Reinterpreting Productivity: New Zealand's Surprising Performance

or

The shortcomings of an engineering approach to productivity measurement

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Abstract

Adam Smith, in *The Wealth of Nations*, argued that "consumption is the sole end and purpose of production". This observation is almost entirely ignored in productivity analyses, both of officials and in the academic literature. Instead 'productivity analyses' typically measure technical efficiency (i.e. the quantity of outputs produced for a given bundle of inputs) and ignore the income available for consumption. The latter is a function both of technical efficiency and allocative efficiency. We compile measures of productivity, conceived as the income available for consumption while maintaining the capital stock intact. This focus means we also account for capital depreciation and resource depletion. When we measure productivity based on this approach we find that New Zealand had very low productivity growth from 1970 to the early 1990s. Since then, however, New Zealand's performance has been impressive and is stronger than for most other developed countries.

1. Introduction

Adam Smith (1776), in *The Wealth of Nations*, argued that "consumption is the sole end and purpose of production". This observation is almost entirely ignored in most productivity analyses, both of officials and in the academic literature. Instead 'productivity analyses' typically measure only technical efficiency. These engineering-style assessments measure the quantity of outputs produced for a given bundle of inputs, ignoring the income that is made available for consumption.

Examples in the New Zealand context abound. The New Zealand Productivity Commission (Nolan et al., 2019) states: "New Zealand is one of a small number of OECD countries with both a low level of labour productivity and low productivity growth" (p.1) … "Productivity is about making better use of inputs by, say, producing more or better outputs with the same resources. The most widely used measure of productivity (labour productivity) takes GDP and divides it by hours of work" (p.4). The OECD (2019) similarly states: "Weak labour productivity growth has reflected both slow multifactor productivity growth and insufficient investment" (p.16).

In contrast to these analyses, we take Smith's observation – and economic theory – seriously. At the aggregate level, on which we focus, what matters for rising material living standards are increases in real income available for the populace to spend while maintaining capital stocks intact. Our analysis, which concentrates on income available for consumption, differs from prior cross-country analyses of actual consumption trends (Attansio et al., 2015; Jones and Klenow, 2016; Grimes and Hyland, 2020) since actual consumption may exceed or fall short of the available income. Given this potential shortcoming of the actual consumption data, the income measure adopted here is a preferable indicator of sustainable consumption. While consumption is a better indicator than (raw) income of people's subjective wellbeing (Carver and Grimes, 2019), we recognize that many non-material factors also influence people's welfare over and above material consumption; implicitly we are holding these other factors constant in the analysis that follows.

The income available for consumption is a function both of technical efficiency and allocative efficiency. Thus productivity, properly conceived as the amount of consumption that can be undertaken for a given bundle of inputs, depends on both forms of efficiency. To put it bluntly, if we had had ever increasing production of horseshoes for given labour and iron inputs over the last century, we would have been no better off. Allocative efficiency required that resources were redirected away from blacksmiths towards producers who make items that people wish to buy. Thus we need to pair allocative efficiency with technical efficiency in determining a country's productivity performance.

To set the scene, in section 2 we present some simple examples and use a simple theoretical general equilibrium macro model to demonstrate that while higher multifactor productivity does naturally lead to increased living standards, so too do other factors. In the general equilibrium setting (with a constant workforce), multifactor productivity is not the sole determinant of output per person, consumption or utility. Exogenous prices also matter. Thus looking only at technical efficiency may provide misleading indications of material progress.

Section 3 foreshadows the empirical aspects of the paper, briefly reviewing relevant national accounts concepts that underpin our analysis. These aspects include issues of using income versus production measures, depreciation, and the appropriate price deflator. Taking account of these issues results in the derivation of the series used for our cross-country analysis: per capita real adjusted net national income (*pcRANNI*) which is a measure of per capita real income available for consumption. The section presents data sources and the methodology used to compile *pcRANNI*. It also briefly reviews related attempts to measure productivity that account for one or more of the issues that we highlight.

Empirical analysis of the data proceeds in section 4 focusing on developments across (long-standing) OECD countries from 1970-2018, a 48 year period; we analyse developments over the full period and also over two 24 year sub-periods. In section 5, we compare long-run developments in *pcRANNI* with developments for the same countries' per capita real Gross Domestic product (*pcRGDP*). Section 6 concludes by emphasizing the policy importance of focusing on a conceptually correct measure of productivity and highlights New Zealand's strong productivity performance since 1994.

2. Theory

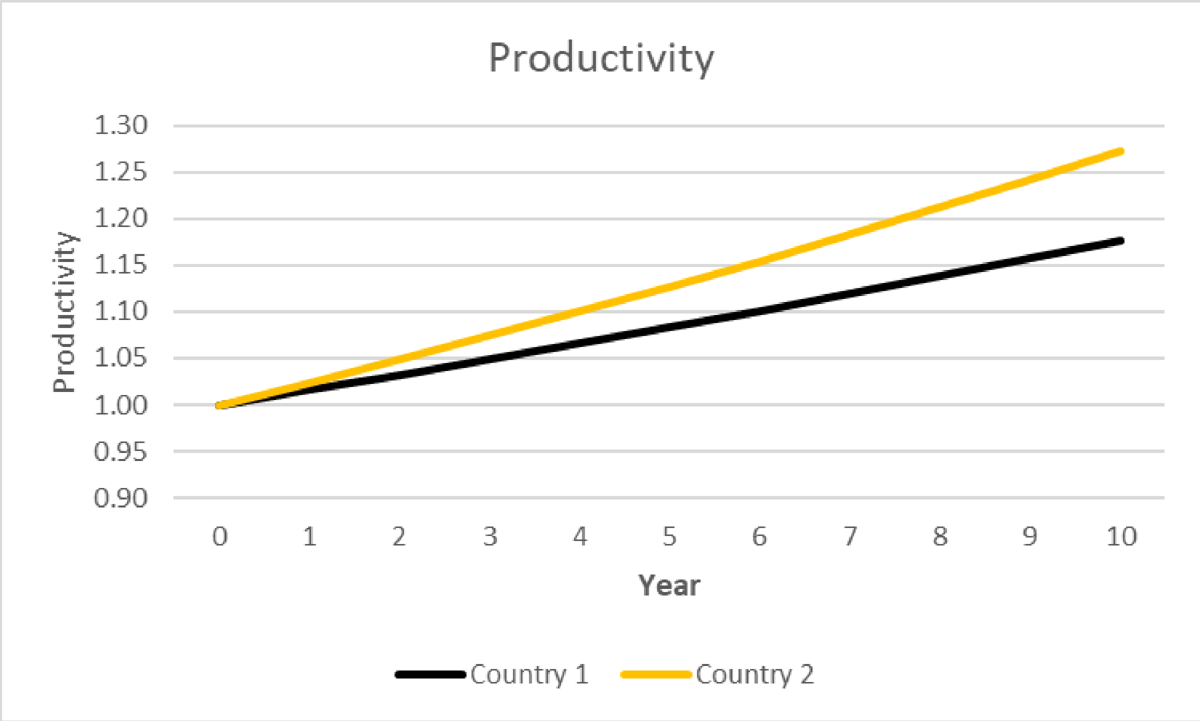
Multifactor productivity (MFP) is not the sole determinant of consumption per person, or even of output per person, in a country. The amount that each domestic resident can consume while maintaining savings intact also depends on prices for imports and exports, the real interest rate, accumulated wealth, the depreciation rate and the capital to labour ratio (noting that the last of these variables is determined endogenously in an economy). In this section, we illustrate the roles of each of these variables in determining per capita consumption and utility within a simple two-sector general equilibrium model of a small open economy. First, however, we provide some intuition using stylized examples.

2.1 Illustrative results

Our first stylized example compares two countries (imaginatively called Country 1 and Country 2). There are two industries (equally imaginatively called Industry A and Industry B). Industry A has a productivity growth rate of 1% per annum (p.a.) while Industry B experiences productivity growth of 3% p.a.

Country 1 has a fixed proportion of 70% (30%) of its labour allocated to Industry A (Industry B) whereas Country 2 has the reverse, 30% (70%) in Industry A (Industry B). Labour supply in each case is constant. The engineering approach to productivity measurement would conclude that Country 2 (with higher exposure to Industry B) would prosper more than Country 1. This is illustrated in ***Figure 1*** in which initial productivity (in year 0) is indexed to 1. By year 10, Country 2’s productivity rises by 27% while that of Country 1 rises by only 18%.

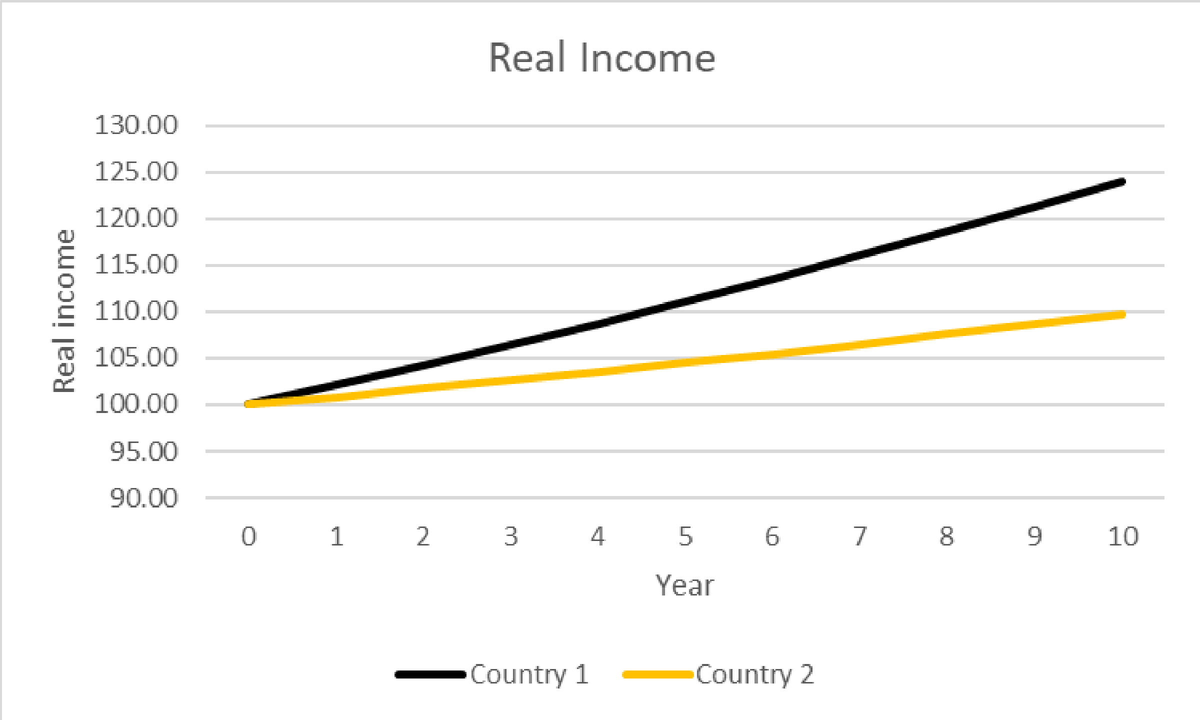
Figure 1. Productivity trends - Countries 1 and 2



An economist – and a profit-maximising private sector entrepreneur – however, knows that prices are also important. Imagine that our engineering-oriented planners and productivity gurus were responsible for allocating resources to (the high productivity) Industry B with the result that Industry B's global price falls at a real rate of 3% p.a. due to its increased supply (think ICTs). Meanwhile, production in Industry A languishes as resources are diverted elsewhere, and further imagine that worldwide demand for Industry A's product is increasing (think dairy); the result is that Industry A's global price rises at a real rate of 2% p.a.

Figure 2 shows the results of this scenario for developments in real income in each country, where real income is determined by production multiplied by the real price of the product (in this illustrative example, costs are assumed to remain unchanged in the two industries). Country 1 (which is oriented towards the 'low productivity' industry) experiences real income growth of 24% by year 10 whereas Country 2 (with the 'high productivity' industry) has a real income rise of just 9.8%. Clearly, relative price trends matter for incomes in addition to MFP growth.

Figure 2. Income trends - Countries 1 and 2



Another glaring deficiency of many existing analyses is to focus on gross (G) rather than net (N) measures (e.g. we see many more reference to GDP or GNI as opposed to NDP or NNI). The net figure deducts depreciation of the capital stock from the gross figures. New Zealand commentators and officials have often noted the country's 'capital shallowness', attributing low productivity to this feature (for a nuanced analysis, see Hall and Scobie, 2005). But being capital shallow has the advantage, *ceteris paribus*, of having lower rates of depreciation so increasing net figures relative to gross figures.

To illustrate the importance of this factor, consider two countries (Country 3 and Country 4). Country 3 is an industrial country while Country 4 has a farming-based economy. Their respective (Cobb-Douglas) aggregate production functions are shown in (1) and (2):

Country 3: $Y = K^{0.5}L^{0.5}$ (1)

Country 4: $Y = (F+K)^{0.5}L^{0.5}$ (2)

where: Y = gross output

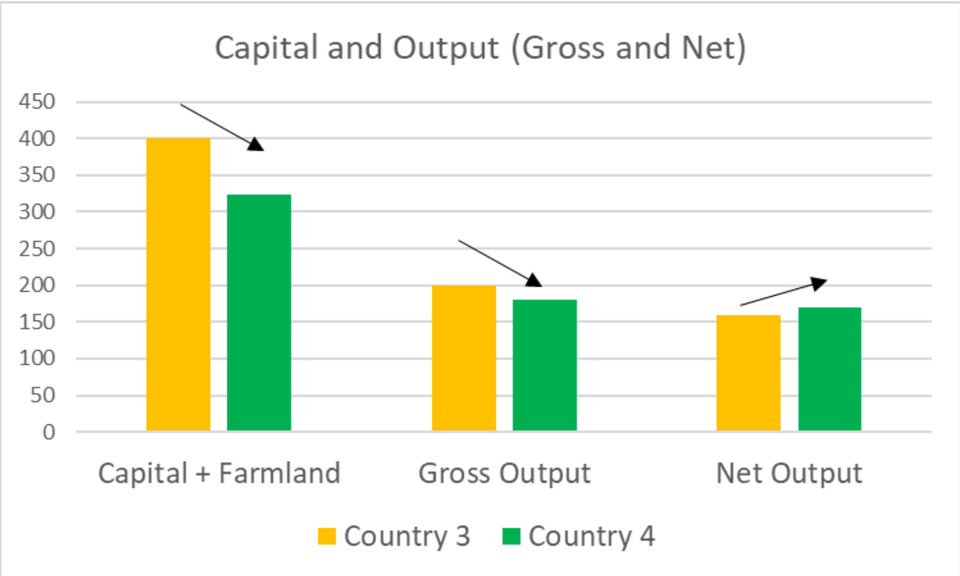
K = produced capital stock (with depreciation rate of 10% p.a.)

F = farmland (with depreciation rate of 0% p.a.)

L = labour

Each country has labour resource of 100, Country 3 has produced capital stock of 400 while Country 4 is capital shallow both in terms of produced capital (K=100) and total capital (F+K=324) Consequently, as shown in ***Figure 3***, Country 3's gross output exceeds that of Country 4 by 11.11% (i.e. 200 vs 180).

Figure 3. Capital (Produced and Farmland), Output (Gross and Net): Countries 3 and 4



Only net output can be consumed sustainably since depreciation must be reinvested to prevent depletion of the capital stock. Once depreciation is deducted, we see in Figure 3 that 'capital shallow' Country 4 can consume 6.25% more than 'capital deep' Country 3 (i.e. 170 vs 160).

These simple, albeit somewhat contrived, examples illustrate that we should not be content to take an engineering and/or gross output-oriented approach to measuring productivity. While doing so may capture some important features that affect material living standards, it will also miss important features that determine the resources available for consumption.

2.2 General equilibrium results

The examples above are partial equilibrium in nature. To check that the same insights follow in a general equilibrium setting, we utilise the two-sector general equilibrium small open economy model formulated in Grimes (2009). The model is an extension of that developed by Caselli and Feyrer (2007). The sectors comprise a tradable sector (for which some output is consumed domestically and some is exported) and a non-traded sector. All capital goods are imported. Tradable goods and non-traded goods are each produced via a Cobb-Douglas production function of capital and labour in each sector, where firms choose capital and labour to maximise profits. Aggregate labour supply is fixed. Exports of tradable goods are sufficient to fund capital goods imports. Capital is subject to depreciation, and all income accruing to domestic residents after deducting depreciation is allocated to consumption across the two goods. The division of consumption between the two goods is determined by a CES utility function of (identical) consumers which is maximized subject to income and to the prices of the two goods.

The model is used to illustrate comparative static outcomes that flow from changes to exogenous variables which comprise: the real interest rate, depreciation rate, the price of (imported) capital goods and the price of tradable goods. The tradable goods price will reflect the pre-determined choice by producers of the tradable goods sector in which they produce. The stock of savings is taken as predetermined and is maintained at that level reflecting the steady state requirement that consumption equals net income (i.e. gross income less depreciation).

The capital to labour ratio is the endogenous outcome of decisions by local producers (subject to an aggregate labour constraint) so cannot be treated as an exogenous variable. It is determined by firms' profit maximising decisions which depend not only on MFP in each sector but also on each of the exogenous factors outlined above. Full details of the model are presented in Grimes (2009) together with results from a range of conceptual experiments involving permanent changes to exogenous variables.[1]

[1] A spreadsheet that solves for all variables given the exogenous variables is available from the first author.

We itemise the impacts of changes in two exogenous variables on per capita consumption (i.e. per capita net income) and on utility (which is the appropriate measure of welfare for the model). While the results formally relate to comparative static outcomes, they can be interpreted as indicating the effects of shocks on alternative economies which have different traded goods sectors (i.e. which have been subject to alternative pre-determined allocative choices).

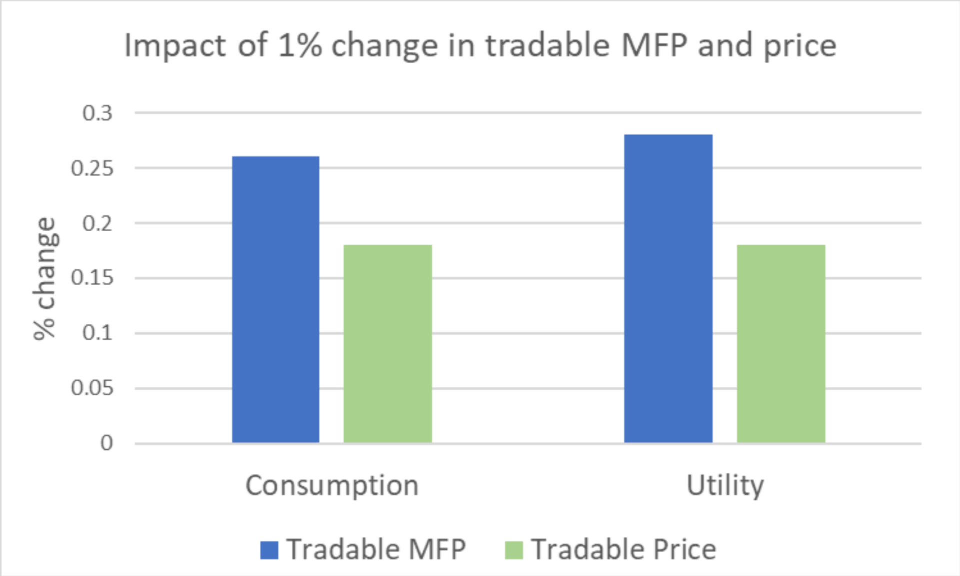
Baseline outcomes reflect the baseline parameters adopted in Grimes (2009), using Cobb-Douglas utility, with three changes reflecting the issues being considered here. The three changes are: (i) to reduce the consumption share of the traded good for domestic consumers (from 0.5 to 0.1); (ii) to reduce the capital share parameter in the production function of the tradable good (from 0.33 to 0.2); and (iii) to increase the capital share parameter in the production function of the non-traded good (from 0.33 to 0.4). These changes bring the model closer to characterizing an economy that has a specialist export product which utilises land (that is in fixed supply) and produces a product that represents only a small share of the domestic consumption budget.

Two separate shocks to the baseline are considered. The first is a permanent increase in tradable sector MFP.[2] This rise in MFP raises tradable sector production and thence incomes which spill over into extra production and consumption of the non-traded good. Labour is reallocated from the non-traded to the tradable sector while the capital stock increases in both sectors to meet the extra demand. Consumption of both goods rises as a result of the tradable sector MFP rise, and hence utility rises.

The second shock is a permanent increase in the price of the tradable good. The nature of responses are almost identical to those for the MFP rise but the price increase mutes the effect on real incomes since residents must pay more for the tradable good.[3] The effects of these shocks on aggregate consumption and utility are shown in **Figure 4**.

[2] A rise in non-traded sector MFP has even larger effects given the small tradable goods sector in this example.
[3] A reduction in the depreciation rate has similar effects to the rise in tradable goods prices.

Figure 4. Impact of 1% change in tradable sector MFP and price on consumption and utility



The results depicted in Figure 4, obtained in a general equilibrium setting, have implications for how living standards can increase over time. First, a rise in technical efficiency (i.e. conventionally measured MFP) increases both consumption and utility. Consumption and utility can also rise, even in the absence of an MFP increase, provided the country produces tradable goods with world prices that are increasing in real terms (i.e. relative to the cost of imported capital goods within this model).[4] Further model simulations indicate that utility increases by more in a country with tradable goods prices rising at 2% p.a. even if its tradable sector MFP is declining at 1% p.a. than in a country with tradables MFP rising at 1% p.a. with stagnant tradables prices.

These lessons set the scene for the following empirical examination of country performances with respect to material living standards over almost five decades.

[4] *Ceteris paribus*, consumption and utility will also be higher if the country utilises capital that has a low depreciation rate.

3. National accounts concepts, data and other approaches

3.1 National accounts concepts

Many economic reports from official agencies adopt real Gross Domestic Product (GDP) as an aggregate measure of country material economic performance. Annual GDP measures the volume of goods and services produced within a country over a year. GDP can be expressed in per capita terms by dividing by the country's population to arrive at a measure of production per head. The numerous shortcomings of (even per capita) GDP as an aggregate measure are now well articulated (e.g. Stiglitz et al., 2009) but three shortcomings, in particular, are relevant to this study.[5]

First, GDP measures production but not (real) income accruing to the residents of a country. From a policy viewpoint, it is income accruing to residents rather than production within a country that matters more for the utility (wellbeing) of those living within the country. This observation often leads to the use of (real per capita) Gross National Income (GNI) in place of GDP.

Second, both GDP and GNI are gross measures and so do not deduct depreciation of produced capital goods. Given that depreciation must be reinvested to maintain living standards (*ceteris paribus*), a preferred measure to GNI is (real per capita) Net National Income (NNI) which is measured net of depreciation.

Third, even NNI has the shortcoming that it does not account for the country's depletion of natural resources that arises through the production process. Adjustments for this depletion are required to represent the full value of depreciation plus depletion. The resulting country aggregate is referred to as Adjusted Net National Income (ANNI).

3.2 Data

The World Bank compiles ANNI for 217 countries from 1970 (or later depending on data availability). The series are expressed in current US dollars (USD) so have to be adjusted for

[5] Other major shortcomings, such as the lack of recognition of non-market production (other than owner-occupied homes), the recognition of activity relating to harmful outcomes (such as the clean-up of pollution) and the lack of consideration of the utility (wellbeing) implications of different activities are not considered here, but all are relevant to a wider evaluation of country economic performance.

several factors. Our series for per capita real adjusted net national income in country i at time t ($pcRANNI_{it}$) is compiled as follows:

$$pcRANNI_{it} = \frac{ANNI_{it} * ExchRate_{it}}{Population_{it} * CPI_{it}} \quad (3)$$

where: $ANNI_{it}$ is the World Bank's series for country i's Adjusted Net National Income in current USD;[6]

$ExchRate_{it}$ is the nominal exchange rate for country i relative to the USD (which converts ANNI into domestic currency);[7]

$Population_{it}$ is country i's population, which converts the measure into per capita terms;[8]

CPI_{it} is country i's consumer price index, which converts the measure into constant dollars.[9]

The last of these steps needs some explanation. Traditionally, a measure such as GDP uses a different deflator to the CPI because it is a measure of production so has different weights to a consumer price measure. In our case, $pcRANNI_{it}$ is designed to be a measure of real income available for consumption of a nation's residents once depreciation and resource depletion are accounted for. Since all this income is available for consumption (while holding the capital stock intact) a relevant measure of prices is country i's Consumer Price Index.

The resulting $pcRANNI_{it}$ series does not take account of level differences in purchasing power across countries so is not a purchasing power parity (PPP) series. It does, however, account for changes in purchasing power over time within countries by virtue of using each country's CPI. Consequently, in the following analysis, we look only at changes in $pcRANNI_{it}$ rather than comparing levels.

[6] Source: https://data.worldbank.org/indicator/NY.ADJ.NNTY.CD
[7] Source: https://data.worldbank.org/indicator/PA.NUS.FCRF
[8] Source: https://data.worldbank.org/indicator/SP.POP.TOTL
[9] Source: https://data.worldbank.org/indicator/FP.CPI.TOTL

3.3 *Comparison with other approaches to measuring productivity*

Typically, MFP is calculated as the residual from a production function (e.g. Wooldridge, 2009), so requires estimates of real output plus estimates of labour and capital (and sometimes other) inputs. The problem with this approach – highlighted in many contributions by Griliches and others (Triplett, 2007) – is that the estimate for MFP incorporates all measurement inaccuracies for output and the inputs. A key measurement difficulty is determining the price/quantity split in nominal outputs, which feeds through both to the GDP deflator and the real GDP estimate.

Griliches (1998) estimated that while 49% of GDP was easily measurable in 1947, this ratio had fallen to just 31% by 1990. The subsequent further growth in hard-to-measure services implies that this ratio will have fallen still further since 1990. Haskel and Westlake (2018) argue that there are major gaps in our understanding and measurement of knowledge and other forms of intangible capital. In the presence of these uncertainties regarding both output and input measures, estimates of aggregate MFP may be highly inaccurate. Any mismeasurement of the trend in quality improvements (in either outputs or inputs) will therefore affect estimates of trend productivity growth.

Freeman et al (2021) highlight a related issue, that of missing inputs when calculating productivity. They still approach productivity measurement from the production side, accounting for the contribution of natural resources that are extracted and used for production by placing a reservation price for the resource equal to the import price of that resource. The use of an income measure as opposed to a production measure avoids the need for us to address this problem directly.

One criticism of looking at per capita measures is that they ignore the actual labour input used in production. A country with a high proportion of its labour force employed will, *ceteris paribus*, have greater production and income than a country with lower labour force participation. This criticism rests, in part, on an assumption that leisure is always to be preferred to working an extra hour; however, the evidence does not support such an assumption. For instance, using German panel data Crost (2011) finds that subsidised employment provides a large boost to the happiness of individuals who would otherwise have been unemployed, even after accounting for self-selection and the higher incomes of the employed. Similarly, using the natural experiment afforded by COVID-19, Burchell et al (2020) find that leaving paid work results in considerably worse mental health outcomes than staying in any form of paid work (part-time, full-time, or even furlough).

Choosing to work is a choice that individuals voluntarily make. Given the positive welfare outcomes of work for many (but not all) people, we therefore consider that measuring outcomes at a per capita, rather than per employee (or per hours worked) basis, is appropriate and reflects the voluntary choices that individuals make when maximising their own utility. Even if one were to ignore the psychological benefits of being in work for many people, one can still justify use of a per capita measure as the appropriate way to consider a country's *material* living standards per person.

4. Empirical analysis

The World Bank supplies complete data for 1970-2018 across the four required series for 38 countries. We restrict our attention to the 22 countries that had complete data and that were members of the OECD at the time that New Zealand joined (in 1973),[10] so comprising 21 high income countries plus Turkey which was then a middle income country. This selection ensures that we are comparing, as much as possible, countries that were alike at the start of the sample (other than the inclusion of Turkey). The beta-convergence literature (Baumol, 1986) indicates that otherwise similar countries which were initially poorer in per capita terms will subsequently tend to grow faster as they catch up with the leaders' technologies and other production practices. In **Table 1**, we present the 22 countries (and the abbreviations we use) ordered on the basis of their real purchasing power parity adjusted GDP per capita in 1970 (in the absence of a levels estimate for *pcRANNI*).[11] From its mid-table ranking (9th of 22), we could expect that New Zealand would subsequently grow at approximately the average rate compared with other countries in the sample.

[10] We omit Iceland which did not have complete data, and omit Luxembourg owing to some data irregularities which likely reflect its small size and its atypical sectoral dependence on finance.
[11] Source: Angus Maddison *Historical Statistics of the World Economy: 1-2008AD*, http://www.ggdc.net/maddison/Maddison.htm.

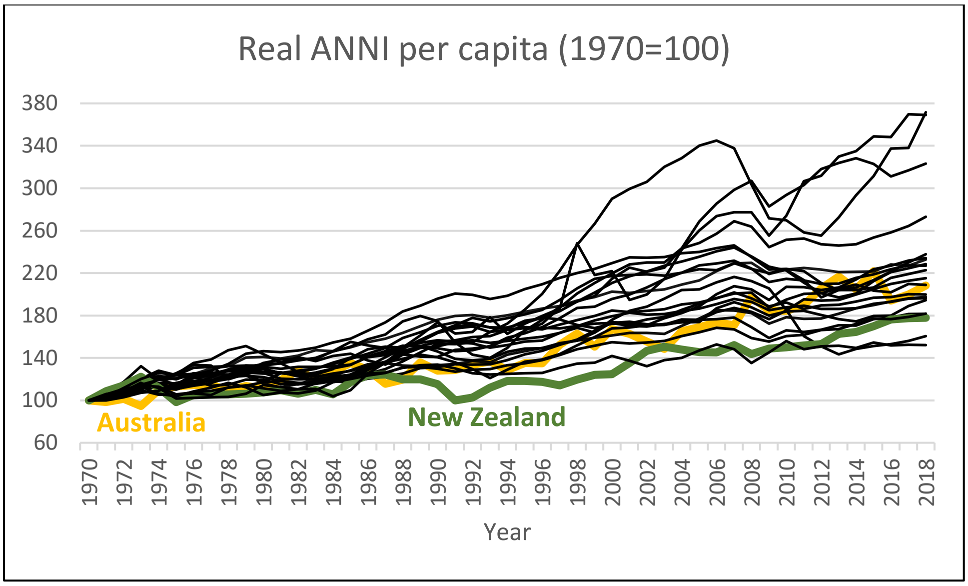
Table 1: Per capita GDP in 1970 (1990 international Geary-Khamis dollars)

Country	Abbreviation	GDP (1970)
Switzerland	SWI	16,904
United States	US	15,030
Sweden	SWE	13,011
Denmark	DEN	12,686
Canada	CAN	12,050
Australia	AUS	12,024
Netherlands	NETH	11,967
France	FRA	11,410
New Zealand	NZ	11,189
Germany	GER	10,839
United Kingdom	UK	10,767
Belgium	BEL	10,611
Norway	NOR	10,027
Austria	AUT	9,747
Italy	ITA	9,719
Japan	JAP	9,714
Finland	FIN	9,577
Spain	SP	6,319
Greece	GRE	6,211
Ireland	IRE	6,199
Portugal	PORT	5,473
Turkey	TUR	3,078

Source: Angus Maddison *Historical Statistics of the World Economy: 1-2008AD*

Figure 5 graphs real ANNI per capita for the full period (1970-2018) for the 22 countries listed in **Table 1**. New Zealand is shown in green, while Australia, for comparison, is shown in gold (other countries are not labelled; summary data for each country are included in **Table 2**). New Zealand's underperformance across the 48 years is apparent. Only two of the other 21 countries had living standards that grew more slowly than New Zealand's over these 48 years: Switzerland and Greece. (The Swiss performance may reflect the outcome of the beta-convergence hypothesis; Greece's performance cannot be explained by the same logic.) Australia fared only moderately over the full period, ranked 13th of the 22 countries.

Figure 5. Real ANNI per capita (1970=100): 22 countries, 1970-2018



New Zealand underwent major structural change over the first half of the sample period (Evans et al, 1996; Grimes, 1998). The country had a *dirigiste* approach to economic policy from (and prior to) 1970 through to 1984 when major economic reforms began. The reform period primarily covered 1984-1991 during which time many inefficient firms (and some industries) failed and others had to restructure comprehensively. The economy suffered recession over 1989-1991 as these adjustments took place. The period 1991-1994 exhibited a bounce-back from recession with strong growth. Australia also reformed its economy (more gradually) through this period (Quiggin, 1998).

In order to disentangle the effects of the reforms from the pre-reform and reform periods, we split the sample at the half-way point, 1994, examining the trends in real ANNI per capita for the two 24 year periods either side of this date. As well as cutting the sample into two halves, 1994 is convenient in that it starts after the bounce-back from recession in New Zealand so does not artificially boost measured growth in living standards either before or after the reform period.

Figure 6 graphs developments in *pcRANNI* for the first sub-period. New Zealand's poor performance over this 24 year period is apparent. Real per capita incomes over these 24 years rose more slowly than in any of the other 21 countries, with a per capita annual growth rate of just 0.7% (and with zero growth from 1970 to 1991). Australia's real income growth over the same period was also relatively poor (at 1.1% per annum), tying with Sweden in having the third lowest growth rate (Switzerland was the second lowest). The reasons for the 1980s and early 1990s reforms in New Zealand and Australia are highlighted by these figures: each country had experienced poor income growth under their economic regimes leading into the 1980s.

Figure 7 graphs developments in *pcRANNI* from 1994 to 2018, rebasing 1994 to 100 to highlight growth since that time. Rather than being laggards, Australia (in sixth place) and New Zealand (in seventh) show relatively strong performance. Australia's real per capita income grew at an annual rate of 2.0% while New Zealand's grew at 1.7% p.a. Thus the post-reform periods in both New Zealand and Australia saw considerable lifts in real income growth both relative to each country's history and relative to other developed nations.

The very strong performance of three countries – Turkey, Ireland and Norway (with annual growth rates of 3.5%, 3.3% and 3.0% respectively over 1994-2018) – compresses the scale of the graph. These three countries each experienced special circumstances over the period that are not easily replicable in other countries: Turkey was a middle income country so experienced considerable 'catch-up', Ireland experienced the benefits of the European Union (though also enacted many other income-enhancing policies), while Norway had the benefit of North Sea oil.

Figure 8 repeats the information in **Figure 7**, omitting these three countries to make the comparison amongst the remaining 19 countries clearer. Finland and Sweden are now the two leading lights, with Australia and New Zealand following. Over this 24 year period, New Zealand's per capita real income growth exceeded that in each of: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, Netherlands, Portugal, Spain, Switzerland, United Kingdom and United States. *Not bad for a country with a 'productivity problem'!*

Figure 6. Real ANNI per capita (1970=100): 22 countries, 1970-1994

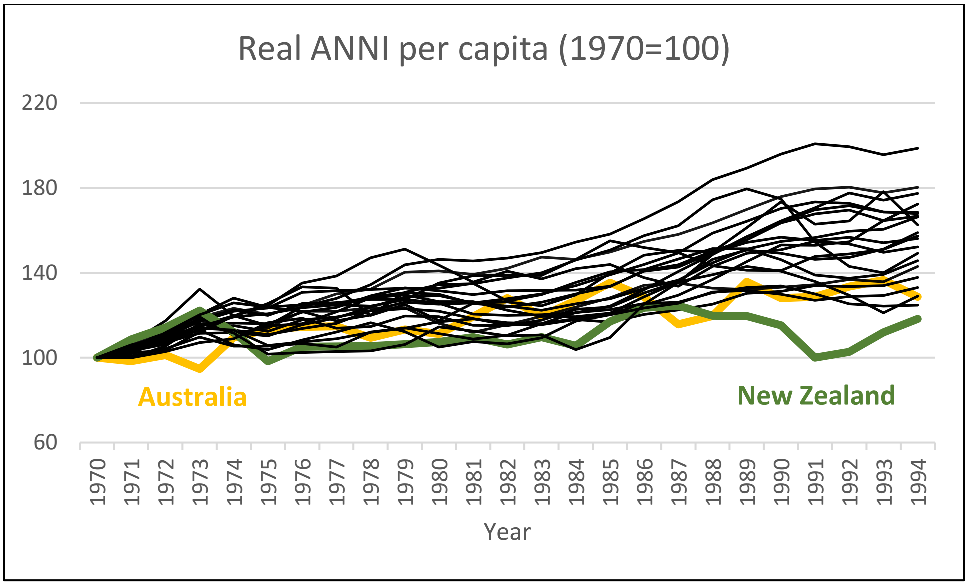


Figure 7. Real ANNI per capita (1970=100): 22 countries, 1994-2008

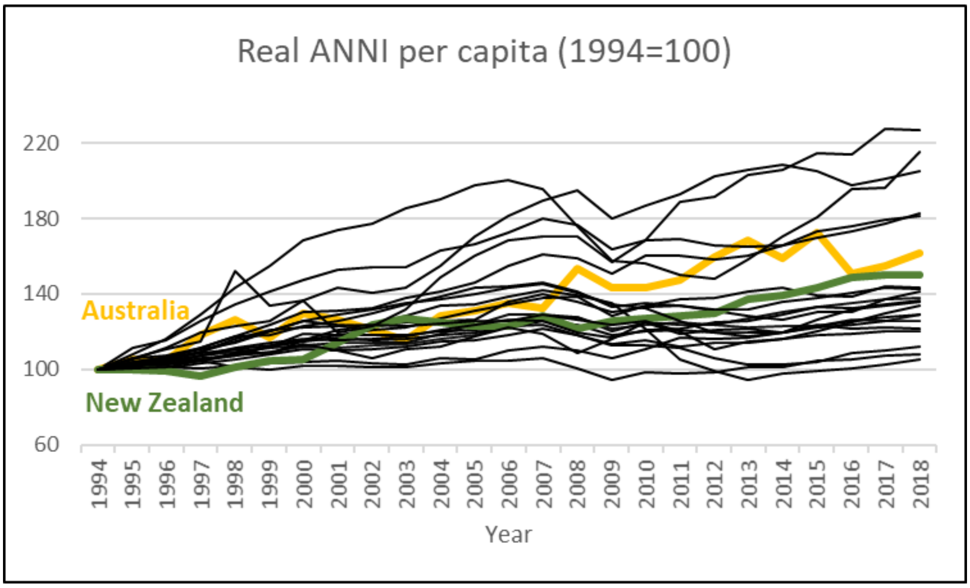


Figure 8. Real ANNI per capita (1970=100): 19 countries, 1994-2008

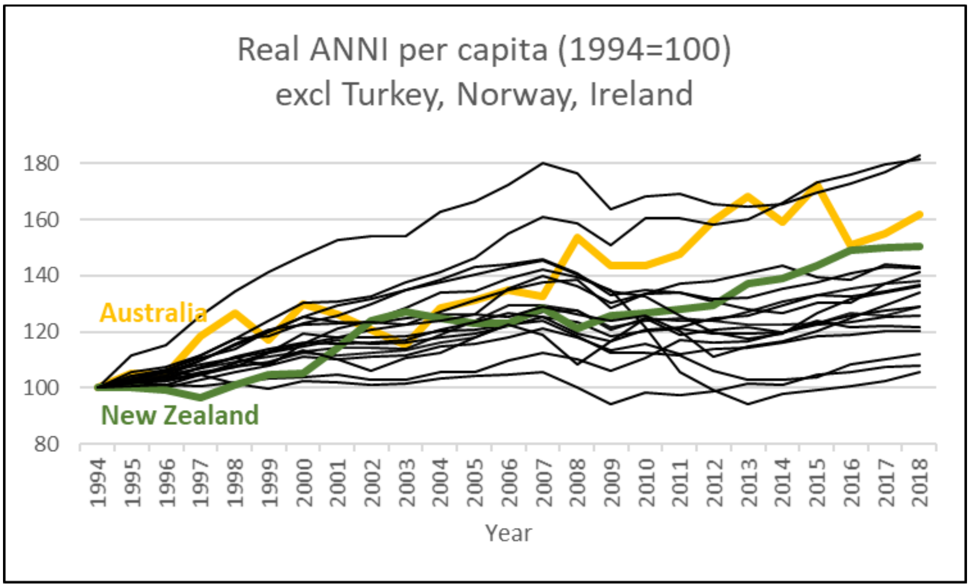
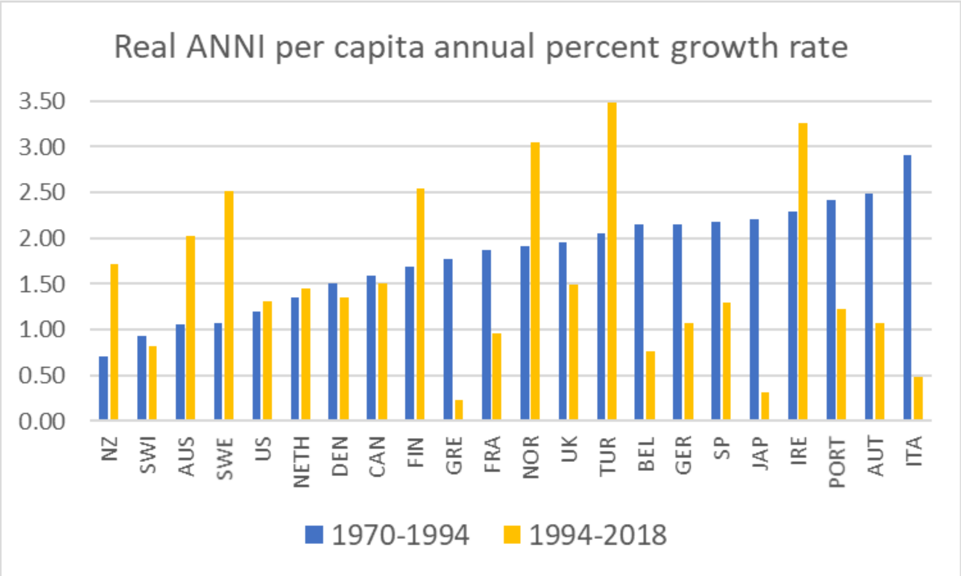


Table 2: *pcRANNI* annual percentage growth rates

Country	1970-2018	1970-1994	1994-2018
AUS	1.54	1.06	2.02
AUT	1.78	2.49	1.07
BEL	1.45	2.14	0.77
CAN	1.55	1.58	1.51
DEN	1.43	1.50	1.36
FIN	2.12	1.68	2.55
FRA	1.42	1.87	0.96
GER	1.61	2.15	1.07
GRE	0.99	1.77	0.22
IRE	2.77	2.29	3.25
ITA	1.68	2.90	0.48
JAP	1.25	2.20	0.31
NETH	1.40	1.35	1.44
NZ	1.21	0.70	1.71
NOR	2.47	1.91	3.04
PORT	1.82	2.42	1.23
SP	1.74	2.18	1.29
SWE	1.79	1.07	2.52
SWI	0.88	0.93	0.83
TUR	2.76	2.05	3.48
UK	1.72	1.95	1.49
US	1.25	1.20	1.31

Figure 9 documents the annual per capita growth rates of each of the 22 countries over the two sub-periods, ordered from the slowest to fastest growing country over the initial period. The leaps in growth of New Zealand, Australia, Sweden, Finland, Norway, Turkey and Ireland are apparent. Also apparent is the often-observed productivity slowdown in Japan and much of Europe (especially Greece, France, UK, Belgium, Germany, Spain, Portugal, Austria and Italy). Despite frequent references in the literature (see the review in Syverson, 2017), there is no such slowdown across these two periods in the United States.

Figure 9. Real ANNI per capita annual growth rate: 22 countries, each sub-period[12]



5. Comparison with GDP per capita

The analysis throughout the paper has been in terms of per capita real ANNI. The choice of this aggregate is based on its conceptual properties, being based on per capita income less depreciation and resource depletion, expressed with respect to consumption possibilities (so deflating by the CPI). The analysis began by citing conceptual criticisms of using GDP to

[12] Country abbreviations: AUS Australia; AUT Austria; BEL Belgium; CAN Canada; DEN Denmark; FIN Finland; FRA France; GER Germany; GRE Greece; IRE Ireland; ITA Italy; JAP Japan; NETH Netherlands; NZ New Zealand; NOR Norway; PORT Portugal; SP Spain; SWE Sweden; SWI Switzerland; TUR Turkey; UK United Kingdom; US United States.

measure a country's material growth rate. Before making conclusions on New Zealand's economic performance, we contrast developments in our *pcRANNI* series with those in per capita real GDP (expressed in purchasing power parity terms).[13] We do so over the second of our sub-periods (1994-2018) given availability of the GDP data.

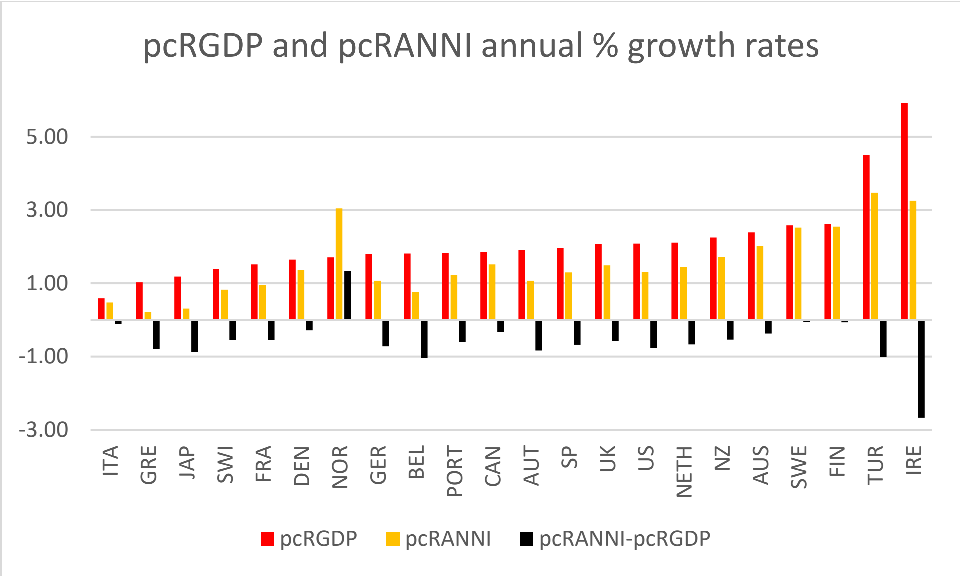
Figure 10 presents the average annual percentage growth rate in each of *pcRGDP* and *pcRANNI* over 1994-2018 for the 22 countries, ordered by their rate of real per capita GDP growth. The graph also shows the difference between the *pcRANNI* and *pcRGDP* annual growth rates over the period.

Some large deviations between the consumption possibilities measure and the production measure emerge in **Figure 10.** Norway is the sole country in which potential consumption growth (i.e. growth in *pcRANNI*) exceeds production growth (i.e. growth in GDP), and the deviation is large representing a 1.34p.p. (percentage points) difference in the average annual growth rates of the two series. This deviation may in part reflect the income earned through the Norwegian sovereign wealth fund. At the other extreme, Ireland's *pcRANNI* average annual growth rate is 2.67p.p. lower than its GDP growth rate. [Stiglitz et al. (2009) similarly note that Ireland's GDP growth rate significantly exceeds its growth in household incomes.] While these extremes exist, the correlation coefficient between the growth rates of the two series, at 0.80, shows that developments in a country's consumption possibilities are still related to its production growth.

Australia and New Zealand are ranked 7th and 8th respectively in terms of the deviation between the growth in *pcRANNI* and *pcRGDP*. Hence sustainable consumption possibilities in Australia and New Zealand are penalised less relative to gross production than in most developed countries. This result indicates the potential danger of making cross-country productivity comparisons based solely on measures of gross production rather than of sustainable consumption possibilities. Nevertheless, in New Zealand's case, if we were to use developments in *pcRGDP* to measure productivity growth, New Zealand would still rank highly (6th highest of the 22 countries) over 1994-2018. Whichever way we measure New Zealand's performance, therefore, we find a strong outcome (in relative terms) for New Zealand's productivity growth story.

[13] Source: https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD

Figure 10. *pcRGDP* and *pcRANNI* annual growth rates: 22 countries, 1994-2018



6. Discussion

Krugman (1997) famously stated:

> *Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.*

The high correlation of developments in *pcRGDP* and *pcRANNI* documented here appear to bear out Krugman's aphorism. However, the analysis also suggests that Krugman's picture does not tell the whole story. Some countries (notably Norway) have sustainable consumption possibilities that rise at a considerably higher rate than their productivity story would suggest while others (notably Ireland) experience the opposite outcome. Most countries (i.e. 21 of 22 countries in our sample) experience slower growth in sustainable consumption possibilities than their per capita GDP developments would indicate.

Since 1994, New Zealand has been less affected by this shortfall in the growth of consumption opportunities relative to GDP than in most other developed countries. The country enacted reforms in the 1980s and early 1990s that improved allocative efficiency as well as technical efficiency. The result has been one of the strongest performances of any developed country in the growth of sustainable consumption possibilities over the second 24 year period covered by our data.

Rather than viewing New Zealand as having a productivity growth problem, the narrative should therefore change. Per capita material living standards have risen at an impressive rate since 1994, resulting in a 51% rise in material living standards per person (on average) in less than two and a half decades. Focus may legitimately switch to how these income gains have been shared across the populace (i.e. whose incomes have risen?) but that issue should not be confused with a poor overall aggregate outcome. To paraphrase Adam Smith, New Zealand's production since 1994 has achieved the end of materially boosting average consumption possibilities.

A danger of ignoring New Zealand's extraordinary aggregate increase in living standards, and clinging to an incorrect belief of a lingering productivity growth problem, is that policy-makers feel obliged to do something to correct the (non-existent) problem. Given the importance of allocative efficiency, those corrections could do more harm than good if they reduce the power of economic agents to allocate resources efficiently.

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