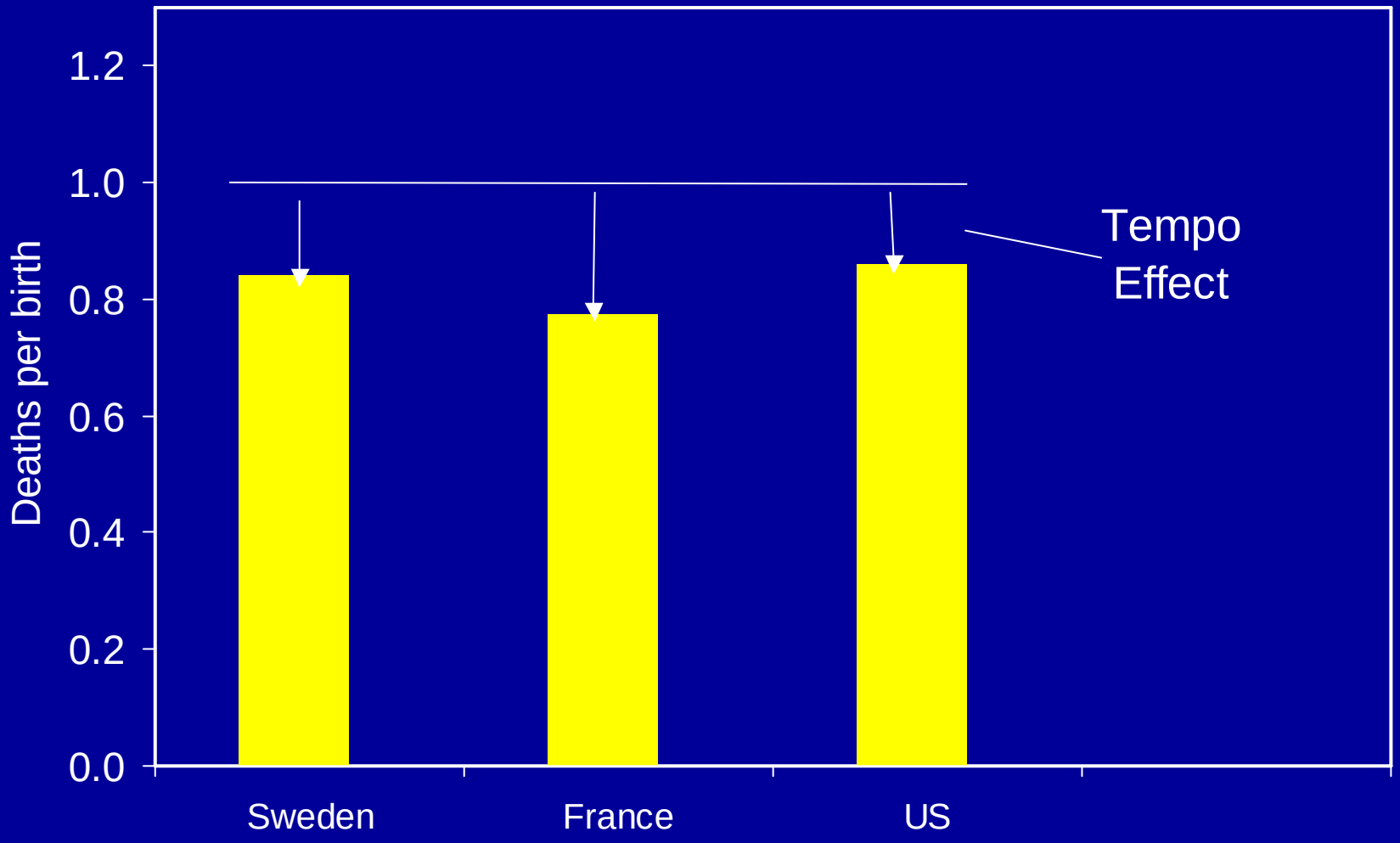
Age specific death rates of 2nd kind

$$d(a,t) = \frac{death\ at\ age\ a\ and\ time\ t}{Persons\ born\ at\ time\ t-a}$$

Total mortality rate

$$TMR(t) = \int_0^\infty d(a,t)da = \int_0^\infty \mu(a,t)\, l_c(a,t-a)da$$

Total mortality rate, females, average 1980-95



Note: No mortality under age 30

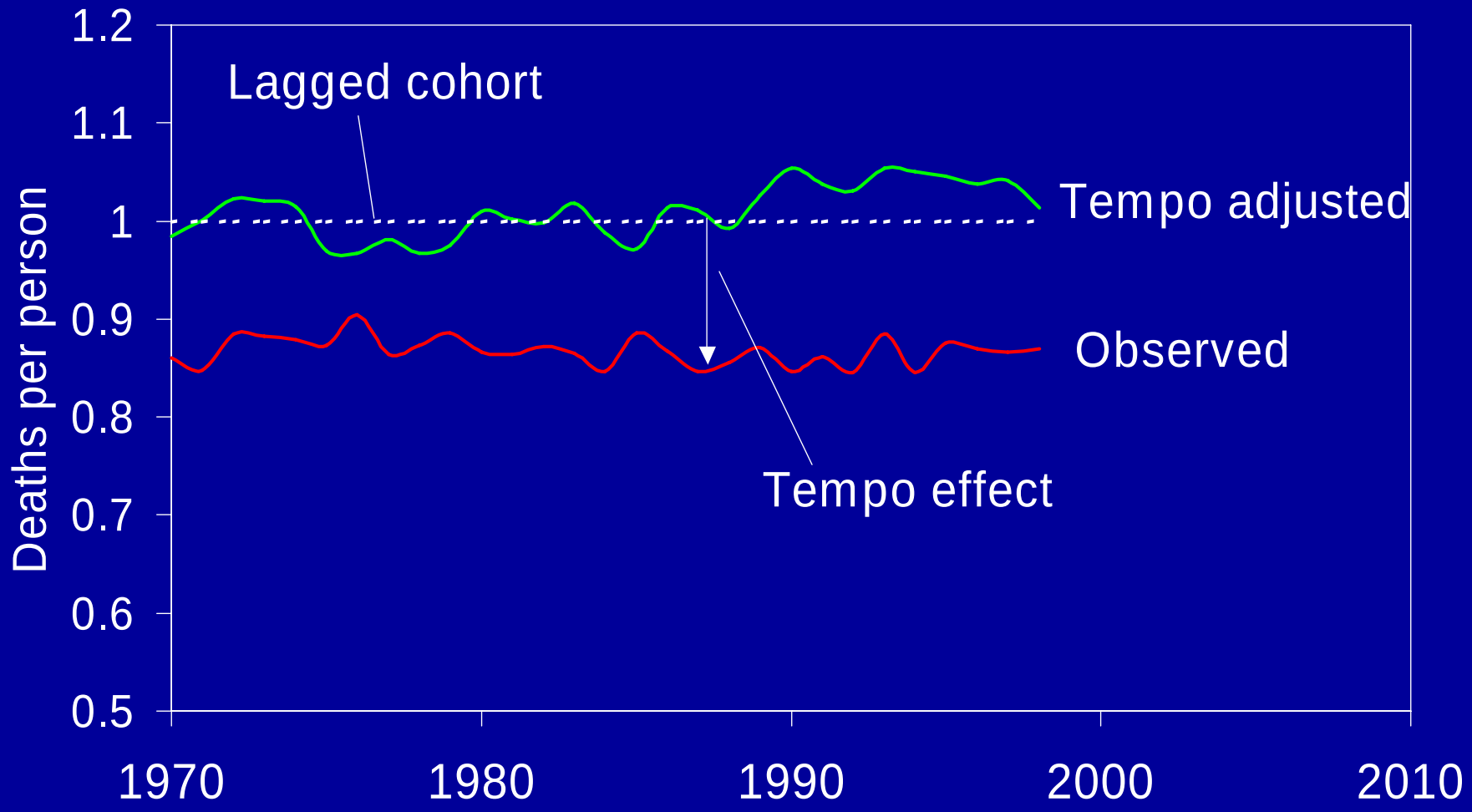
Removing tempo distortion

Tempo adjusted Total Mortality Rate:

$$TMR^*(t) = \frac{TMR(t)}{1 - r(t)} = 1$$

$$r(t) = dMAD(t)/dt$$

Total mortality rate, observed and adjusted, England and Wales



Source: Bongaarts and Feeney 2005

Tempo distortions in the tempo measures of 2nd kind

Tempo measures, adjusted and unadjusted

Mean age at birth

$$MAB(t) = \int_0^\infty a \frac{f(a,t)}{TFR(t)} da = MAB^*(t)$$

Mean age at marriage

$$MAM(t) = \int_0^\infty a \frac{n(a,t)}{TNR(t)} da = MAM^*(t)$$

Mean age at death

$$MAD(t) = \int_0^\infty a \frac{m(a,t)}{TMR(t)} da = MAD^*(t)$$

Conclusions on tempo distortions in measures of the 2nd kind

Quantum measures: Distorted, but can be adjusted

Tempo measures: Not distorted

Assumption: Invariant shape of age pattern of rates

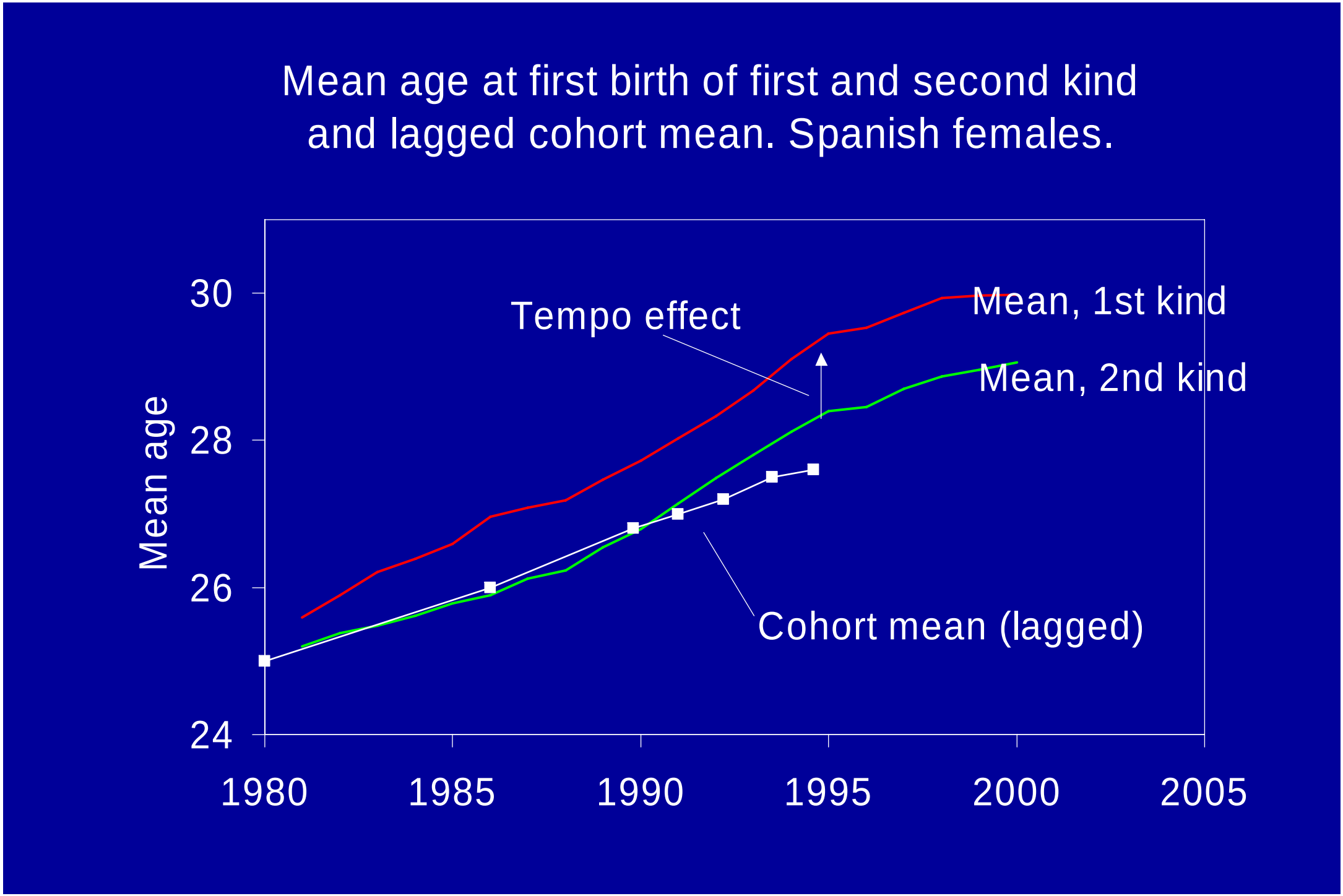
II. Tempo distortions in period measures of 1st kind

Rates of demographic events

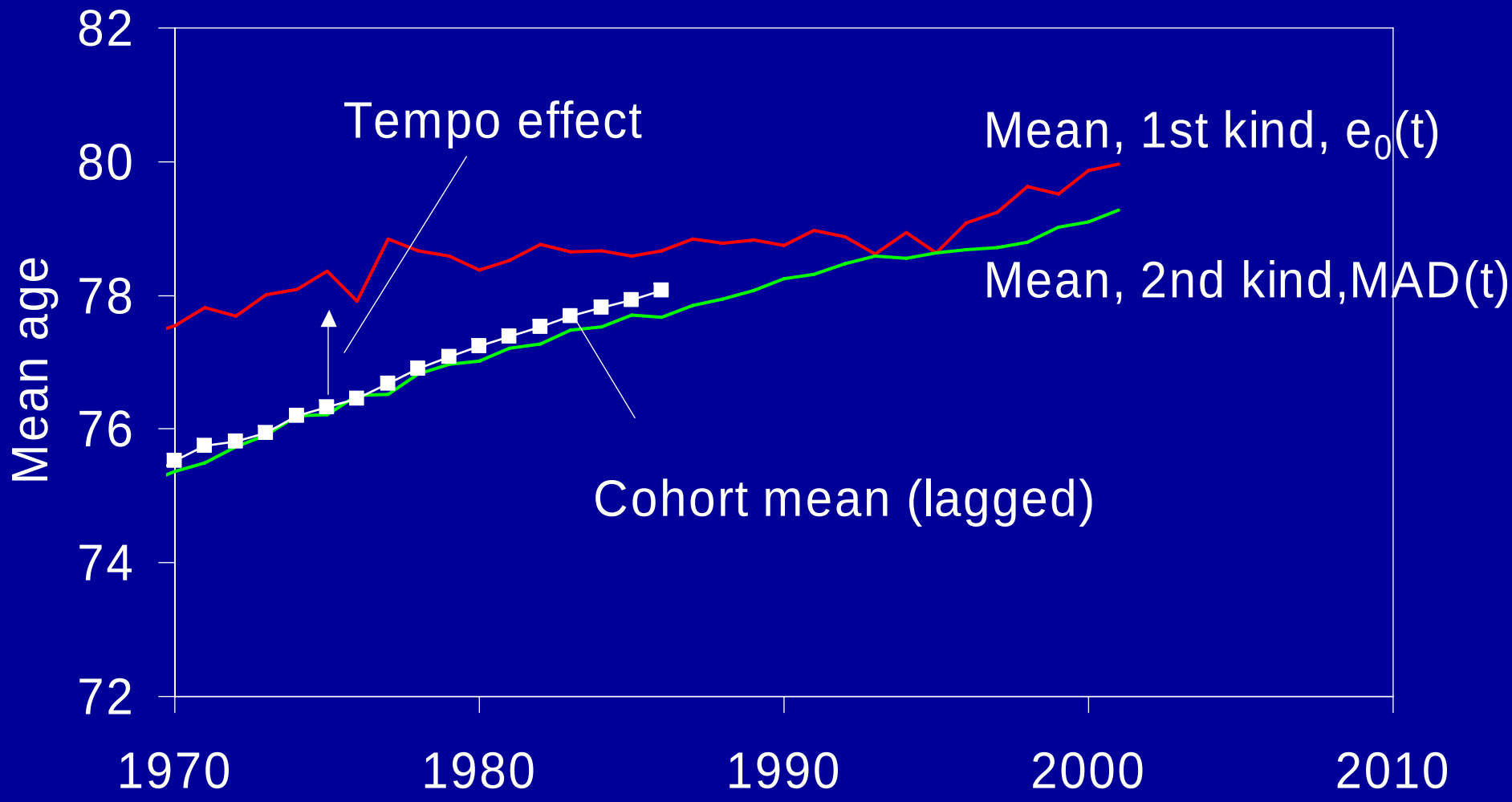
Rate of the 1st kind	Rate of 2nd kind
- Conditional rate - Probability - Intensity - Hazard - Risk - Occurrence/exposure	- Unconditional rate - Frequency - Incidence - Density
Example: Force of mortality	Example: Conventional age specific birth/marriage rate
Used in life tables, e.g. to estimate period life expectancy	Used to calculate quantum measures such as total fertility rate

Period measures of quantum and tempo (1st kind)
Life table estimates

	QUANTUM	TEMPO
Birth (1st)	Proportion ever had 1st birth: $TFR_L(t)$	Mean age at 1st birth: $MAB_L(t)$
Marriage (1st)	Proportion ever married: $TNR_L(t)$	Mean age at 1st marriage: $MAM_L(t)$
Death	Proportion ever dying: $TMR_L(t)=1$	Mean age at death: $MAD_L(t)$ =life expectancy, $e_0(t)$


Mean age at first birth of first and second kind and lagged cohort mean. Spanish females.
Mean age
30
28
26
24
1980
1985
1990
1995
2000
2005
Tempo effect
Mean, 1st kind
Mean, 2nd kind
Cohort mean (lagged)

Mean age at death of first and second kind and lagged cohort mean. Danish females.



Correcting for tempo distortions in tempo measures of 1st kind

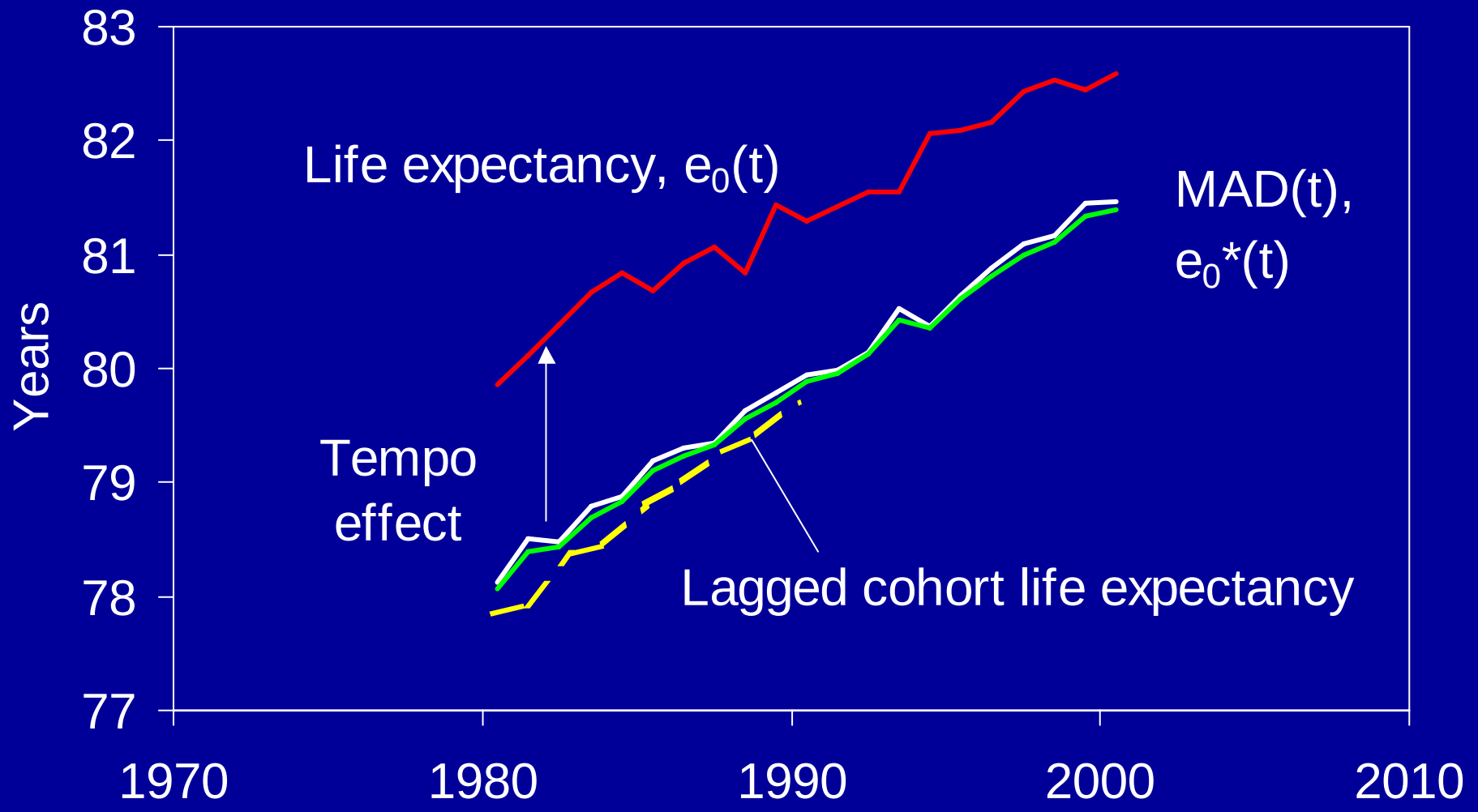
Life expectancy/ mean age at death of 1st kind

$$e_0(t) = \int_0^{\infty} \exp[-\int_0^{x} \mu(a,t)da]dx$$

Tempo adjusted life expectancy

$$e_0{}^*(t) = \int_0^{\infty} \exp[-\int_0^{x} \frac{\mu(a,t)}{1-r(t)}da]dx$$

Trends in alternative mortality tempo measures, Swedish females, 1980-2000 (no mortality under age 30)



Evidence for tempo distortion of period tempo measures of 1st kind

1) Theoretical argument
2) Difference between means of 1st and 2nd kind
3) Difference disappears when mean stalls
4) Lagged cohort mean equals mean of 2nd kind
5) Tempo adjustment removes difference

Conclusions

- Standard methods for measuring period quantum and tempo apply to all life-cycle events
- Period quantum measures of 2nd kind are distorted by tempo effects
- Life table estimates of period quantum and tempo are distorted
- Distortions can be removed with BF procedure for rates of 1st and 2nd kind (assuming constant shape)