Replacement with a Total Fertility Rate Below 2.1: Fertility Level and Long Run Population Growth Prospects in 22 Countries with Net Immigration

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Background

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In 2011-15

- All More Developed Countries, except Israel, had TFR below 2.1.
- 65% had positive net immigration.

- Widespread misconception that TFR below 2.1 will lead (eventually) to population decrease (irrespective of migration).
- Lack of an indicator of which fertility level which is consistent with zero population growth for populations with net immigration.

“this trend of declining fertility, in the absence of a massive increase in immigration, will result in our population declining in absolute terms and, over time, we will simply die out” (Malcolm Turnbull 2002 in Sydney Morning Herald).

Stationary Populations with Below Replacement Fertility and Immigration

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"As long as fertility is below replacement, a constant number and age distribution of immigrants (with fixed fertility and mortality schedules) leads to a stationary population". (Espenshade, Bouvier, and Arthur 1982)

N.B. previously documented by J.H. Pollard AM (1973)

Research Questions

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For 22 more developed countries with below replacement fertility and positive net immigration for 2011-15:

Which (constant) Total Fertility Rate which, combined with constant net migration amount and mortality rates at 2011-15 ('current') levels, would produce a stationary population equal in size to the current population? i.e. the 'With Migration Replacement TFR'

Why do the values differ between countries?

How do current TFRs compare to 'With Migration Replacement TFRs'?

Formula for ‘With Migration Replacement TFR’

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With Migration Replacement TFR ($TFR\downarrow R, A$) - under constant net migration (amounts) ar mortality rates by age and sex, the TFR which equates stationary population size to the size of population A:

$$TFR\downarrow R, A = TFR\downarrow A / NRR\downarrow A \times POP\downarrow A - P\downarrow 1, A / POP\downarrow A - P\downarrow 1, A + P\downarrow 2, A / NRR\downarrow A$$

Where:

TFR_A and NRR_A denote the TFR and NRR respectively for A. $TFR\downarrow A / NRR\downarrow A$ = ‘about 2.1’

POP_A denotes the population size,

$P_{1,A}$ denotes “1st generation component” of TSP_A

= Net Migration × Mean Years After (Net) Migration

$P_{2,A}$ denotes “2nd generation component” of TSP_A

= Births After (Net) Migration (i.e. to $P_{1,A}$ females) × e_0

Properties of 'With Migration Replacement TFR' ($TFR_{R,A}$)

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1) Calculation of $TFR_{R,A}$ assumes unchanged proportionate age distribution of fertility. i.e. for all ages (x)

$ASFR_{x,\,R,A} / TFR_{R,\,A} = ASFR_{x,\,A} / TFR_{A}$

2) If migration = 0, $TFR_{R,A}$ = conventional 'about 2.1' replacement level.

3) $TFR{\downarrow}_{R,\,A}$ is not defined for populations with high (i.e. typically above18.1 per 1000 population) rates of net migration (e.g. for Luxembourg, Kuwait, Oman, Qatar)

Net Migration and TFRs for 2011-15: Selected Countries

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Country	Net Migration (000s)	Net Migration (per 1000)	TFR
Australia	201.8	8.7	1.89
Germany	556.7	6.9	1.44
Italy	201.3	3.3	1.39
Japan	71.6	0.6	1.41
Korea	64.2	1.3	1.24
New Zealand	**27.1**	**6.1**	**2.02**
Norway	48.1	9.5	1.8
Singapore	**67.6**	**12.5**	**1.23**
Slovakia	**1.5**	**0.3**	**1.38**
UK	249.3	3.9	1.85

With Migration Replacement TFR, Ratio to Actual TFR and Net Migration Rate for 2011-15: Selected Countries

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Country	With Migration Replacement TFR (TFR_R)	Ratio of TFR_R to Actual TFR	Net Migration (per 1000)
Slovakia	**2.05**	**0.67**	**0.3**
Japan	2.02	0.70	0.6
Korea	1.98	0.63	1.3
USA	1.80	1.04	3.0
Italy	1.75	0.79	3.3
UK	1.56	1.19	3.9
New Zealand	**1.51**	**1.34**	**6.1**
Germany	1.40	1.03	6.9
Australia	1.00	1.88	8.7
Norway	0.96	1.88	9.5
Singapore	**0.60**	**2.05**	**12.5**

Summary of Main Results

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- $TFR_{R,A}$ ranges from 0.60 in Singapore to 2.05 in Slovakia.

- $TFR_{R,A}$ exceeds actual TFR for A for 14 of 22 countries studied.

In other words, in 14 countries continued fertility, mortality and net migration at 2011-15 levels would lead to population increase.

- The countries with above 'with migration replacement fertility' include Singapore and Germany, both of which have very low TFRs.

- Strong negative correlation between $TFR_{R,A}$ and net migration per 1000 population.

With Migration Replacement TFR vs Net Migration Rate for 2011-15

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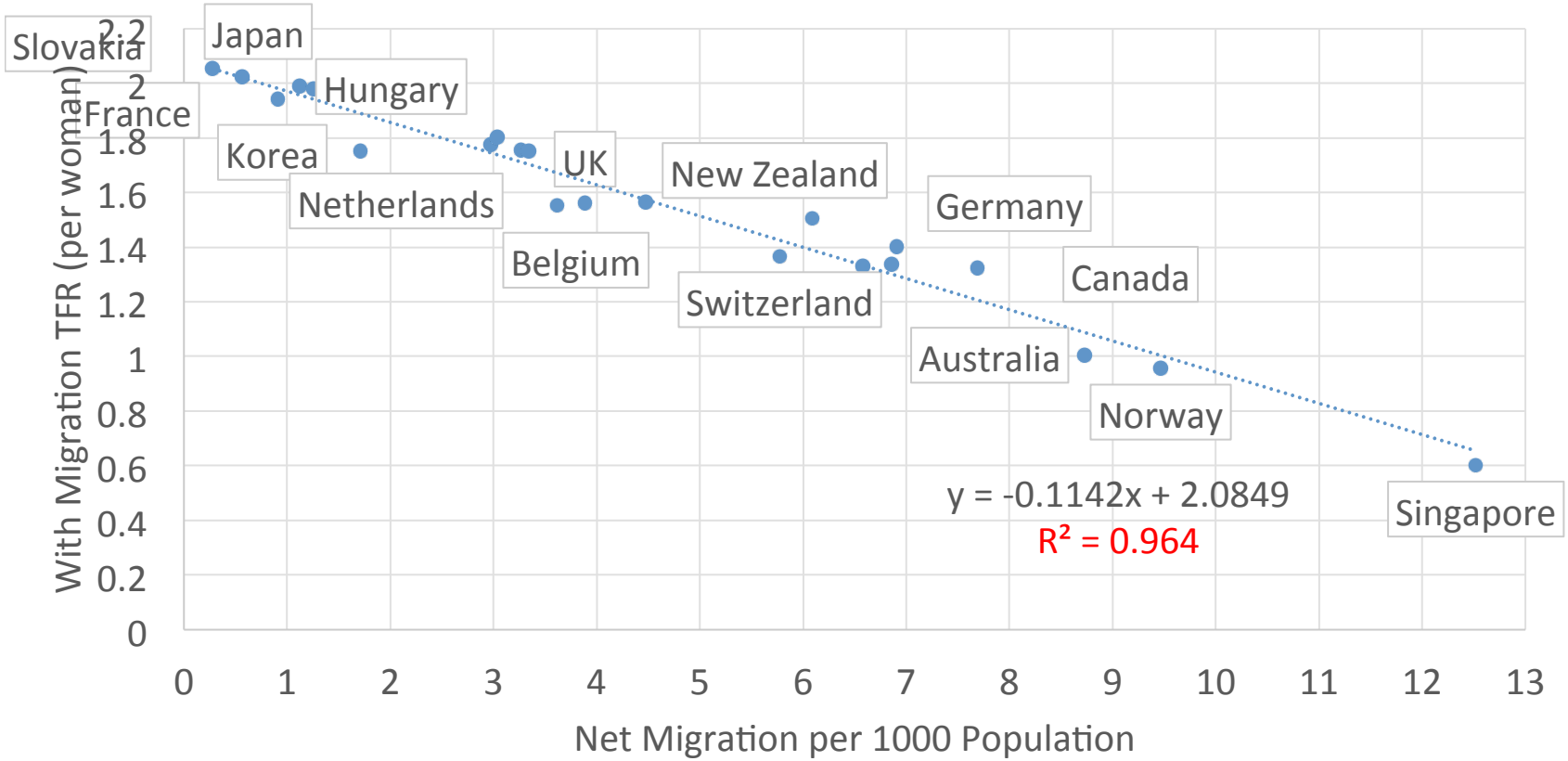

Other Factors Contributing to Differences in With Migration Replacement Fertility $TFR_{R, A}$

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Other data inputs equal, the value of $TFR_{R, A}$ will be lower when A has:

- A higher percentage of females among migrants.
- A younger age profile for migrants.
- Higher life expectancy at birth.
- Higher proportion of life expectancy following migration.
- Older ages at childbearing.

A Simple Short Cut Formula for Estimating TFR_R

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$TFR_{R,A} = 2.0849 – 0.1142 \times NMR(\text{per } 1000)_A$

A simple, reasonably accurate, rule-of-thumb to use (e.g. when time, data or audience tolerance of maths is limited).

Demographers should “stop sitting in the corner being clever with themselves” (adapted from (ex Australian PM) Paul Keating, cited in Atfield 1993).

Potential Uses of $TFR_{R, A}$

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1. For illustrative purposes to counter misconceived views which associate TFRs below 2.1 with inevitable population decline (and to help prevent misconceived pronatalist policy).

2. To subcategorise post-transitional (below 2.1) demographic regimes.
i.e. “long run extinction” – TFR below 2.1 + negative net migration,
“long run decrease” – TFR below with migration replacement
“long run increase” - TFR above with migration replacement.

3. To illustrate levels of fertility could prevent population decrease (or increase)
In combination with specified net migration (and provide target TFR levels for pronatalist polices(??).

Motivation-Misguided (?) Pronatalism in Australia

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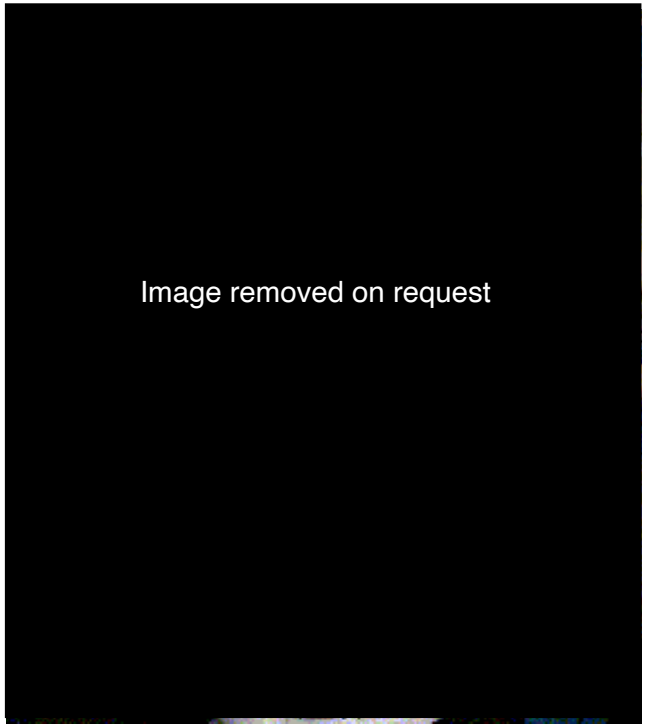
'If you can have children it's a good thing to do – you should have one for the father, one for the mother and one for the country'
former Australian Treasurer Peter Costello (pictured opposite) as quoted in SMH 12/5/2004
(Source of picture opposite: Sun Herald)



"this trend of declining fertility, in the absence of a massive increase in immigration, will result in our population declining in absolute terms and, over time, we will simply die out" (Malcolm Turnbull 2002)
Australia 2002 $TFR_{R,A}$ = 1.52 Actual TFR = 1.74.

Summary of Main Points

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1. The implication of a TFR below 2.1 appears to be widely misunderstood.

2. The ‘with migration replacement TFR’ may be used to indicate the TFR which is coherent with zero long run population growth *if migration continues at the current level*.

3. Current TFRs which are above with migration replacement indicate in 14 of the 22 countries (even though the TFR is below 2.1) the current combination of fertility, mortality and migration is consistent with long run population **growth.**

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A Final Thought

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Will poorer, immigrant-sending countries which complete the demographic transition later in time experience the onset of population decrease whilst the populations of many of the richer, immigrant-receiving countries (e.g. Australia, France, Norway, New Zealand, UK) which were among the first to complete the transition continue to grow?

References

Espenshade, T.J., Bouvier, L.F. and Arthur, W. B. (1982) Immigration and the Stable Population Model. *Demography.* 19(1): 125-133.

Parr, N. and Guest, R. (2014) A method for socially evaluating the effects of long-run demographic paths on living standards. *Demographic Research.* 31(11): 275-318.

Pollard, J.H. (1973) Mathematical Models for the Growth of Human Populations. London: Cambridge University Press.

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- Replacement Migration (e.g. for 2011-15 9 times above current for New Zealand) as a potential device for illustrating how the net migration total which is coherent with zero long run population growth varies with mortality and (below replacement) fertility levels (and the age distributions of fertility, mortality and migration).

- Terminal Stationary Population sizes as a potential complementary device to population projections for illustrating the implications of demographic patterns. TSP size can illustrate implications over longer time horizon than population projections and is unaffected by population age structure.

Formula for TSP Size (Simplified)

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$$P_{TSP} = (\Sigma_x NM_{x,m} e_{x,m}) + (\Sigma_x NM_{x,f} e_{x,f}) + (e_{0,F} (\Sigma_x NM_{x,f} B_{x,f})/(1- NRR)) + (SRB\, e_{0,M} (\Sigma_x NM_{x,f} B_{x,f})/(1- NRR))$$

= “Surviving (net) migrants” + “Surviving local born”

Where

$NM_{x,m/f}$ = Net Migration for age x and sex m/f

$e_{x,m/f}$ = remaining life expectancy for x and sex m/f

$B_{x,f}$ = remaining lifetime births of a female aged x

NRR = Net reproduction rate

SRB = sex ratio at birth (males per female)