THE EFFECTS OF POPULATION AGING ON GDP PER CAPITA IN TWENTY INDUSTRIALISED COUNTRIES: COULD PRODUCTIVITY GROWTH PROVIDE AN OFFSET?

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-- Memorial University of Newfoundland, October 2017 --

Population aging and decline is in prospect

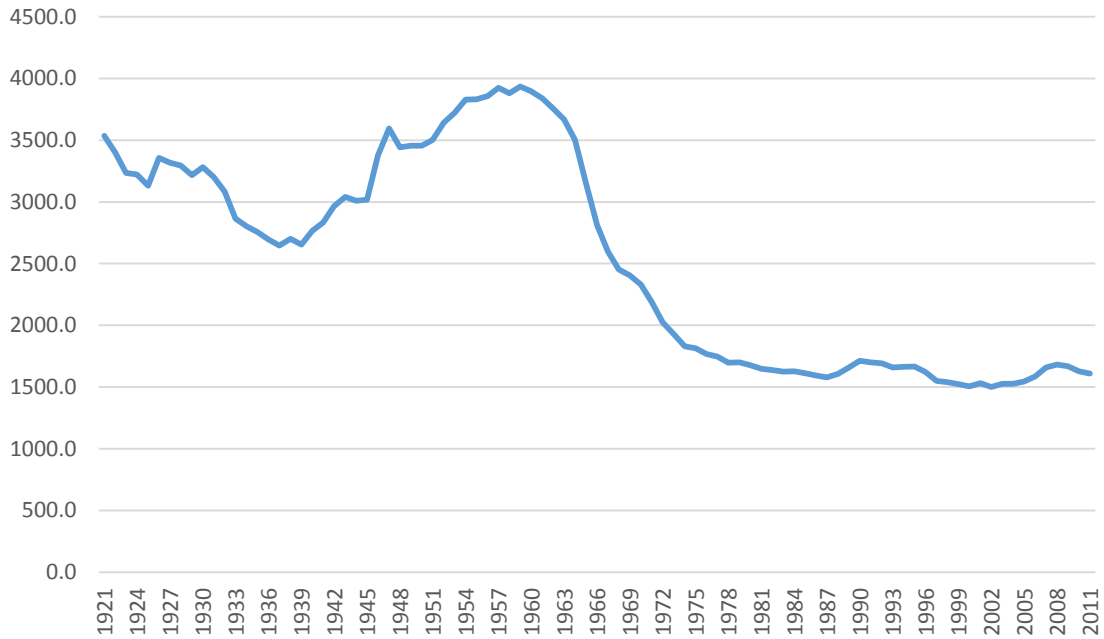
- *All else equal*, that means
  - A decline in labour supply relative to the number of aging and dependent population
  - Hence a reduction in output per capita, Y/N

The concern is not new

- “the … result to prosperity of a change-over from an increasing to a declining population may be very disastrous” (Keynes, 1937)
- “… it behooves us as economists to take cognizance of the significance of this revolutionary change in our economic life” (Hansen, 1939)

But then fertility rates rebounded

E.g., the post-WWII baby boom in Canada



… Before resuming their long-run downward trend

There is now renewed concern …

- Bloom, Canning, and Fink (2011)
  - "OECD countries are likely to see modest … declines in the rate of economic growth"
- National Research Council (2012), co-chaired by Ronald Lee
  - "… the impact of an aging population on overall living standards is likely to be modest"
- Maestas, Mullen, and Powell (2016)
  - a "… 10% growth in the fraction of the population ages 60 and older decreases growth in GDP per capita by 5.5%"
  - "two-thirds of the reduction is driven by a reduction in the rate of growth of … labor productivity"

… even about *secular stagnation*

- Summers (2014, 2016)
  - Focuses on the demand side, and the limitation of monetary policy in attaining full employment
- Gordon (2014, 2016)
  - Argues that the growth of productive potential itself will be reduced by four “headwind” barriers, one of which is demographic (the others are education, inequality, and government debt)

Table 1. Projected Percentages of Population in Dependent Age Groups

	65 and over				Under 20				Under 20 plus 65 and older			
	2015	2025	2035	2045	2015	2025	2035	2045	2015	2025	2035	2045
Australia	15.0	17.8	20.3	21.6	24.9	25.3	24.3	23.1	39.9	43.2	44.6	44.7
Austria	18.8	21.8	27.5	29.7	19.6	19.0	19.0	18.3	38.4	40.8	46.5	48.0
Belgium	18.2	21.0	24.7	26.3	22.4	22.8	21.8	21.3	40.7	43.8	46.5	47.6
Canada	16.1	20.9	24.6	25.7	21.9	21.5	20.7	20.1	38.0	42.5	45.4	45.8
Denmark	19.0	21.3	24.1	24.8	23.2	21.8	22.1	22.1	42.2	43.2	46.2	46.9
Finland	20.5	24.1	26.2	26.1	21.9	21.8	21.1	20.8	42.3	45.9	47.3	46.9
France	19.1	22.4	25.1	26.1	24.4	23.5	22.6	22.5	43.5	45.8	47.7	48.6
Germany	21.2	25.0	30.8	31.6	17.9	17.4	17.5	16.9	39.1	42.4	48.3	48.5
Ireland	13.1	16.6	20.3	24.4	27.5	26.3	22.9	22.8	40.7	42.9	43.1	47.2
Italy	22.4	25.9	31.4	34.9	18.4	17.5	16.9	17.2	40.8	43.4	48.3	**52.2**
Japan	26.3	29.4	31.9	**35.5**	17.6	16.8	16.5	16.6	43.9	46.2	48.4	52.1
Korea	13.1	19.7	27.4	33.3	20.5	17.7	17.4	16.4	33.6	37.4	44.9	49.7
Netherlands	18.2	22.5	27.0	27.7	22.4	20.9	20.8	20.6	40.6	43.4	47.8	48.3
New Zealand	14.9	18.8	22.6	23.9	27.0	25.4	23.7	22.8	41.9	44.2	46.3	46.7
Norway	16.3	18.7	21.6	23.2	24.2	23.9	23.4	22.7	40.6	42.7	45.0	45.8
Spain	18.8	22.7	28.8	34.8	19.4	18.3	16.3	16.4	38.2	41.0	45.0	51.2
Sweden	19.9	21.5	23.5	23.7	22.5	24.0	23.4	22.9	42.4	45.4	46.9	46.7
Switzerland	18.0	21.0	25.8	27.6	20.0	20.1	20.1	19.5	38.1	41.1	45.9	47.1
United Kingdom	17.8	19.6	23.1	24.1	23.6	23.9	22.8	22.0	41.4	43.5	45.9	46.1
United States	14.8	18.9	21.4	21.8	25.4	24.6	24.1	23.6	40.2	43.5	45.5	45.4
Average	18.1	21.5	25.4	27.3	22.2	21.6	20.9	20.4	40.3	43.1	46.3	47.8

What growth in productivity is needed

… to offset the effects of aging on GDP/POP?

And possible “secular stagnation”?

Framework for analysis

$$y = p \sum_{x} r_x e_x h_x q_x n_x$$

$$y = Y/N$$

$$r_x = L_x/N_x$$

$$e_x = E_x/L_x$$

$$h_x = H_x/E_x$$

$q_x = \bar{H}_x/H_x$ -- *work efficiency ratio*

$$n_x = N_x/N$$

p = *productivity ratio*

Index of pure demographic effects on *y*

- $y_t = p_t \sum_x a_{xt} n_{xt}$

- Setting $a_{xt} = a_{x0}$
- $\bar{y}_t = \bar{p}_t \left(\sum_x a_{x0} n_{xt} \right) / \left(\sum_x a_{x0} n_{x0} \right) = \bar{p}_t \bar{d}_t$
- where
  - $a_{xt} = r_{xt} e_{xt} h_{xt} q_{xt}$
  - $\bar{p}_t = p_t / p_0$ is an index of overall productivity
  - $\bar{d}_t$ is an index of pure demographic effects, and
  - $\bar{y}_t = y_t / y_0$ is an index of per capita GDP, conditional on $\bar{p}_t$ and $\bar{d}_t$

Productivity growth as a possible offset

- $\bar{d}_t$ is based on population projections
- What rate of productivity growth would be needed to offset aging?
  - i.e., what would yield $\bar{y}_t = k_t$?
  - Answer: $\hat{p}_t = k_t/\bar{d}_t$
    - E.g., for y_t to remain constant, k_t = 1.0, so $\hat{p}_t = 1/\bar{d}_t$
    - E. g., for y_t to grow , $\hat{p}_t = k_t/\bar{d}_t$ where $k_t = (1+\pi)^t$

Table 2. Projected Indexes of GDP per Capita When Only the Population Changes

	Index				Percentage change			
	2015	2025	2035	2045	2015-25	2025-35	2035-45	2015-45
Australia	100.0	95.8	93.9	93.3	-4.2	-2.0	-0.7	-6.7
Austria	100.0	92.7	85.6	82.7	-7.3	-7.7	-3.4	-17.3
Belgium	100.0	93.9	89.2	87.6	-6.1	-5.0	-1.9	-12.4
Canada	100.0	94.2	90.2	88.9	-5.8	-4.2	-1.5	-11.1
Denmark	100.0	98.0	93.7	92.6	-2.0	-4.4	-1.2	-7.4
Finland	100.0	94.9	93.4	93.0	-5.1	-1.6	-0.3	-7.0
France	100.0	95.2	92.6	92.3	-4.8	-2.7	-0.3	-7.7
Germany	100.0	93.8	86.4	84.7	-6.2	-8.0	-1.9	-15.3
Ireland	100.0	95.4	94.5	90.6	-4.6	-1.0	-4.2	-9.4
Italy	100.0	93.6	85.6	80.8	-6.4	-8.5	-5.6	-19.2
Japan	100.0	96.4	92.7	88.5	-3.6	-3.8	-4.6	-11.5
Korea	100.0	99.3	92.0	86.3	-0.7	-7.3	-6.2	-13.7
Netherlands	100.0	94.3	88.9	88.2	-5.7	-5.8	-0.8	-11.8
New Zealand	100.0	97.6	95.2	95.1	-2.4	-2.5	-0.1	-4.9
Norway	100.0	96.5	92.5	90.7	-3.5	-4.1	-2.0	-9.3
Spain	100.0	92.6	85.1	77.9	-7.4	-8.0	-8.6	-22.1
Sweden	100.0	95.9	92.9	92.8	-4.1	-3.1	-0.1	-7.2
Switzerland	100.0	93.6	87.6	85.1	-6.4	-6.4	-2.9	-14.9
United Kingdom	100.0	96.1	93.1	92.1	-3.9	-3.1	-1.1	-7.9
United States	100.0	96.6	93.9	93.3	-3.4	-2.8	-0.7	-6.7
Average	100.0	95.3	91.0	88.8	-4.7	-4.6	-2.4	-11.2

Figure 1. Indexes of GDP per Capita When Only the Population Changes (Lower Half); Corresponding Indexes of Productivity Required to Prevent GDP per Capita from Declining (Upper Half)

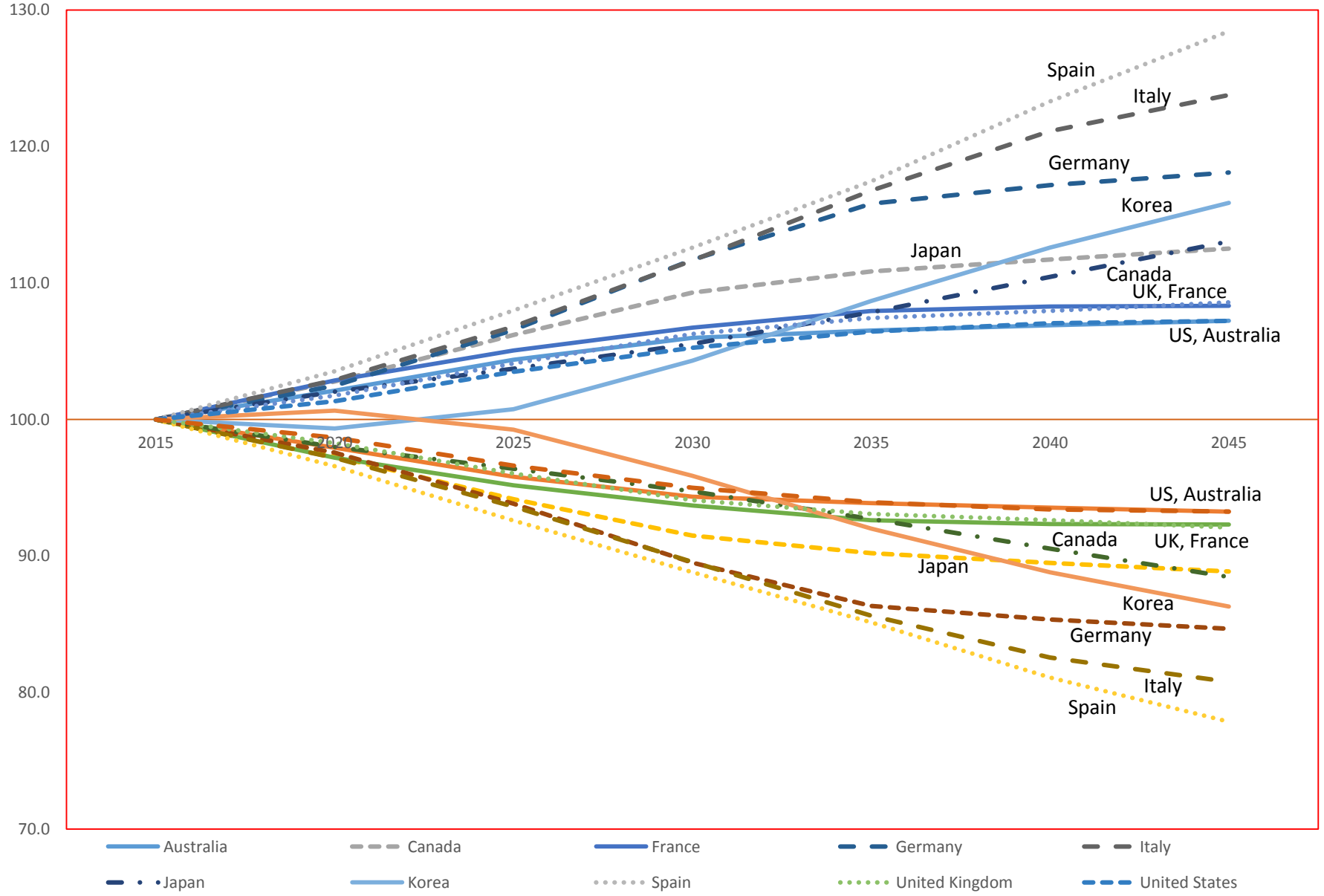


Table 4. Percentage Rates of Growth of Productivity Required in Each Period to Keep GDP per Capita Growing at 1% per Year

	Growth rate per decade				Growth rate per year			
	2015-25	2025-35	2035-45	2015-45	2015-25	2025-35	2035-45	2015-45
Australia	15.3	12.7	11.2	13.1	1.4	1.2	1.1	1.2
Austria	19.2	19.6	14.4	17.7	1.8	1.8	1.4	1.6
Belgium	17.7	16.2	12.6	15.5	1.6	1.5	1.2	1.4
Canada	17.3	15.3	12.1	14.9	1.6	1.4	1.2	1.4
Denmark	12.7	15.6	11.8	13.3	1.2	1.5	1.1	1.3
Finland	16.4	12.3	10.8	13.1	1.5	1.2	1.0	1.2
France	16.0	13.5	10.8	13.4	1.5	1.3	1.0	1.3
Germany	17.7	20.0	12.6	16.8	1.6	1.8	1.2	1.6
Ireland	15.8	11.5	15.3	14.2	1.5	1.1	1.4	1.3
Italy	18.0	20.8	17.1	18.6	1.7	1.9	1.6	1.7
Japan	14.6	14.8	15.8	15.1	1.4	1.4	1.5	1.4
Korea	11.3	19.2	17.8	16.0	1.1	1.8	1.6	1.5
Netherlands	17.1	17.2	11.3	15.2	1.6	1.6	1.1	1.4
New Zealand	13.2	13.3	10.6	12.3	1.2	1.3	1.0	1.2
Norway	14.4	15.2	12.7	14.1	1.4	1.4	1.2	1.3
Spain	19.3	20.1	20.8	20.1	1.8	1.9	1.9	1.8
Sweden	15.2	14.1	10.5	13.2	1.4	1.3	1.0	1.3
Switzerland	18.0	18.0	13.8	16.6	1.7	1.7	1.3	1.5
United Kingdom	15.0	14.0	11.7	13.5	1.4	1.3	1.1	1.3
United States	14.3	13.6	11.3	13.1	1.3	1.3	1.1	1.2
Average	16.0	16.0	13.4	15.1	1.5	1.5	1.3	1.4

Table 5: Comparison of Recent Historical Percentage Rates of Productivity Growth with Projected Rates Required to Keep GDP per Capita Growing at 1% per Year

	Growth rate per decade				Growth rate per year			
	Historical		Projected		Historical		Projected	
	2005 - 2015	1985 - 2015	2015 - 2025	2015 - 2045	2005 - 2015	1985 - 2015	2015 - 2025	2015 - 2045
Australia	13.3	16.1	15.3	13.1	1.3	1.5	1.4	1.2
Austria	11.3	..	19.2	17.7	1.1	..	1.8	1.6
Belgium	5.1	15.7	17.7	15.5	0.5	1.5	1.6	1.4
Canada	8.3	11.3	17.3	14.9	0.8	1.1	1.6	1.4
Denmark	8.2	16.4	12.7	13.3	0.8	1.5	1.2	1.3
Finland	3.9	23.7	16.4	13.1	0.4	2.1	1.5	1.2
France	7.3	17.0	16.0	13.4	0.7	1.6	1.5	1.3
Germany	8.4	17.9	17.7	16.8	0.8	1.7	1.6	1.6
Ireland	49.5	48.3	15.8	14.2	4.1	4.0	1.5	1.3
Italy	0.4	9.5	18.0	18.6	0.0	0.9	1.7	1.7
Japan	7.9	21.8	14.6	15.1	0.8	2.0	1.4	1.4
Korea	38.7	65.3	11.3	16.0	3.3	5.2	1.1	1.5
Netherlands	5.7	11.8	17.1	15.2	0.6	1.1	1.6	1.4
New Zealand	10.6	13.7	13.2	12.3	1.0	1.3	1.2	1.2
Norway	-2.4	16.7	14.4	14.1	-0.2	1.6	1.4	1.3
Spain	13.2	10.4	19.3	20.1	1.2	1.0	1.8	1.8
Sweden	7.9	18.4	15.2	13.2	0.8	1.7	1.4	1.3
Switzerland	6.7	9.2	18.0	16.6	0.7	0.9	1.7	1.5
United Kingdom	4.6	17.1	15.0	13.5	0.5	1.6	1.4	1.3
United States	10.2	16.9	14.3	13.1	1.0	1.6	1.3	1.2
Average	10.9	19.9	16.0	15.1	1.0	1.8	1.5	1.4

Note: The historical series are based on GDP per hour worked (OECD, 2017d); values for Austria for 1985 are not available.

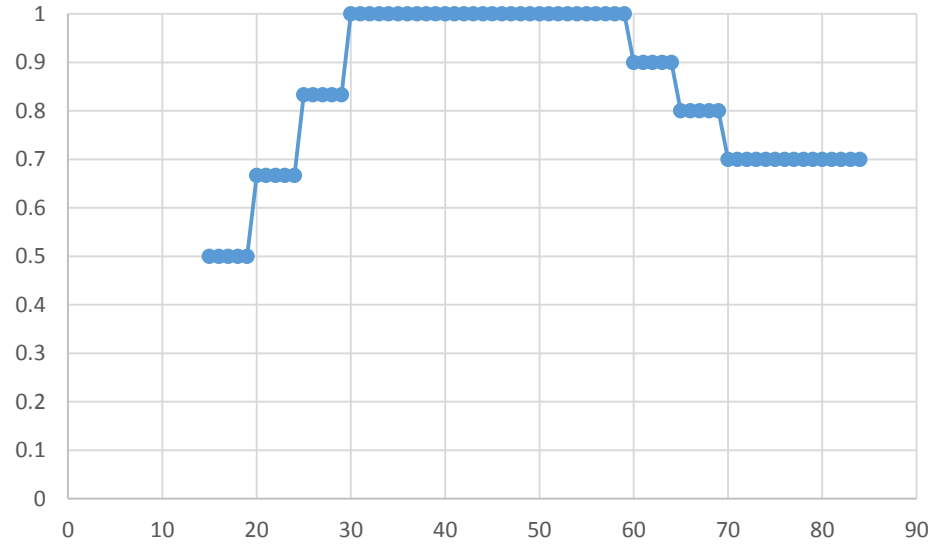
What other possible offsets?

- *Labour force participation rates – r (50% increase by 2025 for ages 65+)*
- *Unemployment rates – u = 1-e (1/3rd lower by 2025)*
- *Average hours worked – h (5% higher by 2025)*

- *Only substantial offset from h*
  - *Full offset in 2025 in 11 of 20 countries*

What about the age composition of the LF?

- i.e., how much does the work-efficiency age profile matter?



- Answer: very little
  - On average, impact on GDP/POP is 0.0 in 2025, -0.4% is 2035 and 2045

Summing up

- Dependency ratios are rising and there is downward pressure on output per capita
  - On average, 11.2% lower in 2045 than in 2015
- What offsets are possible?
  - Productivity growth of only 0.4%/yr would eliminate decline
    - Growth of 1.4%/yr would keep Y/N growing at 1%
  - Deferred retirement, lower unemployment, increase in hours
- Age differences in productivity have relatively little effect on Y/N

What about Canada, and differences across provinces?

Table 1. Percentages of Population Under 20 and 65 and Over: Medium Projections

	65 and over				Under 20			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	16.5	20.9	23.5	24.0	21.8	22.0	21.5	20.9
NL	19.1	27.2	33.5	35.7	19.3	18.1	16.8	16.1
PE	18.9	23.8	27.1	28.0	21.6	21.0	20.2	19.9
NS	19.4	25.9	30.1	31.2	19.6	19.0	18.2	17.6
NB	19.5	26.4	30.9	32.1	20.0	19.0	18.1	17.8
AC	18.1	22.9	25.2	25.8	20.6	21.3	20.7	20.1
ON	16.4	20.8	23.9	24.5	21.8	21.5	21.2	20.4
MB	15.0	18.0	19.7	20.1	25.3	25.7	25.1	24.5
SK	14.8	18.6	20.6	21.5	25.4	26.7	25.8	25.0
AB	11.9	15.8	17.9	18.7	24.2	24.9	24.2	23.5
BC	17.9	22.1	24.4	24.8	20.3	20.3	20.1	19.5

Note: Projections for Canada include the territories.

Across provinces, alternative pop projections

Table 2. Combined Percentages of Population 65 and Over and Under 20: Alternative Projections

	Medium				High				Low			
	2016	2026	2036	2046	2016	2026	2036	2046	2016	2026	2036	2046
Canada	38.3	42.9	45.0	44.9	38.3	43.3	46.0	45.7	38.3	42.7	44.7	45.0
NL	38.4	45.3	50.4	51.8	38.4	45.8	51.7	53.2	38.4	45.0	49.6	51.1
PE	40.5	44.8	47.4	47.9	40.5	45.1	48.1	48.5	40.5	44.8	47.5	48.2
NS	39.0	44.9	48.4	48.7	39.0	45.4	49.6	49.9	39.0	44.6	47.7	48.2
NB	39.6	45.4	49.0	49.8	39.6	45.9	50.2	51.0	39.6	45.1	48.4	49.4
AC	38.7	44.2	45.9	45.9	38.7	44.9	47.5	47.2	38.7	44.1	45.6	45.8
ON	38.2	42.3	45.1	44.9	38.2	42.7	45.9	45.6	38.2	42.2	44.8	45.1
MB	40.3	43.8	44.8	44.6	40.3	44.3	45.9	45.5	40.3	43.5	44.4	44.6
SK	40.2	45.3	46.4	46.5	40.2	45.7	47.6	47.6	40.2	45.0	45.7	46.2
AB	36.1	40.7	42.1	42.3	36.1	41.2	43.3	43.3	36.1	40.4	41.5	42.1
BC	38.2	42.4	44.5	44.3	38.2	42.5	44.9	44.6	38.2	42.5	44.6	44.9

GDP/N if only the population changes

Table 3. Projected Indexes of GDP per Capita When Only the Population Changes

	Indexes					Percentage change		
	2016	2026	2036	2046		2016-26	2026-36	2036-46
Canada	100.0	94.1	91.0	90.4		-5.9	-3.2	-0.6
NL	100.0	89.9	82.6	79.4		-10.1	-8.1	-3.9
PE	100.0	94.1	90.2	89.0		-5.9	-4.1	-1.4
NS	100.0	91.8	86.8	85.4		-8.2	-5.4	-1.7
NB	100.0	91.7	86.3	84.7		-8.3	-5.8	-1.9
AC	100.0	92.8	90.3	89.6		-7.2	-2.7	-0.7
ON	100.0	94.6	90.9	90.3		-5.4	-3.9	-0.6
MB	100.0	95.7	94.1	93.8		-4.3	-1.7	-0.3
SK	100.0	94.2	92.2	91.0		-5.8	-2.2	-1.2
AB	100.0	94.8	92.4	91.5		-5.2	-2.5	-1.0
BC	100.0	94.4	91.4	91.0		-5.6	-3.2	-0.4

Note: Projections for Canada include the territories. Medium population projections are assumed in the calculations underlying this table and all subsequent ones.

Productivity growth required for specified income growth

Table 4. Annual Percentage Rates of Increase of Productivity Required in Each Period to Permit GDP per Capita to Grow at 0, 1, and 2 Percent per Year

	GDP/N growing at 0%			GDP/N growing at 1%			GDP/N growing at 2%		
	2016-26	2026-36	2036-46	2016-26	2026-36	2036-46	2016-26	2026-36	2036-46
Canada	0.61	0.33	0.06	1.62	1.33	1.06	2.63	2.34	2.07
NL	1.07	0.85	0.40	2.08	1.86	1.40	3.09	2.86	2.40
PE	0.61	0.42	0.14	1.61	1.42	1.15	2.62	2.43	2.15
NS	0.86	0.56	0.17	1.86	1.57	1.17	2.87	2.57	2.17
NB	0.87	0.60	0.19	1.88	1.61	1.20	2.89	2.61	2.20
AC	0.75	0.27	0.07	1.76	1.28	1.07	2.77	2.28	2.07
ON	0.56	0.40	0.06	1.57	1.40	1.06	2.57	2.41	2.06
MB	0.44	0.17	0.03	1.44	1.17	1.04	2.45	2.17	2.04
SK	0.60	0.22	0.13	1.60	1.22	1.13	2.61	2.23	2.13
AB	0.54	0.25	0.11	1.54	1.25	1.11	2.55	2.26	2.11
BC	0.58	0.33	0.04	1.59	1.33	1.05	2.59	2.33	2.05

Note: See note to Table 3.

Historical comparisons

Table 5. Comparisons of Recent Historical Annual Percentage Rates of Increase of Productivity with Future Rates Required to Permit GDP per Capita to Grow at 0, 1, and 2 Percent per Year

	Historical		Projected, 0%		Projected, 1%		Projected, 2%	
	1996-2006	2006-2016	2016-26	2016-46	2016-26	2016-46	2016-26	2016-46
Canada		≈1.1	0.61	0.34	1.62	1.34	2.63	2.34
NL			1.07	0.77	2.08	1.78	3.09	2.79
PE			0.61	0.39	1.61	1.39	2.62	2.40
NS			0.86	0.53	1.86	1.53	2.87	2.54
NB			0.87	0.56	1.88	1.56	2.89	2.57
AC			0.75	0.37	1.76	1.37	2.77	2.37
ON			0.56	0.34	1.57	1.34	2.57	2.35
MB			0.44	0.21	1.44	1.22	2.45	2.22
SK			0.60	0.31	1.60	1.32	2.61	2.32
AB			0.54	0.30	1.54	1.30	2.55	2.30
BC			0.58	0.32	1.59	1.32	2.59	2.32

Note: See note to Table 3.

Increased older worker participation?

Table 6. Effects on Projected Indexes of GDP per Capita of an Increase in Older-Worker Labour Force Participation Rates (Δr)

	With population change only				With population change plus Δr			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	100.0	94.1	91.0	90.4	100.0	96.2	93.1	92.4
NL	100.0	89.9	82.6	79.4	100.0	92.3	85.2	81.8
PE	100.0	94.1	90.2	89.0	100.0	96.9	93.0	91.7
NS	100.0	91.8	86.8	85.4	100.0	94.4	89.4	87.8
NB	100.0	91.7	86.3	84.7	100.0	94.1	88.7	86.9
AC	100.0	92.8	90.3	89.6	100.0	94.5	91.9	91.3
ON	100.0	94.6	90.9	90.3	100.0	96.8	93.2	92.5
MB	100.0	95.7	94.1	93.8	100.0	97.9	96.2	95.8
SK	100.0	94.2	92.2	91.0	100.0	97.0	94.7	93.6
AB	100.0	94.8	92.4	91.5	100.0	96.9	94.4	93.5
BC	100.0	94.4	91.4	91.0	100.0	96.5	93.4	92.9

Note: Δr stands for an increase by half of all labour force participation rates for the population 65 and over between 2015 and 2026; the new rates are held constant thereafter. See also note to Table 3.

Reduced unemployment rates?

Table 7. Effects on Projected Indexes of GDP per Capita of a Decrease in Unemployment Rates (Δu)

	With population change only				With population change plus Δu			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	100.0	94.1	91.0	90.4	100.0	96.3	93.2	92.6
NL	100.0	89.9	82.6	79.4	100.0	94.5	86.8	83.5
PE	100.0	94.1	90.2	89.0	100.0	97.8	93.7	92.4
NS	100.0	91.8	86.8	85.4	100.0	94.6	89.4	87.9
NB	100.0	91.7	86.3	84.7	100.0	94.9	89.4	87.7
AC	100.0	92.8	90.3	89.6	100.0	95.1	92.5	91.9
ON	100.0	94.6	90.9	90.3	100.0	96.6	92.9	92.3
MB	100.0	95.7	94.1	93.8	100.0	97.7	96.1	95.8
SK	100.0	94.2	92.2	91.0	100.0	96.3	94.2	93.0
AB	100.0	94.8	92.4	91.5	100.0	97.5	95.1	94.1
BC	100.0	94.4	91.4	91.0	100.0	96.3	93.3	92.8

Note: Δu stands for a reduction of all unemployment rates by one-third between 2015 and 2026; the new rates are held constant thereafter. See also note to Table 3.

Increase in average hours of work?

Table 8. Effects on Projected Indexes of GDP per Capita of an Increase in Average Hours Worked per Year (Δh)

	With population change only				With population change plus Δh			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	100.0	94.1	91.0	90.4	100.0	98.8	95.6	95.0
NL	100.0	89.9	82.6	79.4	100.0	94.4	86.8	83.4
PE	100.0	94.1	90.2	89.0	100.0	98.8	94.8	93.4
NS	100.0	91.8	86.8	85.4	100.0	96.4	91.2	89.7
NB	100.0	91.7	86.3	84.7	100.0	96.2	90.7	88.9
AC	100.0	92.8	90.3	89.6	100.0	97.4	94.8	94.1
ON	100.0	94.6	90.9	90.3	100.0	99.3	95.4	94.8
MB	100.0	95.7	94.1	93.8	100.0	100.5	98.8	98.5
SK	100.0	94.2	92.2	91.0	100.0	98.9	96.8	95.6
AB	100.0	94.8	92.4	91.5	100.0	99.5	97.0	96.0
BC	100.0	94.4	91.4	91.0	100.0	99.1	95.9	95.5

Note: Δh stands for a general increase of 5 percent in average hours worked between 2015 and 2026; the new rates are held constant thereafter. See also note to Table 3.

Increased LFPRs, decreased u-rates, and increased hours?

Table 9. Combined Effects on Projected Indexes of GDP per Capita of Increased Labour Force Participation Rates (Δr), Decreased Unemployment Rates (Δu), and Increased Average Hours Worked per Year (Δh)

	With population change only				With population change plus Δr, Δu, Δh			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	100.0	94.1	91.0	90.4	100.0	103.4	100.1	99.4
NL	100.0	89.9	82.6	79.4	100.0	101.8	93.9	90.3
PE	100.0	94.1	90.2	89.0	100.0	105.6	101.4	100.0
NS	100.0	91.8	86.8	85.4	100.0	102.0	96.6	94.9
NB	100.0	91.7	86.3	84.7	100.0	102.3	96.4	94.5
AC	100.0	92.8	90.3	89.6	100.0	101.7	98.9	98.2
ON	100.0	94.6	90.9	90.3	100.0	103.9	99.9	99.2
MB	100.0	95.7	94.1	93.8	100.0	104.9	103.1	102.7
SK	100.0	94.2	92.2	91.0	100.0	104.0	101.6	100.4
AB	100.0	94.8	92.4	91.5	100.0	104.6	102.0	101.0
BC	100.0	94.4	91.4	91.0	100.0	103.4	100.1	99.6

Note: See notes to Tables 6, 7, 8.

Account for age-related productivity?

Table 10. Effects on Projected Indexes of GDP per Capita of Alternative Assumptions About Age-Related Productivity (Δq)

	With population change only				With population change plus Δq			
	2016	2026	2036	2046	2016	2026	2036	2046
Canada	100.0	94.1	91.0	90.4	100.0	94.0	90.7	90.1
NL	100.0	89.9	82.6	79.4	100.0	89.6	82.0	78.7
PE	100.0	94.1	90.2	89.0	100.0	93.7	89.8	88.4
NS	100.0	91.8	86.8	85.4	100.0	91.7	86.4	84.9
NB	100.0	91.7	86.3	84.7	100.0	91.2	85.7	84.1
AC	100.0	92.8	90.3	89.6	100.0	92.7	89.8	89.2
ON	100.0	94.6	90.9	90.3	100.0	94.5	90.7	90.1
MB	100.0	95.7	94.1	93.8	100.0	95.8	94.0	93.7
SK	100.0	94.2	92.2	91.0	100.0	94.3	91.8	90.5
AB	100.0	94.8	92.4	91.5	100.0	94.7	92.0	90.9
BC	100.0	94.4	91.4	91.0	100.0	94.3	91.2	90.7

Note: Δq stands for replacement of flat age/productivity profile with profile that has lower productivity at young ages and old ages. See text for details. See also note to Table 3.