THE DEVIL IS IN THE DETAILS:

DEMONSTRATING THE IMPACT OF MEASUREMENT CHOICES ON INPUTS TO GOVERNMENT SECTOR PRODUCTIVITY

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Abstract

Statistics New Zealand's recent feasibility study into measuring productivity of health care and education noted that there are some big challenges for the compiler related to scope of measurement, definition of government output quantity and quality, and the lack of economically meaningful prices. How much difference do these choices really make? This paper uses 2000-07 school data published by the Ministry of Education to illustrate the different input and output estimates that flow out of different definitions of scope, varieties of quality adjustment, and price proxies. Results are interpreted in terms of the specifics of the New Zealand school system.

JEL Codes: [Up to 3 codes]

Keyword(s): education, productivity, public sector

Introduction

There has been growing interest in gaining a better understanding of the performance of government services, in New Zealand and around the globe. This is reflected in a variety of international reports, notably the UK's *Atkinson Review* (2005) and the *Report of the Commission on the Measurement of Economic Performance and Social Progress* (2009), commonly known as the 'Stiglitz Report'.

The performance of government services is multi-faceted, with many different aspects that could be measured. One important aspect is productivity, the ratio of change in the volume of services produced to change in the volume of resources used in producing those services: providing the same amount of services for fewer inputs, or providing more services with the same amount of resources constitutes an increase in productivity and vice versa.

While the high-level concept is fairly straight-forward, the devil is in the methodological details. Productivity change is fundamentally a residual: it is what is left over when changes in measured output and changes in measured input are controlled for. This means that its accuracy rests on the correct specification and measurement of the numerator and denominator (outputs and inputs, respectively). Any measurement errors and misspecifications in outputs and inputs will show up in the estimate of productivity, as will mismatches in the coverage and incorrect application of weights or index methodology.

Statistics New Zealand's recent feasibility study on the topic (2010) identified three core measurement challenges: (1) definition of scope, (2) definition of output quantity and quality, and (3) appropriate value-proxies for weighted aggregation in the absence of observed market prices. This paper demonstrates the impact of measurement choices by constructing several variations on each of the following productivity components:

1. direct volume measures of output;
2. output weights;
3. volume measures of labour input; and
4. estimates of educational quality.

Concepts and challenges

Scope

A key question which precedes the measurement choices discussed in this paper is that of the scope or coverage of government education productivity measures. There are a number of perspectives from which productivity performance is of interest, and from each perspective the question—and therefore the answer—differs.

From the perspective of both the New Zealand National Accounts and the economy-wide official productivity estimates, the key question is 'how much does the education industry[1] contribute to total

[1] The Australian and New Zealand Standard Industrial Classification (ANZSIC) division N. Currently official economic statistics use ANZSIC 1996, but a transition to ANZSIC 2006 is currently underway.

economic output?' The industry includes public and private providers of formal and non-formal education at a variety of levels, as well as providers of ancillary services like test preparation. To address the industry perspective, Statistics NZ must provide estimates of government productivity that are consistent with the existing market sector productivity estimates. This will facilitate the expansion of the 'measured sector' covered by the official productivity estimates from its current 74 percent coverage of the total economy.

From the perspective of those in charge of public sector service provision, a key economic question might be 'how do publicly-owned parts of the education system contribute to the economy, and how is the associated productivity changing over time?' Here the scope is defined by whether the education production is carried out by the public or private sector. This question is confounded by co-production and co-financing across that boundary. A prominent example of this in the school sector is state integrated schools, where labour is paid for by the Ministry of Education, but buildings are privately owned. Similarly, substantial portions of early childhood education are paid for by the Ministry of Education, but the providers are private rather than public.

From the perspective of taxpayers, the question might be 'how well are taxpayer funds, or government controlled funds, being used in delivering education?' Here the scope is defined by the source of financing. There are several permutations of the question, depending on whether it is narrowly defined to cover only Ministry of Education funding, or expenditure on education by other parts of the public sector–such as the Ministry of Social Development, prisons and the armed forces.

These scoping questions matter, as the information requirements differ and perhaps more importantly the end results will also differ.

This paper relies exclusively on publicly available data from the Ministry of Education's data website www.educationcounts.govt.nz. The full scope of the data covers state and state integrated schools, broken down into nine school types (see methodology section). Private schools are excluded, as are the system-wide services provided by the Ministry of Education for the school sector. This coverage of the school sector aligns most closely with the 'publicly-owned' scope above, though it is a necessary building block for the 'industry' definition of scope.

Defining educational output

Educational output is the service that is delivered in schools. Output is distinct from *outcome*, which is the change in state that is desired by the end user (or their parents)–increased knowledge and skills, better prospects on the job market, etc. Defining the output[2] of service industries in a manner that can be consistently measured at constant quality is challenging under the best of circumstances. This is true even in the market sector, especially for highly customised services like banking and legal services.

Output has both quantity and quality components, which must be specified or be assumed unchanging (OECD 2001). Taking the simple, direct, one-to-one service example of a haircut, the service quantity produced by the stylist is the same as the one consumed by the consumer. To incorporate quality, the output can be more tightly defined: 'cut, style and blowdry by senior stylist with 5–10 years experience'. Services that meet this specification should be homogenous and relatively interchangeable to the producer and consumer. By specifying the quality-determining characteristics of the service, we've defined something that can be measured consistently over time.

Unlike a haircut, schooling is a one-to-many service that happens in groups of varying sizes. This means that an hour of a teacher's time can provide varying amounts of individual educational benefit to students. To satisfy measurement framework identities between what is consumed and what is produced, the statistical convention in this area (see Eurostat 2001) is that the appropriate output measure of education is the **sum of the individual educational benefit provided to each pupil.**

Following the model of tight specification above, individual educational benefit is expressed as pupil-hours of schooling at a particular level and type of school (e.g. primary, secondary, special). This approximates the volume of educational services delivered by teachers and received by students, assuming that teaching services and pupil-hours move in parallel, and that teaching services are of a constant quality. Pupil-hours are considered superior to headcounts, because they capture differing levels of educational intensity in areas where less-than-full time participation is common.

Aggregating these homogenous groups to represent the whole school sector requires selecting appropriate weights. This question is considered in the next section.

Prices and their non-market proxies

Prices play an important role in the calculation of output volume. According to economic theory, prices are set in competitive markets at the level where the marginal value to the consumer equals the marginal cost of production. The price, therefore, conveys information about the relative value or importance to the consumer of each and every good and service that is bought in competitive markets.

The price, or relative value, is used in economic accounting in a simple re-arrangement of the equation

[2] 'Output' in this paper is gross output. The official productivity estimates published by Statistics New Zealand are produced on a value-added basis, which is gross output less intermediate consumption.

that says expenditure is price multiplied by volume. Growth in the volume of output can be calculated by removing the effect of changing prices (inflation) from expenditure on goods and services. Additionally, growth in the volume of different goods and services can be aggregated into total volume of output, using prices as the measure of relative importance (OECD 2001).

State educational services are typically provided free to the consumer or at prices that do not reflect the relative value given by the price in a competitive market. This lack of economically meaningful prices compounds the difficulty of measuring output in the non-market sector. In order to create estimates of change in the volume of government output, an explicit relative value must be selected as a proxy for the price.

International consensus holds that the most reliable and systematically-available replacement for price as a measure of relative value is the cost of production for each of the goods and services. But whose costs should be used? The New Zealand education system features a large amount of co-funding, which confounds the question. Expenditure by schools excludes teacher salaries, which are paid directly by the Ministry of Education. The Ministry pays operational and property funding to schools, but it does not supply the entirety of school expenditure: most schools engage in supplementary local fundraising, and at state integrated schools parents pay school fees. Some funding is designated for particular programmes, making it easy to identify as an input to particular kinds of education (e.g. Teen Parent Units); however, significant chunks are in discretionary bulk grants, making the task of matching inputs to outputs substantially more difficult.

Output quality

A more problematic area in deriving output volumes for education services is measuring the way in which quality changes over time. 'Quality' in this context does not necessarily denote that something is better or worse, but that it has different defining characteristics. Education quality is multi-dimensional, encompassing such things as the range or choice of subjects, proximity to home, and 'fit' with the student's learning style. What dimension or dimensions of quality are relevant to particular types of education is a choice to be made. A key dimension is likely to be more students attaining worthwhile qualifications, however improved attendance and engagement of students in education could also be relevant. Further, there is little agreement among users about how these dimensions should be added together into a single number; how *relatively* important are exam scores compared with, say, availability of art and music classes, or number of computers available for student use?

The statistician's primary tool for measuring changes in the mix of services included in output is using a system of disaggregation and differential weighting, as described in this paper. This implicitly captures many elements of quality change, such as the increased proportion of students in secondary school, (although not all – changes in quality within a given school type will still not be captured). This differentiation between various types of output is the National Accounts' main tool for incorporating quality change alongside quantity change.

Two further techniques are available:

- defining the measure of output in terms of quality, such as adjusting for attendance rates; and
- adjusting the existing measures of quantity change using a measure of quality change, (e.g. changes in standardised exam scores, school inspection scores or qualification rates).

An example of the first option is the UK Office of National Statistics' treatment of school output (ONS 2009). The principle here is straight forward: if students are not attending classes, educational services are not being delivered to them. Change over time in the average attendance rate is a change in the *quantity* of output, irrespective of quality.

Explicit adjustment to reflect educational outcomes is more contentious. Grades, exam scores, credits, and the like depend greatly on student efforts in and out of the classroom, and are not indicators of change in educational services as such. However, *if the assumption is made that student effort is in constant proportion to teaching services*, student attainment can be taken as a proxy for the volume of teaching services *of a constant quality*. Put another way, if outcome metric changes over time without any change in the quantity of educational services (i.e. number of pupil-hours), it is likely that the quality of educational service being delivered has changed.

While that observation seems intuitively true at arm's length, there are a number of challenges inherent in quality adjustment of educational services, especially around the correct attribution of quality change. If student performance has improved, how much of that improvement is attributable to increased quality of educational services, and how much is attributable to changes in parent engagement, longer opening hours at the library, better maternal and early childhood nutrition, or another of the array of factors that can influence educational outcome? Similarly, if the goal is to estimate year-on-year changes in quality, how does one correctly attribute the improved standardised test scores of a cohort of 12 year-olds over the previous six years of education?

A further complication emerges around whether or not to take into account differences in the mix of pupils going through the education system. For example, if in one year the cohort of children beginning school has a higher starting point in terms of educational status, all other things being equal the school might need to do less to get the same exam scores. Or the school might provide the same level of service as for the previous cohort, but the children achieve better exam scores simply because of their different starting point. Ideally, such differences in the schoolchildren should be taken

into account in the measure of the school's output. In practice, this is very data intensive.

Inputs to education

For the purposes of productivity analysis, both outputs and inputs are ideally expressed in direct volume measures where possible, to avoid potentially-distorting price effects. In practice, direct volume estimates are simpler for labour (i.e. hours) than for capital or intermediate consumption, which are often expressed in expenditure terms and then deflated using price indexes.

The scope of inputs must match that of output in the productivity equation; the labour, intermediate consumption, and capital services used in the production of output should feature as the inputs to production. Failure to capture the full range of inputs can lead to flawed productivity estimates, as substitutions are possible between different forms of labour (e.g. teachers doing administrative work), and between labour and intermediate consumption or capital (e.g. using computers and broadband to facilitate distance learning rather than adding teachers).

Labour

The ideal direct volume measure of labour input is actual hours worked broken down by type (e.g. teacher, principal, or administrator). As with output definition, this tightly defined grouping should return relatively homogenous input categories that can be consistently measured over time. These various labour aggregates can be weighted by their relative wage rates to form a time-series of total labour input.

The labour volume measure used by Statistics NZ for productivity analysis uses hours paid as a proxy for hours worked for reasons of data availability and robustness at the industry level. Existing official productivity estimates use a labour volume series that combines various Statistics NZ labour data sources into a coherent volume measure of labour services by industry.

Within the education-specific data, teaching staff is generally recorded separately from other labour, and is the focus of analytical reporting. While teaching is the primary category of labour in education, failure to incorporate other forms of labour can lead to bias in input volumes.

Capital

Capital inputs to production are not the capital itself, but the flow of services from capital, which are not directly observable. These services are approximated by assuming that service flows are in proportion to the productive capital stock (stock of capital assets after each vintage has been converted into 'efficiency-standardised' units representing the amount of use remaining in them). The capital services used in Statistics NZ's productivity estimates are derived from a perpetual inventory model (PIM) of productive capital stock of fixed capital for each of 26 assets by industry and year.

No estimates of capital services are included in this paper, as no appropriate proxy could be identified in the publicly-available school data. Direct property funding to schools was considered, but its volatile movement is more indicative of changes in policy than of flow of capital services.

Intermediate consumption

Major components of intermediate consumption in education are educational materials and services such as transportation. As noted above, the existing suite of official productivity estimates are based on industry value added, rather than gross output. This means that intermediate consumption is incorporated into the numerator of the productivity equation rather than the denominator. As with other inputs, accurate estimates of productivity change depend on understanding how the proportion of inputs change over time.

Because there was no proxy for capital, no attempt has been made to model schools' intermediate consumption in this paper. Productivity estimates calculated with incomplete coverage of input measures are likely to be misleading.

Methodology

This paper relies exclusively on publicly available data from the Ministry of Education's data website www.educationcounts.govt.nz to construct several variations on each of the following: direct volume measures of output, output weights, volume measures of labour input, and an index of educational quality. The details of each are treated in separate sections below.

The full scope of the data covers state and state integrated schools, broken down into nine school types, comprising the educational years shown in brackets. Private schools are excluded.

State	State integrated
Full primary school[3] (1–8)	Full primary school (1–8)
Contributing school (1–6)	Contributing school (1–6)
Intermediate school (7–8)	Intermediate school (7–8)
Composite school[4] (1–15)	Composite school (1–15)
Restricted composite school (7–10)	
Correspondence school	
Secondary school (7–15)	Secondary school (7–15)
Secondary school (9–15)[5]	Secondary school (9–15)
Special Schools	

[3] Includes Kura Kaupapa Maori (primary) and Kura Teina (primary)
[4] Includes Kura Kaupapa Maori (composite) and Kura Teina (composite)
[5] Includes teen parent units

Output quantity estimates

The Ministry of Education carries out statistical collections (roll returns) from all schools in New Zealand at 1 March and 1 July each year, in line with the statutory requirements as detailed in the Education Act 1989. The Ministry uses the data provided through these collection exercises in a number of ways: to fund and staff schools; to support policy analysis, development and decision making; to monitor the outcomes of the New Zealand education system; and for national and international reporting purposes. The March data are mainly used for schools' resourcing purposes, while the July data are used more for trend analysis as detailed information on age and ethnicity are collected at this time. The data offer several options for estimating pupil-hours.

1. Headcounts of enrolled students are taken annually at July 1. Shown on tables as 'enrolments'.
2. An estimate of full-time student equivalents (FTSEs) prepared by the Central Forecasting and Modelling Unit for funding purposes, using the March roll returns for secondary years of schooling (years 9 to 15) and the July roll returns for primary years of schooling (years 1 to 8). Shown on tables as 'FTSE (composite)'.
3. A second measure of FTSEs prepared by the Indicators & Reporting Unit from the March roll return at the beginning of each school year. Shown on tables as 'FTSE (March).

Each of these sources can provide discrete time series of directly measured volume of educational service output by level and school type. These are shown in Table 1.

Output weights

For the purposes of this paper, two different weight schema have been calculated on the basis of the annual proportional distribution of:

1. Total expenditure and teacher salaries by school type and owner (i.e. whether state or state integrated) from the Financial Information Database for Schools (FIDS);
2. State funding by school type and owner, estimated by summing teacher salaries, operational funding, and direct property funding.

In order to proxy relative value of different types of education in the absence of market prices, relative expenditure per student by school type and ownership was calculated by summing total school expenditure and teacher salaries, and dividing by FTSEs. Expenditure weights were then built up by expressing each as a proportion of the total on a year-on-year basis. A similar process was followed for funding weights, using operational funding in the place of total expenditure. These series are shown in Tables 2A and 2B; Table 2C shows the funding per student as a proportion of per-student expenditure.

These can be matched to the level of disaggregation of the output volume discussed the previous section. The resulting cost-weighted output volume measure places greater emphasis on those education services that are more expensive to provide. As an example, a pupil-hour of secondary educational services carries a heavier weight than an equivalent pupil-hour at primary or intermediate school. The main reason for this difference is that providing specialist teachers across the curriculum requires more teachers on average per student than for primary schools (except in year 1).

The weights were used to calculate annually chain-linked Laspeyres output indexes. The use of chain-linking incorporates year-to-year changes in the mix of educational services being provided.

Output quality estimates

For the purposes of this demonstration, three different possible sources of quality adjustment have been selected:

1. Absence rate by school type, from attendance and absence surveys carried out in 1998, 2002, 2004, and 2006;
2. Mean New Zealand scores on the 4-yearly standardised Trends in International Mathematics and Science Study (TIMSS) exams given to students in years 5 and 9; and
3. Qualifications of school leavers, collected in the March school roll returns.

Attendance rates

The Ministry undertakes regular attendance and absence surveys, in which state and state integrated schools are asked to record absences for a selected week. Time series were constructed for attendance rates by school type (excluding special schools and the Correspondence School) using data shown below from 1998, 2002, 2004, and 2006.

Comparison of absence rates[6]

School type	Absence rate (percent)			
	1998	2002	2004	2006
Primary	6.9	7.2	8.9	8.9
Intermediate	6.3	7.2	8.9	8.4
Composite	9	8.8	11.6	12.7
Secondary	11.6	11.9	15.2	16.3

Straight-line interpolation was applied to the intervening years and the trend was extended for years

[6] The absence rate is calculated based on the total school rolls for the participating schools and relate to an average (mean) daily absence for the week per 100 students. It should be noted that this does not tell us whether it is the same students that are absent, or whether different students are involved each day.

2007 and 2008. These rates were applied as multipliers to the March FTSEs, directly adjusting the output volumes. These attendance-adjusted volumes were used to calculate annually chain-linked Laspeyres output indexes, as above. The resulting index is shown in Table 4B.

Standardised test scores

There are several international student achievement tests that are used for cross-national comparisons of education. The advantage of these tests is that they are internationally benchmarked and quality-tested, leading to reduced chances of drift over time. The disadvantage is that they are only offered to a sample of students every few years. The TIMMS was selected for pragmatic reasons—of the major international standardised exams, it alone offers continuous data points for two different age groups. Time series were constructed for years 5 and 9 using real data below from 1998, 2002, and 2006 (year 5 only), straight-line interpolation for the intervening years, and trend-continuation for years 2006 and 2007. These were then re-expressed as an index based in the same year as the output index.

New Zealand students' mean mathematics scores in TIMSS (1994–2006)

	1994	1998	2002	2006
Year 5	469	481	496	492
Year 9	501	491	494	…

The resulting indexes were used as a multiplier on the weighted FTSE indexes, with the year 5 index applied to full primary and contributing school output, and year 9 applied to intermediate, composite and restricted composite schools. The application of the exam outcomes to the output volumes for this demonstration is fairly blunt, and based on a variety of assumptions which are almost certainly untrue. All change in educational outcome was attributed to educational services received, and none to student effort, parental engagement, etc. No effort was made to offset in time the educational services received and the quality change, although a change in the quality of educational services would reasonably be expected to precede the change in test scores by one or more years.

Secondary school qualifications

As a measure of secondary school quality, the Ministry of Education's existing published annual indicator on the percentage of school leavers with little formal attainment was inverted to form an annual indicator of students leaving school with *some* form of formal attainment. This should pick up improvements at the low-achieving end of the secondary school spectrum, although it will not reveal quality changes at the other end, as it does not differentiate between the qualifications achieved.

As an alternative measure of secondary school quality, the Ministry of Education's existing published annual indicator on the percentage of school leavers achieving university entrance standard was used. Both of these were re-expressed as indexes of educational quality with scales equal to the output indexes, shown in Table 4A. Quality-adjusted school output is shown in Table 4B. To avoid confusion and undue proliferation of series, adjustments have only been applied to the expenditure-weighted March FTSE series.

Labour inputs

Two different labour input series have been devised using the published time series of full-time teacher equivalents by school type, shown in Table 5.

1. Unweighted full-time teacher equivalents by school type; and
2. Full-time teacher equivalents by school type, weighted by mean teacher salary by school type.

The purpose of the second series is to incorporate any underlying quality change in the labour inputs over time through a process of disaggregation and cost-weighting. Changes in experience and/or qualification levels in the pool of teacher labour over time should be picked up through disaggregation—all else being equal, an increase in the ratio of new teachers to experienced teachers would cause a drop in the weighted labour input index because new teachers are paid less. Conversely, an increase in the proportion of more-highly qualified teachers would be reflected as an increase in the labour volume. Variation in teaching quality within groups of equal qualification and experience will not be picked up through this weighting.

The labour input represented by these series has a number of limitations. It assumes that hours contracted is the same as actual hours worked. It excludes non-teacher labour; while teaching is the primary category of labour in education, substitutions are possible between different forms of labour, and between labour and other factors of production.

Discussion of results

Output quantity (Table 1)

Unweighted July enrolments rise sharply between 2001 and 2003, and then flatten, slowly declining from a peak in 2004. This is driven by changes in the school-age population, with any fluctuations in the national birth rate showing up in primary and composite schools and then moving through the secondary school. Aside from underlying population, enrolments are affected by such things as the proportion of children homeschooled, varying retention of students over 16, and external factors like unskilled job opportunities.

The two different FTSE measures move in tandem with one another, with the March FTSE consistently lower than the composite FTSE figures by 0.8–1.8 percent (as would be predicted by their different purposes, discussed below). The gap between enrolments and

March FTSEs spreads from 2.5 percent in 2001 to 4 percent in 2002, suggests an unanticipated increase in pupils or a change in the accuracy of forecasting. From 2004 the growth rate of enrolments slows and enrolments come closer to convergence with March FTSEs.

The difference between the March and composite FTSEs are driven by contributing and primary schools, for which composite (i.e. funded, intended to represent maximum enrolment during the course of the school year) FTSEs are respectively about 10,000 and 5,700 higher than March FTSEs throughout the series. This reflects children entering school as they reach school age throughout the year. The difference between the two measures in the lower grades is somewhat offset by secondary schools, for which March FTSEs are higher than composite FTSEs by 3,000 to 8,000 annually. This represents school leavers throughout the year.

The entry of year 1 students into primary and contributing schools is stable from 2000-08, reflecting the underlying birth rate. Mid-year secondary school leavers show more variance, increasing 2000-03, then decreasing 2004-05, and holding relatively steady from 2006-08. This could reflect the changing prospects outside of school for students over 16.

Output weights (Tables 2A, 2B, and 2C)

The first thing to emerge from consideration of the weight data is that special education services are much more costly to produce than any other variety. This is precisely the sort of distinction that weighting is intended to reflect. Failure to do so is to assume that special education is of equal value and utility to the consumer as mainstream education at a comparable level. It is a fundamentally different service, and should be treated separately from mainstream education.

The Correspondence School stands out at the opposite end of the spectrum. Its reported operational funding is nil most years[7], which results in a substantial difference between expenditure and funding weights. When weighted by expenditure per student, the Correspondence School takes a weight of 0.049 (out of 1.0); when calculated by funding, the school drops to nil.

Excluding those two cases, both expenditure and funding weights showed a clear paired pattern through the series, with the lowest-equal weights to intermediate and restricted composite schools, medium-equal weights to contributing and primary schools, and high-equal weights to secondary and composite schools. This suggests that the relative value of education at different levels maps to a curve rather than a line, with the lowest value assigned to the middle years.

Expenditure per student was consistently higher than the sum of operational funding and salaries per student across all school types; the difference between funding and expenditure is made up in things like local fundraising and student fees for state integrated schools. The relative gap between funding weights and total expenditure weights varies by school type, with special schools and the Correspondence School showing the most significant variance, and secondary school showing the least.

Weighted output volume (Table 3)

The combination of volume measures and weights schemes yields six possible output volume indexes, shown in Table 3 alongside the control measure of unweighted enrolments. Expenditure-weighted output is marginally higher than funding-weighted. Regardless of which FTSE measure is used as a base, the weighted indexes show a steady increase in output volume, driven by the growth in secondary schooling in both an absolute sense (i.e. enrolments) and relative to less-expensive schooling. Strong upward momentum is also created by the moderate growth in heavily-weighted special education, which grew 16.9 percent from 1999–2008. When special schools are excluded, this is lessened.

The narrowest definition of state education when measuring school sector output and productivity could exclude state integrated schools on the basis of public-private co-production. Table 4B shows output indexes for some variations on scope: state schools only, as well as 'core' state schools, which excludes special schools and the Correspondence School. This core group includes 98 percent of state school FTSEs.

Output quality (Tables 4A and 4B)

Attendance rates

Attendance rates vary by age, with secondary students missing class at twice the rate of primary and intermediate school students, and composite school falling in between. Attendance rates were relatively unchanged between 1998 and 2002, with composite schools even showing a slight increase in attendance. Absences increased most abruptly across all school types from 2002 to 2004, increasing more slowly 2004 to 2006 for most categories. Intermediate school absences dropped during that period, though not as far as their 2002 rates.[8]

While education researchers treat student attendance and engagement as an indicator of educational quality, it is possible to incorporate it directly into the

[7] When expressed in GST-exclusive thousands of dollars.

[8] There was a change in survey methodology in 2002. Prior to 2002, surveys gathered school level summary data and took an arithmetic mean, whereby each school's rates were calculated, and then the overall mean was calculated. From 2002, surveys used the number of students on the roll and the individual student's participation in the survey as a denominator, providing a more accurate representation of student absence. Response rates are over 80 percent.

definition of output. Attendance is less fraught than other quality metrics with questions of attribution: regardless of the underlying cause, either a student was in the classroom or they were not.

Standardised test scores

TIMMS exam scores move within a narrow range, suggesting that the quality of New Zealand education is consistent over time. Year 5 shows incremental improvement between 1994 (outside of the range of this study) and 2002, with a slight decline in 2006. Year 9 scores are highest in 1994, declining about 2 percent in 1998 and improving marginally in 2002. There is no 2006 data for Year 9 students, so the trend has been extended through the end of the series.

Secondary school qualifications

The percentage of school leavers with some form of qualification can be interpreted as a measure of the extent to which school leavers are prepared for entry-level jobs or further training. This time series falls from 2000 to 2002, when NCEA was introduced. It improves episodically to a peak in 2006, and then falls slightly. This is as likely to reflect changing opportunities outside of schooling as it is to reflect changes in educational quality.

The percentage of school leavers achieving university entrance standard is relatively flat around 27 percent from 1999 to 2002, and then climbs steadily to 43 percent of students in 2008. This tells a very different story from both the minimal qualification series and the standardised international test scores. It may suggest that the quality of education for above-average students has increased radically while that for below-average or less engaged students has improved only moderately. Alternatively, in the absence of any international moderation, it may suggest that the university entrance standard has changed over time, or simply that more students are staying in school longer.

The qualification data highlights one of the risks inherent in using data compiled for purposes other than productivity analysis. The manner in which this measure is constructed—university standard as a proportion of *all* school leavers—conflates quantity and quality change. If students stay in school longer past the age of 16, this is picked up as increased volume of educational output quantity in the secondary schools. To record this again as an increase in quality would overstate the output of secondary schools. A better quality metric would be the proportion of students achieving UE to the students attempting it. A metric of that description would still be subject to difficulties in attributing improvements to a particular year of education.

Labour inputs (Table 5)

Over the period 2000-07, there was a 12.6 percent increase in FTTEs. In an absolute sense, the largest increase was in the number of secondary school teachers from 15,219 FTTEs to 18,679 FTTEs, an increase of 23 percent and the smallest change was the reduction of Correspondence School teachers from 298 to 205 (31 percent decrease). Proportionally, the largest changes were a 45 percent increase in FTTEs at composite (including restricted composite) schools and the 47 percent increase in special school FTTEs.

The difference between the weighted and unweighted labour volume series ranges from -0.13 to -4.8 percent. This suggests that there has been an increase in teachers of lesser experience and qualification in the period in question. FTTEs are reported for state and state integrated schools together, so an exact scope match between inputs and outputs cannot be made.

Compiling productivity

Any calculation of productivity based on a limited scope of inputs implicitly makes assumptions about the proportional volume and movement of the unmeasured inputs to production. Because a robust measure of capital services was not available in the publicly-available data, resulting productivity estimates could be biased and misleading. For this reason, no attempt has been made to proxy intermediate consumption or to estimate labour productivity based on the data in this paper. The lowest and highest estimate of output and labour input are presented in Figure 1.

What productivity doesn't reveal

Productivity analysis can be very important in assessing the efficiency of production processes. But it says little about their effectiveness in delivering the desired longer-term outcomes. Education serves a variety of purposes for the individual student, for families, and for society at large. Not all of these are reflected in a measure of economic productivity. Some of them negatively impact economic productivity by requiring a trade-off between economic efficiency and other goals, as in the choice to keep rural schools open so that children can go to school in their home community. There is no consensus, domestically or internationally, on the relationship between these factors and education quality. Different users apply differing weights to these factors, depending on their perspective as parents, community members, educational policymakers, labour economists, etc.

Likewise, there are significant differences in the mix of students in different schools in terms of gender, socio-economic status, ethnicity, previous educational history, family engagement etc. These are of great interest from a policy perspective but are not reflected in a measure of system-wide economic productivity.

Conclusions

Measurement choices are non-trivial in their impact on productivity estimates. In this paper, ten different output possibilities have been presented for the state school sector alone, showing growth ranging from 3 to 10 percent over an eight-year period. Two different

labour volume estimates show growth of between 7 and 12 percent. These suggest an entire fan of potential productivity estimates.

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Table 1. School enrolments and Full-time student equivalents (FTSE)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Enrolment	705,494	708,144	720,462	732,864	735,478	733,398	730,818	729,117	727,039
FTSE (March)	687,968	690,306	691,453	701,603	714,772	720,595	719,226	718,298	718,247
Difference between enrolments & FTSE (March)	2.5%	2.5%	4.0%	4.3%	2.8%	1.7%	1.6%	1.5%	1.2%
FTSE (composite)	700,818	701,233	700,731	708,406	720,291	726,213	728,056	727,138	725,353
Difference between enrolments & FTSE (composite)	0.7%	1.0%	2.7%	3.3%	2.1%	1.0%	0.4%	0.3%	0.2%

Table 2A. Expenditure[9] per FTSE (March) by school type

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Composite	17.37	18.35	19.31	20.12	21.99	23.22	25.02	25.92	29.71
Contributing	12.67	12.76	14.01	14.37	15.63	15.76	16.80	17.66	21.03
Full primary	12.92	13.58	13.87	14.58	15.42	16.24	17.35	18.14	21.36
Intermediate	6.70	6.73	6.87	7.18	7.76	8.19	8.72	9.00	10.79
Restricted composite	7.57	7.46	7.52	7.91	8.99	9.79	9.57	10.31	10.84
Secondary (7-15)	18.30	18.52	19.13	20.30	21.64	22.36	23.79	24.50	28.29
Secondary (9-15)	18.19	18.71	19.56	21.05	22.10	23.64	24.45	25.79	30.07
Correspondence School	8.74	9.51	10.50	10.18	9.93	10.34	10.77	9.81	10.81
Special schools	46.23	48.46	50.40	51.44	55.52	59.88	61.21	65.26	69.93
Total	148.70	154.08	161.18	167.13	178.99	189.42	197.67	206.40	232.82

Table 2B. Funding[10] per FTSE (March) by school type

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Composite	9.17	9.88	10.15	10.54	11.34	12.21	13.11	13.55	15.41
Contributing	6.68	6.86	7.45	7.57	8.15	8.27	8.83	9.17	10.39
Full primary	6.88	7.33	7.45	7.74	8.14	8.61	9.15	9.48	10.71
Intermediate	3.45	3.53	3.58	3.70	3.97	4.22	4.44	4.56	5.11
Restricted composite	3.83	3.92	3.89	4.15	4.49	5.31	5.25	5.39	5.82
Secondary (7-15)	9.25	9.38	9.53	9.96	10.57	11.03	11.67	11.99	13.06
Secondary (9-15)	9.28	9.43	9.53	10.09	10.52	11.32	12.02	12.51	13.62
Correspondence School	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Special schools	22.61	24.46	24.91	25.20	27.74	29.78	31.16	32.55	36.09
Total	71.15	74.78	76.49	78.94	84.92	90.75	95.64	99.21	110.20

Table 2C. State funding per FTSE (March) as a percentage of total expenditure, by school type

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Composite	53%	54%	53%	52%	52%	53%	52%	52%	52%
Contributing	53%	54%	53%	53%	52%	53%	53%	52%	49%
Full primary	53%	54%	54%	53%	53%	53%	53%	52%	50%
Intermediate	51%	52%	52%	51%	51%	52%	51%	51%	47%
Restricted composite	51%	53%	52%	52%	50%	54%	55%	52%	54%
Secondary (7-15)	51%	51%	50%	49%	49%	49%	49%	49%	46%
Secondary (9-15)	51%	50%	49%	48%	48%	48%	49%	49%	45%
Correspondence School	0%	0%	0%	0%	0%	0%	0%	0%	0%
Special schools	49%	50%	49%	49%	50%	50%	51%	50%	52%

[9] Total expenditure by school type, including teacher salaries, in GST exclusive nominal dollars; 2007-2008 expressed in pre-2007 reporting conventions.

[10] Total operational funding, direct property funding, and teacher salaries, in GST exclusive nominal dollars.

Table 3. School output volume indexes (2000=1000)

Indicator	Weighting	2000	2001	2002	2003	2004	2005	2006	2007	2008
Enrolments	Unweighted	1000	1004	1021	1039	1043	1040	1036	1033	1031
FTSE (March)		1000	1002	1016	1035	1044	1042	1041	1040	1034
FTSE (composite)		1000	999	1010	1027	1036	1038	1036	1034	1030
FTSE (March)	Expenditure	1000	1012	1024	1036	1048	1060	1073	1085	1097
FTSE (composite)		1000	1012	1023	1035	1048	1060	1072	1084	1097
FTSE (March)	Funding	1000	1011	1023	1035	1046	1058	1070	1082	1094
FTSE (composite)		1000	1011	1022	1034	1046	1058	1069	1081	1093

Table 4A. Output quality indexes (2000=1000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
TIMSS Year 5 index	1000	1008	1015	1013	1011	1009	1007	1005	1003
TIMMS Year 9 index	1000	1002	1003	1005	1006	1008	1009	1011	1012
Percentage of leavers with any qualifications	1000	995	979	1014	1045	1043	1065	1139	1135
Percentage of leavers with university entrance standard	1000	974	1011	1075	1202	1232	1360	1461	1633

Table 4B. Adjusted expenditure-weighted March EFTS indexes (2000=1000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
State schools only	1000	1013	1026	1039	1052	1066	1079	1092	1106
Core state schools[11]	1000	1009	1017	1026	1035	1044	1054	1063	1072
Attendance-adjusted core	1000	1010	1020	1031	1041	1052	1062	1073	1083
Outcome-adjusted[12] core	1000	1007	1014	1022	1029	1037	1044	1052	1059

[11] Excluding state integrated schools, state special schools and the Correspondence School

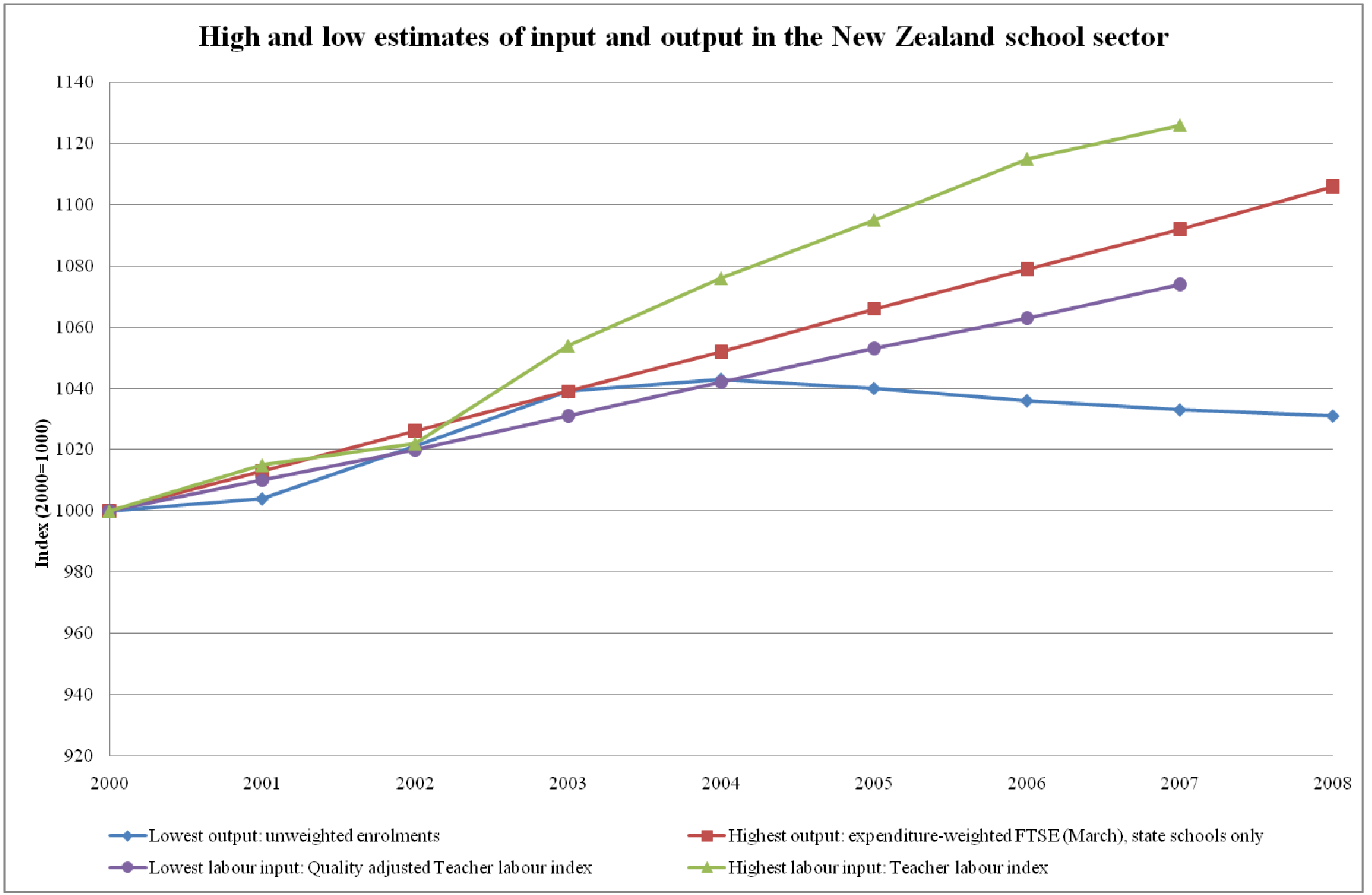
[12] Using TIMMS scores at year 5 for primary and contributing schools, TIMMS scores at year 9 for intermediate and composite schools, and proportion of school leavers with some form of qualification for secondary schools

Table 5A. Full-time teacher equivalents by school type

	2000	2001	2002	2003	2004	2005	2006	2007
Contributing Full Primary Intermediate	23,102	23,365	23,364	23,617	23,583	23,357	23,738	23,891
Composite Restricted Composite	1,418	1,485	1,572	1,691	1,795	2,008	2,042	2,062
Secondary (Year 7-15) Secondary (Year 9-15)	15,219	15,378	15,597	16,485	17,281	18,044	18,471	18,679
Correspondence School	298	318	290	290	285	244	210	205
Special School	663	745	764	799	835	909	931	974
Total Teacher FTEs	40,700	41,291	41,587	42,882	43,779	44,562	45,392	45,811

Table 5B. Full-time teacher equivalent indexes (2000=1000)

	2000	2001	2002	2003	2004	2005	2006	2007
Teacher labour index	1000	1015	1022	1054	1076	1095	1115	1126
Quality adjusted Teacher labour index	1000	1010	1020	1031	1042	1053	1063	1074


High and low estimates of input and output in the New Zealand school sector
Index (2000=1000)
1140
1120
1100
1080
1060
1040
1020
1000
980
960
940
920
2000
2001
2002
2003
2004
2005
2006
2007
2008
Lowest output: unweighted enrolments
Highest output: expenditure-weighted FTSE (March), state schools only
Lowest labour input: Quality adjusted Teacher labour index
Highest labour input: Teacher labour index