Reconceptualizing Educational Productivity for New South Wales Public Schools: An Empirical Application of Modified Quadriform Analytics

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Introduction

Little is known about the educational productivity of public schooling organizations when examined outside of market-based, cost-minimization frameworks (Hickrod et al. 1990; Anderson 1996; Rolle 2003, 2004a,b; Houck, Rolle, and He 2010). Consequently, the purpose of this research was to extend the literature that supports the appropriateness of measuring levels of the economic efficiency of public schools via an alternative approach, utilizing modified quadriform analytics (MQA) to assess the educational productivity of New South Wales public elementary and secondary schools in Australia over three school years, 2008-2010.[1] To that end, this study identified and compared the economic efficiency of New South Wales schools in terms of level of fiscal resources and national, mandated academic test scores while taking into account sociodemographic factors over which a school has no control.

In the following sections, this article: (1) presents historical background and alternative perspectives on educational productivity and its measurement; (2) describes the history of primary and secondary school funding in Australia and New South Wales; (3) reviews recent efficiency research on Australian schools; (4) explicates MQA, research methods, and data sources; and (5) presents analytical results. Analytical results include those for New South Wales schools using the school as the unit of analysis followed by a comparison of New South Wales schools by region. The concluding section summarizes findings and discusses implications of the study for educational efficiency theory, research, and policy within the Australian context, and makes recommendations for future research.

Historical Background on Educational Productivity and Its Measurement

Debate surrounding educational efficiency has endured more than half a century after the release of Coleman et al.'s 1966 research in *Equality of Educational Opportunity* which challenged conventional wisdom that factors, like

level of educational expenditure, had an effect on student achievement. In sharp contrast, Coons, Clune, and Sugarman (1970, 30) dissented, stating:

> Whatever it is that money may be thought to contribute to the education of children, that commodity is something highly prized by those who enjoy the greatest measure of it. If money is inadequate to improve education, the residents of poor districts should at least have an equal opportunity to be disappointed by its failure (1970, 30).

Subsequently, a large cadre of researchers turned to the use of an economic model and multivariate analytic approach referred to as "production function" to determine what, if any, statistically significant relationship existed between educational inputs, such as, but not limited to, expenditures, and academic outcomes (See, for example, Hanushek 1986; Murphy and Hallinger 1986; Odden 1986; Rossmiller 1987; Murnane 1991; Hedges, Laine, and Greenwald 1994; Laine, Greenwald, and Hedges 1996).

The net result of decades of production function research, as well as more recent studies using difference-in-difference, discontinuity, and value-added regression methodologies (Jacob and Lefgran 2004; Donald and Lang 2007; Rothstein 2009; Ou 2010; Corcoran and Goldhaber 2013; Goldhaber, Cowan, and Walch 2013), is inconclusive, giving rise to the need to consider alternative economic theories and methodologies, such as those embodied in collective choice theory.

Collective choice theory challenges the assumption of traditional economic analyses that public schools, like private sector businesses, act as cost-minimizing agencies (Buchanon and Tollison 1984; Stevens 1993; Peacock 1997; Downs 1998). Rather, extant research on public school administrator behavior challenge that notion (Kirst 1983; Hentschke 1988; Bennett 1992; Hughes, Moon, and Barnett 1993; Sowell 1993; Barnett 1994; Hanushek 1996; Rolle 2003), with findings that school administrators are more likely to be budget-maximizers.

In that regard, collective choice theory emphasizes two central features of public sector organizations that support budget-maximizing behavior (Michaelsen 1977, 1981, cited in Boyd and Hartman 1988, 293). First, unlike private sector managers and executives, public school administrators lack property rights (e.g., corporate stock accumulation) or profit motives that would support cost-minimizing behavior. Second, public schools receive annual allocations of tax-based revenues independent of levels of "consumer satisfaction." Hence, individual goals of public school administrators may take precedence over stated educational performance goals, generating economically inefficient outcomes.[2, 3] In support of this theoretical assertion, several studies have found that public sector managers systematically requested larger budgets regardless of the level of organizational output generated (Bush and Denzau 1977; Blais and Dion 1991; Campbell and Naulls 1991; Lynn 1991; Rolle 2004b).

This theoretical assertion and body of research remained relatively unchallenged until recently.[4] Eventually, both challenging and extending the work of proponents of collective choice theorists, Rolle (2003, 2004a) and Houck, Rolle, and He (2010) found, using MQA, statistically significant relationships between expenditures and outputs in Indiana and Georgia public school districts, respectively. The study reported in this article builds upon those findings.

History of Australia and New South Wales Primary and Secondary School Funding

Prior to 1964, the Australian government provided no direct funding to primary and secondary schools. Beginning in 1964, capital funding was made available to public and private secondary schools for science laboratories and equipment. The scope of capital funding was expanded to public and private secondary school libraries in 1969. In 1972, general purpose capital funding became available to public primary and secondary schools, with private primary and secondary schools included beginning in 1973 (Harrington 2013).[5]

The 1973 "Karmel Commission Report,"[6] which recommended funding to both public and private schools on a needs basis, was a watershed moment in Australian primary and secondary school finance policy (Blackburn 1983; Hinz 2010). The Commission recommended seven main education finance support programs: (1) general resources; (2) general buildings; (3) libraries; (4) disadvantaged schools; (5) special education; (6) teacher development; and (7) innovation (140-141).

In the report's final chapter, "Summary and Recommendation," the Commission noted serious deficiencies in Australia's schools in three broad areas:

- Most schools lack sufficient resources, both human and material, to provide educational experiences appropriate to the young in a modern democratic industrial society.
- Among schools there are gross inequalities, not only in the provision of resources but also in the opportunities that they offer to boys and girls from varied backgrounds. In particular there are many inner-city schools which draw their pupils from populations that suffer grave socioeconomic disadvantage, and there are handicapped children for whom quite inadequate opportunities for schooling exist.
- The quality of education leaves much to be desired. Many teachers have been inadequately trained and the provision for their professional development is frequently meager. Curricula and teaching methods tend to be unresponsive to differences between pupils and to address themselves to the development of a range of attributes which is narrow in relation to the possibilities of life in a complex technological society. In some schools and school systems, the authoritarian and hierarchical atmosphere inhibits the human relationships that should prepare young people for their place in the adult world (139).

The Commission recognized these vertical inequities and recommended the following:

> Differences in deficiencies require differences in treatment. Accordingly, the Committee is recommending relatively larger grants for some schools and school systems. Its long-term aim is that, by the end of the present decade, Australian schools should all have reached minimum acceptable standards; and its detailed recommendations have been determined on the principle that help should be given to all schools below these standards to approach them by that time. It follows that those schools which are presently nearer the standards will receive somewhat less help. It should be apparent that this approach to need implies that schools with fewer real resources have greater needs than those with more (140).

In light of the report, the Australian government established a "Schools Commission" in 1974 to distribute funding to schools on an annual basis. From 1985 to 2008, most Australian government funding for schools was provided on a quadrennial basis.[7] Over that time period, there were also some changes in funding formulas and resource standards that determined levels per-pupil funding across different funding programs.[8]

In 2009, the Australian government restructured public school funding based on a new framework for federal-state financial relations: The "National Schools Specific Purpose Payment" (ACARA 2011). Other Australian government funding for schools is provided through national partnerships and the Australian government's own school education programs, known as Commonwealth Own-Purpose Expenses, administered primarily by the Department of Education, Employment and Workplace Relations (Harrington 2013, 4).

The state of New South Wales uses a centralized system to allocate funding to elementary and secondary schools.[9] State allocations comprise approximately 82.5% of schools' annual revenue. Commonwealth (federal) allocations are approximately 13%, and school derived-revenues make up about 5%. Provided through two basic methods, centralized allocations and direct central payments of school-based costs, state funding categories are: (1) salaries for school-based teachers and school administrators; (2) global funding;[10] (3) "tied" and "untied" grants;[11] (4) capital outlay and maintenance; and (5) cleaning (Keating et.al 2011, 49).

Personnel costs constitute approximately 81% of New South Wales public school budgets. School administrative support staff and specialists, as well as nonteaching staff, positions are allocated on the basis of student enrollments. Staffing formulas, faculty appointments, and faculty transfer systems are subject to collective bargaining between the New South Wales Department of Education and Communities and individual schools (Keating et.al 2011).

Additional funding programs are dedicated to equity. The Priority Schools Funding Program, which targets schools with relatively high percentages of low socioeconomic students, provides resources to improve literacy and numeracy achievement and engagement of students. Other equity allocations take into account student and school characteristics. The former include those with disabilities, English language learners (ELLs), new arrivals, and indigenous and isolated students. School circumstances include location, enrollment size (e.g., diseconomies of scale), and complexity.[12] Equity allocations are made mainly through the staffing formulas (Keating et al. 2011, 56).

Over the last decade, increasing attention has been paid to the fiscal performance and academic accountability of Australian schools. In particular, in 2010, the commonwealth introduced the "My School" website (www.myschool.edu.au) hosted by the Australian Curriculum Assessment and Reporting Authority. Open to the public, the site posts student performance by school on national standardized tests, specifically, the National Assessment Program: Literacy and Numeracy (NAPLAN), administered in grades three, five, seven, and nine. Not surprisingly, the resulting publication of school rankings and "league tables," the latter made possible by test score data on the web site, have been controversial, particularly when used by the media to "name and shame" individual schools. In spite of the commonwealth's stated goals of public accountability and transparency, a number of concerns have been raised that: (1) the site's focus leads to public perception that test scores are the single most important piece of information in judging a school's success; (2) under pressure to improve student test scores, teachers will move away from a broad commitment to student learning to a focus on "teaching to the test"; and (3) students will experience increasing stress around national testing that damage their wellbeing and have a negative effect on test results (Cook 2014, 22). Nonetheless, the commonwealth maintains that the transparency and accountability for education results and efficient use of resources the site provides are essential. The study results reported in this article on school efficiency represent a natural outgrowth of the commonwealth's ongoing commitment to these goals.

Recent Efficiency Research on Australian Primary and Secondary Schools

This section describes several recent studies that provide a snapshot of educational performance and productivity research on Australian schools. For the most part, this group of studies used traditional research methods, like the production function, although more recent approaches like data envelopment and multilevel multivariate models are also found. Together, their results are mixed, and, in that sense, represent the larger body of research in this domain.

In 2002, Mante and O'Brien assessed the technical efficiency of 27 Victorian secondary schools using the basic data envelopment analysis model of Charnes, Cooper, and Rhodes (1978). They found that a majority of the 27 schools examined were in a position to increase their outputs through more efficient use of available resources.

Bradley, Draca, and Green (2004) discussed the role of "league tables" (school rankings based upon academic performance) in providing signals and incentives using a quasi-market model. They compared a range of unadjusted

and model-based league tables for primary school performance in Queensland public schools. Results indicated that model-based tables which took into account student socioeconomic status and student intake quality varied significantly from unadjusted tables.

In a 2004 report for the Victorian Department of Premier and Cabinet, Lamb, Rumberger, Jesson, and Teese examined the effects of core funding, locally raised funds, and a number of special sources of funding, e.g., English as a second language (ESL) funding, together with variables measuring teachers' background using multilevel multivariate models. Though effects generally were found to be small or statistically insignificant, overall research conclusions supported the notion that the level and utilization of school resource variables had positive effects on student outcomes.

Miller and Voon (2011) examined Australia's National Assessment Program for Literacy and Numeracy (NAPLAN) results for 2008 and 2009 using production function analysis. Test score data for students in grades three, five, seven, and nine were regressed on socioeconomic characteristics, type of school, percent of female students, student attendance, school size, and state and region. No information on school financial resources was used in their analysis. They found large differences in educational outcomes by state and school type. Preliminary findings indicated that some schools had academic achievement both better and worse than their characteristics would suggest.

Leigh and Ryan (2011) also used a production function framework. Combining data from two nationally representative tests, they analyzed long-run student achievement for Australian adolescents, ages 13-14, and found a small but statistically significant fall in mathematics achievement between 1964 and 2003, and in both literacy and mathematics 1975-1998, even after controlling for student demographics. At the same time, real per-pupil expenditure increased substantially over this period, which the authors concluded implied a fall in school productivity.

Methodology

This study used modified quadriform analytics (MQA), a relative measure of economic efficiency, to assess the educational productivity of New South Wales (NSW) public elementary and secondary schools in Australia over three school years, 2008-2010. A quadriform is an abstract tool devised to allow a hypothesized relationship to be viewed both graphically and quantitatively. (See Figure.)

The MQA examines expenditure and output variations of schools relative to others and places each into one of four quadrants, as described below:

Quadrant 1: Efficient Schools. Efficient schools are those that generate higher than expected outcomes using lower than expected expenditures.

Quadrant 2: Effective Schools. Effective schools are those that generate higher than expected outcomes using higher than expected expenditures.

Quadrant 3: Ineffective Schools. Ineffective schools are those that generate lower than expected outcomes using lower than expected expenditures.

Figure | **Basic Quadriform Diagram**

Quadrant 1: Inefficient High Input – Low Output	**Quadrant 2:** Effective High Input – High Output
Quadrant 3: Ineffective Low Input – Low Output	**Quadrant 4:** Efficient Low Input – High Output

Quadrant 4: Inefficient Schools. Inefficient schools are those that generate lower than expected outcomes with higher than expected expenditures.

Quantitatively, the modified quadriform is constructed as a two-stage model that: (1) captures the input-output relationship as two separate regressions; and (2) uses discriminant analysis to identify alterable characteristics[13] that distinguish efficient from inefficient schools.[14] The model can be represented by the following regression equation:

$$Z_i = \alpha + \Sigma B_i W_{t\text{-}i} + u_t$$

where

Z_i = the expected values (expenditure or outcome) for each school

W_i = the unalterable values for each school.

The values for Z_i create the axes of the quadriform, and the regression residuals determine the assignment of a school to a particular quadrant.[15] In this study, school expenditures were measured across the horizontal axis, and academic outcomes were measured along the vertical axis.

The MQA shows only annual efficiency categorizations. In order to determine the longitudinal nature of efficiency among New South Wales public schools, an additional layer of analysis was added, which enabled classification of schools that were "perennially" (i.e., consistently) efficient, effective, inefficient, or ineffective over the three year period.[16]

Data Sources and Variables

The data source for this study was departmental annual financial statements for the state of New South Wales, Australia. School level data elements used in the study are listed below:[17]

School resource data. School resource data represented financial resources, such as teacher salary per student, and school structures such as student-teacher ratio.

School and Student characteristics. Student characteristics included percentages of students with disabilities, English language learners (ELL), and indigenous students by school. In addition, values for schools, based upon the Index of Community-Socio Educational Advantage (ICSEA), were used. Developed by the Australian Curriculum Assessment and

Reporting Authority (ACARA), the index was designed as a scale to enable fair comparisons of NAPLAN test achievement by students in schools across Australia. The scope of the index is broader than socioeconomic status. According to ACARA (2015):

> A value on the index corresponds to the average level of educational advantage of the school's student population relative to those of other schools. Research shows that key factors in students' family backgrounds (parents' occupation, their school education and non-school education) have an influence on students' educational outcomes at school. Research has also shown that school- level factors (a school's geographical location and the proportion of Indigenous students a school caters for) need to be considered when summarising educational advantage or disadvantage at the school level. ICSEA provides a numeric scale that represents the magnitude of this influence, or level of educational advantage, and takes into account both student and school level factors.

Student academic outcomes. Academic outcomes were represented by student scores on National Assessment Program - Literacy and Numeracy (NAPLAN). These are standardized tests administered at grades three, five, seven and nine in reading, writing, language conventions (spelling, grammar and punctuation) and numeracy (mathematics) (ACARA 2010). This study used a combined average score on these tests, referred to as a "multi-examination" average.[18]

MQA Results

This section is divided into two parts. The first presents MQA results for schools in the Australian state of New South Wales based upon NAPLAN multi-examination average scores, 2008-2010, for students in grades three, five, seven, and nine. Here the school is the unit of analysis. The second part of this section presents MQA results by region in the state of New South Wales, with the region as the unit of analysis. The first part allows for comparison of individual schools across the state of New South Wales, while the second section allows comparisons of student achievement across regions.

MQA Results for New South Wales Schools

Table 1 presents MQA results for third grade multi-examination average scores from 2008 to 2010. Specifically, Table 1 shows that the percentage of schools designated as efficient ranged from 30.5% to 33.1%, while the percentage of schools identified as inefficient varied from 19.1% to 20.4%. Table 1 also contains MQA results for schools with a perennial categorization. Just over 41% of schools were designated perennially efficient over this three year period, while 18.4% were perennially inefficient. It is also important to note that almost one-third (32.1%) of schools were found to be perennially ineffective; that is, they generated lower than expected academic outcomes with lower than expected expenditures.

Table 2 contains MQA results for fifth grade multi-examination average scores. It shows that the percentage of schools designated as efficient ranged from 32.6% and 33.3%, while the percentage of schools classified as inefficient varied from 20.5% and 21.3%. Just over 40% of schools were found to be perennially efficient, while 18.5% were perennially inefficient. As with third grade results, it is important to point out that almost one-third (32.1%) of schools were perennially ineffective.

MQA results for seventh grade multi-examination average scores are found in Table 3. The percentage of schools designated as efficient ranged from 26.7% to 32.1%, while the percentage of schools identified as inefficient varied from 22.6% to 24.5%. Just over 30% of schools were perennially efficient, while one quarter (25.3%) were deemed perennially inefficient. However, the largest proportion of schools, 35.9%, were identified as ineffective.

MQA results for ninth grade multi-examination average scores are presented in Table 4. Between 28.8% and 30.2% of schools were found to be efficient compared to 21.6% and

Table 1 | **MQA Results for Grade Three Student Achievement: 2008-2010**

Year	N	Percent/ Number	Ineffective Schools	Efficient Schools	Effective Schools	Inefficient Schools	Non-Labeled
2008	1342	Percent	34.2%	30.8%	15.3%	19.8%	
		Number	408	448	184	278	24
2009	1342	Percent	32.5%	33.1%	14.1%	20.4%	
		Number	404	456	174	277	31
2010	1342	Percent	34.0%	30.5%	16.4%	19.1%	
		Number	417	429	203	262	31
Perennial Results		Percent	32.3%	41.1%	8.2%	18.4%	
		Number	186	237	47	106	766

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Table 2 | **MQA Results for Grade Five Student Achievement: 2008-2010**

Year	N	Percent/ Number	Ineffective Schools	Efficient Schools	Effective Schools	Inefficient Schools	Non-Labeled
2008	1342	Percent	32.5%	32.6%	14.3%	20.5%	
		Number	425	426	187	268	36
2009	1342	Percent	32.2%	33.1%	13.4%	21.3%	
		Number	422	433	176	279	32
2010	1342	Percent	31.1%	33.3%	14.4%	21.2%	
		Number	409	437	189	279	28
Perennial Results		Percent	32.3%	40.3%	8.8%	18.5%	
		Number	190	237	52	109	754

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Table 3 | **MQA Results for Grade Seven Student Achievement: 2008-2010**

Year	N	Percent/ Number	Ineffective Schools	Efficient Schools	Effective Schools	Inefficient Schools	Non-Labeled
2008	371	Percent	34.5%	26.7%	16.2%	22.6%	
		Number	128	99	60	84	0
2009	371	Percent	32.3%	30.5%	13.5%	23.7%	
		Number	120	113	50	88	0
2010	371	Percent	32.1%	32.1%	11.3%	24.5%	
		Number	119	119	42	91	0
Perennial Results		Percent	35.9%	30.3%	8.6%	25.3%	
		Number	71	60	17	50	173

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

25.3% deemed inefficient. With regard to MQA results for schools with a perennial categorization, 31.5% of schools were classified as perennially efficient, while 27% were perennially inefficient. In addition, almost 31% of schools were classified as perennially ineffective.

MQA Results by Region in the State of New South Wales

The Commonwealth of Australia is comprised of six states and two territories. States include New South Wales, Victoria, Queensland, South Australia, Western Australia, and Tasmania. The two territories are the Australian Capital Territory and the Northern Territory. Nearly one-third of the commonwealth's 24 million people reside in New South Wales, making it the most populous state (Australian Bureau of Statistics 2015).[19] New South Wales, located along Australia's southeast coast, is divided into ten distinct school regions: Hunter/Central Coast, Illawarra-South East New South Wales, New England, North Coast, Northern Sydney, Riverina, South Western Sydney, Sydney, Western New South Wales, and Western Sydney.[20] The number of schools by region ranges from 13 in New England to 95 in South Western Sydney.

Table 5 presents MQA perennial results by region for third grade NAPLAN multi-examination average scores over the course of three academic years, 2008-2010.[21] Overall, 41% of schools across the state were perennially efficient while 18.4% were perennially inefficient. The percentage of perennially efficient schools by region varied from 11.1% in Riverina to 92.5% in Northern Sydney, while the percentage of perennially inefficient schools varied from 1.3% in Northern Sydney to 44.4% in Riverina. In addition, it is noteworthy that almost one-third (32.3%) of the state's schools were classified as perennially ineffective, including almost half of schools in the Hunter/Central Coast, North Coast, and Illawarra and South East, and Western Sydney regions.

Table 4 | **MQA Results for Grade Nine Student Achievement: 2008-2010**

Year	N	Percent/ Number	Ineffective Schools	Efficient Schools	Effective Schools	Inefficient Schools	Non-Labeled
2008	371	Percent	31.0%	30.2%	17.3%	21.6%	
		Number	115	112	64	80	0
2009	371	Percent	33.2%	29.6%	11.9%	25.3%	
		Number	123	110	44	94	0
2010	371	Percent	35.3%	28.8%	12.7%	23.2%	
		Number	131	107	47	86	0
Perennial Results		Percent	30.9%	31.5%	10.7%	27.0%	
		Number	55	56	19	48	193

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

MQA perennial results by region for fifth grade NAPLAN multi-examination average scores are found in Table 6. In total, 40.3% of schools across the state were perennially efficient while 18.5% were perennially inefficient, a result similar to that for third grade student achievement. The percentage of perennially efficient schools by region ranged from 12.9% in Riverina to 92.3% in Northern Sydney. Almost two-thirds of Sydney schools were designated perennially efficient as well. The percentage of perennially inefficient schools by region ranged from zero in Northern Sydney to 48.4% in Riverina. As with third grade achievement, approximately one third of the state's schools were classified as perennially ineffective, including over half (51.9%) of Western Sydney schools, half (50%) of schools in Illawarra and South East, and nearly half (48.9%) in Hunter/Central Coast.

Table 7 contains MQA perennial results by region for seventh grade NAPLAN multi-examination average scores. In comparison to third and fifth grade findings, the percentage of perennially efficient schools in the state decreased to 30.3% while the percentage of perennially inefficient school increased to 25.3%. The percentage of perennially efficient schools by region ranged from zero in New England to 56% in Northern Sydney. Over half (53.8%) of Western South Wales schools were designated perennially efficient as well, along with 50% of Sydney schools, and 45% of Hunter/Central Coast schools. The percentage of perennially inefficient schools by region varied from 4.0% in Northern Sydney to 50% in Riverina. In addition, one third of schools were found perennially inefficient in three regions: Illawara and Southeast; New England; and North Coast. With regard to perennially ineffective schools statewide, the percentage rose in comparison to third and fifth grade results to 35.9% for seventh grade achievement. By region, perennially ineffective schools ranged from zero in Northern Sydney to 66.7% in New England. Over half of schools were classified as perennially ineffective in North Coast (58.3%) and Illawara and South East (55.6%). In addition, nearly half of schools in South Western Sydney (48.9%) and Western Sydney (47.8%) were designated perennially ineffective.

MQA perennial results by region for ninth grade NAPLAN multi-examination average scores are found in Table 8. In total, the percentage of perennially efficient schools in the state was 30.9% while the percentage of perennially inefficient was 27%. The percentage of perennially efficient schools by region varied from 10% in South Western Sydney to 60% in Northern Sydney. Half (50%) of Hunter/Central Coast schools were classified perennially efficient as well. The percentage of perennially inefficient schools by region varied from 5.0% in Northern Sydney to 42.5% in South Western Sydney. In addition, 40% of Riverina schools were designated perennially inefficient. Statewide, 30.9% of schools were deemed ineffective. Perennially ineffective schools by region ranged from zero in Northern Sydney to 47.5% in South Western Sydney. Illawara and South East followed closely with 43.8% of schools designated perennially ineffective. For three additional regions, the percentage of perennially ineffective schools was one-third or higher: Hunter/North Coast (33.3%), New England (33.3%), North Coast (36.4%), and Western Sydney (37.5%).

In summary, using the school as the unit of analysis, a higher percentage of New South Wales schools were designated perennially efficient at the third and fifth grade levels than those at the seventh and ninth grades; that is, approximately 40% of schools were identified as perennially efficient at the lower grade levels in contrast to around 30% at the upper grades. At the same time, a lower percentage of schools, approximately 18%, at the third and fifth grade levels were classified as perennially inefficient compared to over one-quarter of at the upper grade levels. However, the percentage of schools regarded as perennially ineffective was fairly consistent across all grade levels, ranging from 30.9% to 35.9%.

Table 5 | **MQA Perennial Results for Grade Three Student Achievement by Region: 2008-2010**

Region		Ineffective	Efficient	Effective	Inefficient	Total
Hunter/Central Coast	N (schools)	41	30	7	10	88
	Region %	46.6%	34.1%	8.0%	11.4%	100.0%
	Category %	22.0%	12.7%	14.9%	9.4%	15.3%
Illawara and South East	N (schools)	22	9	2	12	45
	Region %	48.9%	20.0%	4.4%	26.7%	100.0%
	Category %	11.8%	3.8%	4.3%	11.3%	7.8%
New England	N (schools)	1	7	5	5	18
	Region %	5.6%	38.9%	27.8%	27.8%	100.0%
	Category %	.5%	3.0%	10.6%	4.7%	3.1%
North Coast	N (schools)	24	13	6	7	50
	Region %	48.0%	26.0%	12.0%	14.0%	100.0%
	Category %	12.9%	5.5%	12.8%	6.6%	8.7%
Northern Sydney	N (schools)	0	74	5	1	80
	Region %	0.0%	92.5%	6.3%	1.3%	100.0%
	Category %	0.0%	31.2%	10.6%	.9%	13.9%
Riverina	N (schools)	9	3	3	12	27
	Region %	33.3%	11.1%	11.1%	44.4%	100.0%
	Category %	4.8%	1.3%	6.4%	11.3%	4.7%
South Western Sydney	N (schools)	39	18	2	36	95
	Region %	41.1%	18.9%	2.1%	37.9%	100.0%
	Category %	21.0%	7.6%	4.3%	34.0%	16.5%
Sydney	N (schools)	4	45	12	5	66
	Region %	6.1%	68.2%	18.2%	7.6%	100.0%
	Category %	2.2%	19.0%	25.5%	4.7%	11.5%
Western New South Wales	N (schools)	10	9	3	8	30
	Region %	33.3%	30.0%	10.0%	26.7%	100.0%
	Category %	5.4%	3.8%	6.4%	7.5%	5.2%
Western Sydney	N (schools)	36	29	2	10	77
	Region %	46.8%	37.7%	2.6%	13.0%	100.0%
	Category %	19.4%	12.2%	4.3%	9.4%	13.4%
Total	N (schools)	186	237	47	106	576
	Region %	32.3%	41.1%	8.2%	18.4%	100.0%

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Turning to the inter-regional MQA results, it was possible to identify patterns where some regions consistently had higher–and lower–percentages of perennially efficient schools across grade levels. For example, in the Northern Sydney region, the percentage of perennially efficient schools, by grade level, ranged from 50% to 92.5%. In contrast, in Riverina, the percentage of perennially efficient schools was only 10.0% to 12.9%. It follows that only a small fraction of Northern Sydney schools were found perennially inefficient (zero to 5%) whereas 40% to 50% of Riverina schools fell into this category. A similar pattern was found with regard to the percentages of perennially ineffective schools. Clearly, these results, including school and regional units of analysis, are of interest to school, regional, state, and commonwealth educators and policymakers as they seek to maximize educational efficiency and productivity.

Conclusion

The goal of this study was to contribute to the body of research literature on alternative approaches to the the measurement of the economic efficiency of public schools using modified quadriform analytics (MQA) to assess the educational productivity of New South Wales public elementary and secondary schools in Australia over a three year period. To do so, the study identified and compared the economic efficiency of schools in terms of level of fiscal resources and national, mandated academic test scores for third, five, seventh, and ninth grade students, while taking

Table 6 | **MQA Perennial Results for Grade Five Student Achievement by Region: 2008-2010**

Region		Ineffective	Efficient	Effective	Inefficient	Total
Hunter/Central Coast	N (schools)	43	31	5	10	89
	Region %	48.3%	34.8%	5.6%	11.2%	100.0%
	Category %	22.6%	13.1%	9.6%	9.2%	15.1%
Illawara and South East	N (schools)	27	10	3	14	54
	Region %	50.0%	18.5%	5.6%	25.9%	100.0%
	Category %	14.2%	4.2%	5.8%	12.8%	9.2%
New England	N (schools)	2	5	4	2	13
	Region %	15.4%	38.5%	30.8%	15.4%	100.0%
	Category %	1.1%	2.1%	7.7%	1.8%	2.2%
North Coast	N (schools)	19	16	6	10	51
	Region %	37.3%	31.4%	11.8%	19.6%	100.0%
	Category %	10.0%	6.8%	11.5%	9.2%	8.7%
Northern Sydney	N (schools)	0	72	6	0	78
	Region %	0.0%	92.3%	7.7%	0.0%	100.0%
	Category %	0.0%	30.4%	11.5%	0.0%	13.3%
Riverina	N (schools)	5	4	7	15	31
	Region %	16.1%	12.9%	22.6%	48.4%	100.0%
	Category %	2.6%	1.7%	13.5%	13.8%	5.3%
South Western Sydney	N (schools)	39	19	0	37	95
	Region %	41.1%	20.0%	0.0%	38.9%	100.0%
	Category %	20.5%	8.0%	0.0%	33.9%	16.2%
Sydney	N (schools)	6	46	13	6	71
	Region %	8.5%	64.8%	18.3%	8.5%	100.0%
	Category %	3.2%	19.4%	25.0%	5.5%	12.1%
Western New South Wales	N (schools)	7	8	5	5	25
	Region %	28.0%	32.0%	20.0%	20.0%	100.0%
	Category %	3.7%	3.4%	9.6%	4.6%	4.3%
Western Sydney	N (schools)	42	26	3	10	81
	Region %	51.9%	32.1%	3.7%	12.3%	100.0%
	Category %	22.1%	11.0%	5.8%	9.2%	13.8%
Total	N (schools)	190	237	52	109	588
	Region %	32.3%	40.3%	8.8%	18.5%	100.0%

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

into account sociodemographic factors over which schools have no control. Analytical results included those for New South Wales schools using the school as the unit of analysis as well as a comparison of New South Wales schools by region. Result were further divided into cross-sectional, by year, and "perennial," the latter referring to consistency in results over a three year period.

Although MQA identified schools as falling into four distinct categories–efficient, inefficient, effective, ineffective–the primary focus of the study was on efficient and inefficient schools where efficient schools were defined as those that generated higher than expected academic outcomes with lower than expected expenditures, and inefficient schools were those that generated lower than expected outcomes with higher than expected expenditures. In addition, the analysis considered the relatively high incidence of ineffective schools, defined as those that generated lower than expected academic outcomes using lower than expected expenditures.

Accountability for academic outcomes in elementary and secondary education continues to be an important policy objective in the Commonwealth of Australia (Senate Standing Committee on Education, Employment, and Workplace Relations 2013). At the same time, as the results of this study indicated, it is a complex challenge. Further, the MQA results in this study represented only one state, New South Wales, out of the six that comprise the commonwealth, along with two territories. As such, there is ample opportunity and need for similar research in other states along with localized,

Table 7 | **MQA Perennial Results for Grade Seven Student Achievement by Region: 2008-2010**

Region		Ineffective	Efficient	Effective	Inefficient	Total
Hunter/Central Coast	N (schools)	8	9	0	3	20
	Region %	40.0%	45.0%	0.0%	15.0%	100.0%
	Category %	11.3%	15.0%	0.0%	6.0%	10.1%
Illawara and South East	N (schools)	10	1	1	6	18
	Region %	55.6%	5.6%	5.6%	33.3%	100.0%
	Category %	14.1%	1.7%	5.9%	12.0%	9.1%
New England	N (schools)	4	0	0	2	6
	Region %	66.7%	0.0%	0.0%	33.3%	100.0%
	Category %	5.6%	0.0%	0.0%	4.0%	3.0%
North Coast	N (schools)	7	1	0	4	12
	Region %	58.3%	8.3%	0.0%	33.3%	100.0%
	Category %	9.9%	1.7%	0.0%	4.0%	6.1%
Northern Sydney	N (schools)	0	14	10	1	25
	Region %	0.0%	56.0%	40.0%	4.0%	100.0%
	Category %	0.0%	23.3%	58.8%	2.0%	12.6%
Riverina	N (schools)	2	1	2	5	10
	Region %	20.0%	10.0%	20.0%	50.0%	100.0%
	Category %	2.8%	1.7%	11.8%	10.0%	5.1%
South Western Sydney	N (schools)	22	5	0	18	45
	Region %	48.9%	11.1%	0.0%	40.0%	100.0%
	Category %	31.0%	8.3%	0.0%	36.0%	22.7%
Sydney	N (schools)	5	13	1	7	26
	Region %	19.2%	50.0%	3.8%	26.9%	100.0%
	Category %	7.0%	21.7%	5.9%	14.0%	13.1%
Western New South Wales	N (schools)	2	7	2	2	13
	Region %	15.4%	53.8%	15.4%	15.4%	100.0%
	Category %	2.8%	11.7%	11.8%	4.0%	6.6%
Western Sydney	N (schools)	11	9	1	2	23
	Region %	47.8%	39.1%	4.3%	8.7%	100.0%
	Category %	15.5%	15.0%	5.9%	4.0%	11.6%
Total	N (schools)	71	60	17	50	198
	Region %	35.9%	30.3%	8.6%	25.3%	100.0%

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

school-based case studies to determine which factors, policies, and practices contribute to or impede improvements in efficiency and productivity.

Endnotes

[1] Note that public schools are referred to as "government" schools in Australia.

[2] Individual goals might include maximizing "...the size of their budget, the scope of their activities, the ease of their work, and their power and prestige" (Michaelsen 1977, 1981, cited in Boyd and Hartman 1988, 293).

[3] See also, Niskanen (1971). Working within the larger context of collective choice economic theory and building on the seminal works of von Mises (1944), Tullock (1965), and Downs (1998), Niskanen challenged traditional normative economic analytical assumptions for public bureaus. He developed a

Table 8 | **MQA Perennial Results for Grade Nine Student Achievement by Region: 2008-2010**

Region		Ineffective	Efficient	Effective	Inefficient	Total
Hunter/Central Coast	N (schools) Region % Category %	6 33.3% 10.9%	9 50.0% 16.1%	0 0.0% 0.0%	3 16.7% 6.3%	18 100.0% 10.1%
Illawara and South East	N (schools) Region % Category %	7 43.8% 12.7%	2 12.5% 3.6%	2 12.5% 10.5%	5 31.3% 10.4%	16 100.0% 9.0%
New England	N (schools) Region % Category %	2 33.3% 3.6%	2 33.3% 3.6%	1 16.7% 5.3%	1 16.7% 2.1%	6 100.0% 3.4%
North Coast	N (schools) Region % Category %	4 36.4% 7.3%	2 18.2% 3.6%	2 18.2% 10.5%	3 27.3% 6.3%	11 100.0% 6.2%
Northern Sydney	N (schools) Region % Category %	0 0.0% 0.0%	12 60.0% 21.4%	7 35.0% 36.8%	1 5.0% 2.1%	20 100.0% 11.2%
Riverina	N (schools) Region % Category %	2 20.0% 3.6%	1 10.0% 1.8%	3 30.0% 15.8%	4 40.0% 8.3%	10 100.0% 5.6%
South Western Sydney	N (schools) Region % Category %	19 47.5% 34.5%	4 10.0% 7.1%	0 0.0% 0.0%	17 42.5% 35.4%	40 100.0% 22.5%
Sydney	N (schools) Region % Category %	5 20.8% 9.1%	11 45.8% 19.6%	1 4.2% 5.3%	7 29.2 14.6%	24 100.0% 13.5%
Western New South Wales	N (schools) Region % Category %	1 11.1% 1.8%	3 33.3% 5.4%	2 22.2% 10.5%	3 33.3% 6.3%	9 100.0% 5.1%
Western Sydney	N (schools) Region % Category %	9 37.5% 16.4%	10 41.7% 17.9%	1 4.2% 5.3%	4 16.7% 8.3%	24 100.0% 13.5%
Total	N (schools) Region %	55 30.9%	56 31.5%	19 10.7%	48 27.0%	178 100.0%

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

theory of budget-maximizing bureaucratic behavior which asserted that subject to a budget constraint greater than or equal to the costs of supplying the output expected by a public bureau's sponsors, bureaucrats attempt to maximize the agency's total budget during their tenure. As a result of this budget-maximizing behavior, Niskanen's theory asserts that public bureaus generate budgets that are larger than optimal; outputs that are too low relative to expenditure levels; and outputs that are produced inefficiently.

[4] An early dissenter was Wildavsky (1964) who claimed that bureaucrats request moderate annual budget increases in order to maximize long-term budget goals.

[5] The Australian government first provided recurring funding for operational costs to private schools, in the form of modest flat grants in 1970 (Harrington 2013).

[6] The "Karmel Commission Report" is an informal name for the publication, "Schools in Australia," a report of the Australian government's Interim Committee for the Australian Schools Commission.

[7] The Schools Commission was abolished in 1988.

[8] See Harrington (2013) for a fuller explanation of these.

[9] This section provides only an overview of state funding for New South Wales Schools. For a detailed explanation, see the Keating et al. (2011, 49-62) chapter on New South Wales.

[10] "Global" denotes that every school receives this type of funding.

[11] "Tied" grants are specific purpose payments to schools while "untied" grants are general purpose payments.

[12] "Complexity" here refers to multi-site schools.

[13] Alterable characteristics represent those over which a school has control.

[14] Because this study was concerned primarily with determining the efficiency levels of public schools, only the first stage of modified quadriform method was utilized.

[15] More specifically, the expenditure regression residual values are plotted on the x-axis and the outcome regression residual values are plotted on the y-axis. Each corresponding (x,y) pairings of residuals represents the quadrant to which a specific school is assigned.

[16] After the initial modified quadriform analysis was completed, each school was given an annual value of one for the category in which it fell and annual values of zero for the remaining three categories. Then, an arithmetic mean was calculated. As a result, a school was defined as a perennially efficient, effective, ineffective, or inefficient if its school average was equal to one in any category. Schools with averages below one were excluded from further analyses. Finally, perennially categorized schools were re-analyzed within a new set of quadriforms.

[17] Univariate and multivariate statistical analyses were conducted. Univariate statistics (e.g., means, medians, and standard deviations) were calculated to provide general and comparative descriptions of individual variables. Multivariate statistical analyses examined variables underlying regression relationships necessary for modified quadriform analyses, which, in turn, were used to make inferences about levels of efficiency.

[18] For those interested specifically in reading and numeracy (mathematics) MQA results, these are available in the Appendix.

[19] Sydney is the capital of New South Wales. The metropolitan area, referred to as "Greater Sydney," represents 64% of the state's population (Australian Bureau of Statistics 2014).

[20] For a description of each region, see New South Wales government website (https://www.nsw.gov.au) and the New South Wales Department of Education website (http://www.dec.nsw.gov.au/home).

[21] Analyses of numeracy and reading by region also were conducted. For more information, please contact the author.

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Appendix
MQA Results for Reading and Numeracy Achievement: 2008-2010

Table A-1 | **MQA Results for Grade Three Reading and Numeracy Achievement: 2008-2010**

Grade Three Numeracy							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	1342	Percent	34.2%	30.8%	15.3%	19.8%	
		Number	450	405	201	261	25
2009	1342	Percent	32.3%	32.9%	14.0%	20.3%	
		Number	425	433	184	267	33
2010	1342	Percent	33.9%	30.4%	16.3%	19.0%	
		Number	446	400	215	250	31
Perennial Results		Percent	36.9%	37.1%	9.7%	16.4%	
		Number	205	206	54	91	788
Grade Three Reading							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	1342	Percent	32.0%	32.9%	14.2%	20.9%	
		Number	421	432	187	274	28
2009	1342	Percent	32.5%	33.2%	14.2%	20.1%	
		Number	424	434	185	263	36
2010	1342	Percent	33.5%	31.0%	15.3%	20.2%	
		Number	439	407	200	265	31
Perennial Results		Percent	33.8%	39.4%	9.6%	17.3%	
		Number	187	218	53	96	788

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Appendix (continued)
MQA Results for Reading and Numeracy Achievement: 2008-2010

Table A-2 | **MQA Results for Grade Five Reading and Numeracy Achievement: 2008-2010**

Grade Five Numeracy							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	1342	Percent	35.4%	29.9%	14.1%	20.9%	
		Number	460	389	183	272	38
2009	1342	Percent	35.1%	30.3%	13.6%	21.2%	
		Number	459	396	177	277	33
2010	1342	Percent	32.9%	31.5%	14.4%	21.2%	
		Number	432	414	189	278	29
Perennial Results		Percent	37.6%	37.6%	7.0%	18.3%	
		Number	214	211	40	104	773
Grade Five Reading							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	1342	Percent	33.4%	31.9%	14.7%	20.0%	
		Number	434	415	191	260	42
2009	1342	Percent	33.0%	32.4%	15.4%	19.2%	
		Number	431	423	201	251	36
2010	1342	Percent	32.3%	32.0%	14.8%	20.9%	
		Number	425	421	194	274	28
Perennial Results		Percent	34.6%	39.7%	8.7%	17.0%	
		Number	195	224	49	96	778

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Appendix (continued)
MQA Results for Reading and Numeracy Achievement: 2008-2010

Table A-3 | **MQA Results for Grade Seven Reading and Numeracy Achievement: 2008-2010**

Grade Seven Numeracy							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	371	Percent	35.0%	26.1%	17.0%	21.8%	
		Number	130	97	63	81	0
2009	371	Percent	32.9%	29.9%	14.0%	23.2%	
		Number	122	111	52	86	0
2010	371	Percent	31.8%	32.3%	12.9%	22.9%	
		Number	118	120	48	85	0
Perennial Results		Percent	35.9%	28.7%	9.9%	25.4%	
		Number	65	52	18	46	190
Grade Seven Reading							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	371	Percent	35.6%	25.6%	16.2%	22.6%	
		Number	132	95	60	84	0
2009	371	Percent	32.3%	30.5%	13.5%	23.7%	
		Number	120	113	50	88	0
2010	371	Percent	33.4%	30.7%	12.9%	22.9%	
		Number	124	114	48	85	0
Perennial Results		Percent	38.1%	28.0%	10.1%	23.8%	
		Number	72	53	19	45	182

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.

Appendix (continued)
MQA Results for Reading and Numeracy Achievement: 2008-2010

Table A-4 | **MQA Results for Grade Nine Reading and Numeracy Achievement: 2008-2010**

Grade Nine Numeracy							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	371	Percent	33.7%	27.5%	17.3%	21.6%	
		Number	125	102	64	80	0
2009	371	Percent	31.3%	31.5%	13.7%	23.5%	
		Number	116	117	51	87	0
2010	371	Percent	34.2%	29.9%	13.7%	22.1%	
		Number	127	111	51	82	0
Perennial Results		Percent	36.0%	30.7%	10.6%	22.8%	
		Number	68	58	20	43	182
Grade Nine Reading							
Year	**N**	**Percent/ Number**	**Ineffective Schools**	**Efficient Schools**	**Effective Schools**	**Inefficient Schools**	**Non-Labeled**
2008	371	Percent	33.2%	28.0%	18.3%	20.5%	
		Number	123	104	68	76	0
2009	371	Percent	31.5%	31.3%	13.7%	23.5%	
		Number	117	116	51	87	0
2010	371	Percent	37.2%	27.0%	12.7%	23.2%	
		Number	138	100	47	86	0
Perennial Results		Percent	34.6%	29.7%	12.1%	23.6%	
		Number	63	54	22	43	189

Note: These represent multi-examination average scores on the NAPLAN. The unit of analysis is the school. Results control for unalterable sociodemographic characteristics.