Productivity Change in New Zealand Secondary Schools

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Abstract

Purpose-The purpose of this research was to identify whether New Zealand Government policies over the period 1997-2001 helped secondary schools to improve their productivity performance.
Design/methodology/approach- The theoretical framework for this research involved the design of a Malmquist productivity index using panel data gathered on 333 New Zealand Secondary schools for the period under investigation.
Research limitations/implications- The results have implications for future government education policies. The paper has shown that current policies are not working satisfactorily in improving secondary schools’ productivity and, therefore, need revision. The managers of the schools also need to rethink and revise their current policies. Schools could possibly benefit from studying the management practices of their ‘best-practice’ peers, which have been identified by the present research. Future research may try to identify factors that are responsible for variations in total factor productivity and its two components across secondary schools.
Findings- The key finding of this paper is that the schools as a whole experienced a decline in their total factor productivity at an annual rate of about 1% during the study period due to technical regression. Individual schools were found to have performed differently from one another in terms of productivity change. Some 34 per cent of the schools improved their total factor productivity at a rate of 4.6 per cent per annum during this period while others suffered deterioration in the same. Secondary schools at the lower end of the efficiency distribution improved their efficiency from 60.8 per cent to 71 per cent.

Keywords: New Zealand, secondary schools, productivity change, Malmquist productivity index, technical efficiency
Introduction

One of the objectives of this paper is to analyse the productive performance of individual New Zealand (NZ) secondary schools over time. One way of approaching this problem is to look at how their productivity has changed over time. Schools use many inputs in producing many outputs. As a result, productivity measurement becomes complicated. In situations like this, many researchers have used partial productivity measures to assess economic performance. Labour productivity, for example, measures productivity of a production unit as the ratio of output to the number of workers (or the number of labour hours) used. Land productivity is another example. These measures are of limited value as they do not look at the total factor productivity (TFP) of a decision making unit producing multiple outputs using multiple inputs. In this paper, we examine the inter-temporal economic performance of NZ secondary schools using a measure of TFP of a school. The TFP of a school is the ratio of some aggregate of its outputs to some aggregate of its inputs.

Information about changes in productivities of the schools is valuable not only to the Government of New Zealand but also to the parents and guardians of pupils and school managers. It is valuable to the Government as it can identify economically non-performing schools and provide them with assistance or take some other measures to improve their performance, such as merging schools, or closing schools down. Parents and guardians can use the information to select the best school for their children while school managers can use it to determine whether their efforts and policies are paying dividends in terms of improved productivity.

The Government of New Zealand is trying to improve the performance of the secondary schools through various policy measures. For example, the Government introduced a range of reforms, known as “Tomorrow’s Schools”, in 1989 (Ministry of Education 2010). These reforms now provide the basis for the current system of funding for schools in which funding for schools is disbursed from the centre to a school’s Board of Trustees (Fiske & Ladd 2000). The Board of Trustees elected by parents and guardians of pupils then has the responsibility for using the allocated funds in the best possible way. Before 1989, secondary schools had to report to Boards of Governors (Ministry of Education 2010). The Government of New Zealand also pursued a programme of “Network Reviews” to improve the efficiency of resource use in New Zealand secondary schools until 2004 (Ministry of Education 2008, p. 21). The programme involved constant appraisal of schools in terms of how they are using their resources and if necessary recommended changes in the form of school closures or mergers.

The Government regularly monitors the performance of secondary schools through two agencies: the Education Review Office (ERO) and the New Zealand Qualifications Authority (NZQA). Officials from the ERO visit schools on a three- or four-yearly cycle and write publicly available reports on its findings as regards the quality of processes and educational outcomes in a school (Education Review Office 2010). The NZQA compiles and publishes statistics on each school’s performance in national examinations (New Zealand Qualifications Authority 2010).

It is very important for the Government to know how efficiently schools are using their funds and other resources to achieve academic outcomes for their pupils. Alexander, Haug and Jaforullah (2010) examined the technical efficiency of New Zealand secondary schools. That is, they examined the extent to which individual schools are efficient in using their inputs (funds and other resources) in achieving their outputs (academic achievements for pupils). Using data on 324 schools for the year 2001, they found that the average technical efficiency of New Zealand secondary schools was 86 per cent. From the Farrell (1957) definition of technical efficiency it follows that the schools could have achieved the
same outputs in that year with 14 per cent (100 – 86 = 14) less inputs. Technical efficiencies of individual secondary schools were found to vary between 32% and 100%. Alexander and Jaforullah (2006) using the same data set decomposed technical efficiency into pure technical efficiency and scale efficiency. The average pure technical efficiency and scale efficiency of New Zealand secondary schools were found to be 91 per cent and 95 per cent respectively. It was found that 55 per cent of the schools in the sample operated at the sub-optimal scale, 10 per cent operated at the supra-optimal scale and 35 per cent operated at the optimal scale.

Alexander, Haug and Jaforullah (2010) and Alexander and Jaforullah (2006) could not examine how schools’ productivity changed over time as they used cross-section data. The present paper attempts to fill that information gap utilising a panel dataset obtained from the NZ Ministry of Education. Schools can improve their TFP by either improving their efficiency with no change in the production technology (the catch-up effect or efficiency change) or adopting a better technology (the innovation effect or technical change) or both. The second objective of this paper is to decompose the TFP change into components reflecting the catch-up effect and the innovation effect.

The New Zealand Secondary School System

In New Zealand, pupils complete 13 years of schooling, of which the last 5 years are in a secondary school, before entering a university (or a polytechnic). Before 2002, students attending secondary schools gained three academic qualifications: School Certificate (SC), Sixth Form Certificate (SFC) and University Bursary (UB). They gained SC, SFC and UB in their school years 11, 12 and 13 (Alexander, Haug & Jaforullah 2010). Performance of a student in SC and UB was determined through national examinations while in SFC it was determined through internal assessments done by his/her secondary school. Starting in 2002, a new system of academic qualifications has gradually replaced the above mentioned old system. It also consists of three qualifications replacing respectively SC, SFC and UB: National Certificate in Educational Achievement (NCEA) Level 1, Level 2 and Level 3. The phasing in of the new system was completed in 2004 (New Zealand Qualifications Authority 2010).

New Zealand Secondary Schools can be classified into different types according to their characteristics such as: (a) ownership of a school, (b) gender of pupils taught by a school and (c) location of a school. Based on ownership, secondary schools can be classified into three groups: (a) State, (b) Integrated and (c) Private. State schools are completely owned and operated by the New Zealand Government. Integrated schools were initially private schools owned and operated by non-government organisations, but later chose to be integrated into the State Schooling system under the Private Schools Conditional Integration Act 1975. This Act allows private schools to be integrated into the State system while permitting them to keep their special character which usually relates to some religious or philosophical beliefs. Integrated schools must follow state-prescribed curriculum requirements. School buildings and land used by an Integrated school remain the property of the private owners and costs of property maintenance and development are, therefore, their responsibility. All other operational expenses, including teacher salaries, are met by the Government at the same level of funding per pupil as provided to State schools (Alexander, Haug & Jaforullah 2010). The third and final type of school ownership is private or Independent. These are the few schools that have not taken the opportunity to integrate into the State system. Independent schools are not included in our analysis due to lack of data. However, State and Integrated schools cover about 93% of secondary school enrolments (Minister of Education 2003, Table A11).
Based on gender, schools can also be classified into three types: (a) boys’ schools, (b) girls’ schools and (c) co-ed schools. In many population centres relatively old established secondary schools cater for only boys or only girls. Typically, such schools exist in pairs, one for girls and the other for boys. Relatively new secondary schools are co-educational. It seems important to distinguish among schools on the basis of the gender of pupils. There is considerable evidence that suggests that whether children are in a single-sex or a co-educational environment may affect academic outcomes. Fergusson and Horwood (1997) have found in the New Zealand context that girls do better than boys academically at all levels of schooling, whether measured by standardised tests or teacher ratings or qualifications on leaving school. There is also evidence suggesting that students attending single-sex schools tend to outperform their peers in co-educational schools (see Woodward, Fergusson & Horwood 1999). The analysis of technical efficiency of New Zealand secondary schools by Alexander, Haug and Jaforullah (2010, p. 107) provides further support to this point.

Based on location, New Zealand secondary schools can also be classified into four categories: (a) main urban, (b) secondary urban, (c) minor urban and (d) rural. A main urban area in New Zealand is defined as having a population of over 30,000, while a minor urban area is defined as having a population between 1,000 and 9,999. A secondary urban area has a population between 10,000 and 30,000 and a rural area has a population less than 1,000. New Zealand has a population of slightly more than 4 million.

Measurement of Productivity Change

Economists use productivity change as a measure to determine whether the economic performance of a production unit has improved over time (see Färe et al. 1994b; Kasman & Turgutlu 2009; Kim & Park 2006; Kong & Tongzon 2006). A secondary school can be considered to have improved its productive performance if its total factor productivity changes positively over time. A school may be able to improve its productivity in two ways. Firstly, without changing the present production technology it may reduce its production inefficiency, that is, move towards the existing production frontier. Secondly, it may move towards a higher frontier by changing the production technology.

A number of techniques exist to measure the productivity change of a production unit. A discussion of these can be found in Coelli et al. (2005). One of these techniques is the Malmquist Productivity Index and we use it here as it allows us to decompose TFP change into its two components: efficiency change and technical change. While Caves, Christensen and Diewert (1982) developed the Malmquist productivity index (MPI) in terms of distance functions, Färe et al. (1994a) decomposed it into an efficiency change index and a technical change index. Färe et al. (1994a) showed that the MPI is the product of the efficiency change index and the technical change index:

$$M_{jt} = E_{jt} T_{jt}$$

(1)

where $y^{t-1}$ and $y^t$ refer to vectors of outputs of school j from period t-1 and period t respectively, $x^{t-1}$ and $x^t$ refer to vectors of inputs of the school from period t-1 and period t respectively, $M_{jt}$ is the MPI of school j in period t, $E_{jt}$ is the efficiency change index of the school and $T_{jt}$ is the technical change index of the school. Both $E_{jt}$ and $T_{jt}$ are a ratio of two distance functions.¹ These are defined below:

¹ For a discussion on distance functions see Deaton (1979), Deaton and Muellbauer (1980), Debreu (1951) and Malmquist (1953).
where \( D^t(y^t, x^t) \) refers to an input distance function representing technology from period \( t \), whose arguments are inputs and outputs from the same period, \( D^{t-1}(y^{t-1}, x^{t-1}) \) has the same definition as the former but relates to time period \( t-1 \), and \( D^{t-1}(y^t, x^t) \) refers to an input distance function representing technology from period \( t-1 \), whose arguments are inputs and outputs from the following period, \( t \). The way the values of these distance functions are computed is discussed below. Note that if the value of \( M_j \) is greater than one, then there has been a positive total factor productivity change for school \( j \) between periods \( t-1 \) and \( t \). Similar interpretations hold for \( E_j \) and \( T_j \).

Färe et al. (1994a) have shown that the method of Data Envelopment Analysis (DEA) developed by Charnes, Cooper and Rhodes (1978) can be used to calculate the values of the input distance functions appearing in equations (2) and (3). The constant returns to scale input-oriented efficiency of a school as computed by DEA is the reciprocal of an input distance function.

To define the various input distance functions rigorously, let us assume that there are \( N \) secondary schools each producing \( M \) outputs using \( P \) inputs. Let \( Y^t \) be an \((M \times N)\) matrix of outputs of all secondary schools in year \( t \) where \( y_{ij} \) is the quantity of the \( i \)th output produced by the \( j \)th school. Assume \( X^t \) to be a \((P \times N)\) matrix of inputs of all secondary schools in year \( t \) where \( x_{kj} \) is the quantity of the \( k \)th input used by the \( j \)th school to produce its outputs. Let \( y_{j}^t \) be an \((M \times 1)\) vector of outputs and \( x_{j}^t \) be a \((P \times 1)\) vector of inputs of the \( j \)th school in year \( t \). Also assume that \( z^t \) is an \((N \times 1)\) vector of weights whose values are to be determined. The values of the input distance functions can be obtained by solving the following four linear programming (LP) problems for each of the \( N \) schools.

\[
\begin{align*}
(D^{t-1}(y^{t-1}, x^{t-1}))^{-1} &= \min / \\
\text{s.t.} & \quad y_{j}^{t-1} \in Y^{t-1} z^{t-1} \\
& \quad x^{t-1} z^{t-1} \in x_{j}^{t-1} \\
& \quad z^{t-1} \geq \mathbf{0} \quad (4)
\end{align*}
\]

\[
\begin{align*}
(D^t(y^t, x^t))^{-1} &= \min / \\
\text{s.t.} & \quad y_{j}^t \in Y^t z^t \\
& \quad x^t z^t \in x_{j}^t \\
& \quad z^t \geq \mathbf{0} \quad (5)
\end{align*}
\]
Note that the minimised value of $l$ is likely to be different in the four LP problems of an individual school j. In LP problem (4), it measures the efficiency of school j in period t-1 relative to the production frontier or technology in that year; in LP problem (5) it measures the efficiency of the school in year t relative to the production frontier in that year; in LP problem (6) it measures the efficiency of the school in year t relative to the production frontier in year t-1; and in LP problem (7) it measures the efficiency of the school in year t-1 relative to the production frontier in year t. $l$ is a scalar that represents proportional reduction in all inputs holding output levels constant. The minimised value of $l$ lies between zero and one. The value of $l$ measures the technical efficiency of a school. If the value of $l$ is unity for a school, the school is on the production frontier and, therefore, 100 per cent efficient (or fully efficient). A school that is on the production frontier is also known as a ‘best-practice’ school. If the value of $l$ is, say, 0.6, the school is 60 per cent efficient. It can reduce its input quantities by 40 per cent ($1 – 0.6 = 0.4$) in producing its outputs.

**Data**

Although a secondary school plays important roles in many areas of the lives of its pupils such as character formation, social-skill development, etc., its paramount role is to produce academically qualified pupils. It uses inputs such as teachers and learning resources to produce outputs such as academic achievements for its students. Secondary schools vary in efficiency in using the inputs to produce outputs. Over time, some schools improve their productive performance by either increasing their efficiency or adopting innovative methods of teaching or both while others have their productive performance unchanged or deteriorated. The objectives of the present paper are to measure productivity changes of individual New Zealand secondary schools over time and to decompose them into their components. To achieve these objectives, we have used a panel dataset for the period of 1997-2001. Data on 333 secondary schools were obtained from the New Zealand Ministry of Education.

In solving the mathematical programming models, we have used three output variables, seven input variables and two environmental variables. These variables will now be described.

A secondary school produces three academic qualifications for its pupils in their last three years in school. Since our data relate to the pre-2002 period when the older system of qualifications was in place, we have assumed that a secondary school produces three outputs of qualifications: SC, SFC and UB. The output of SC of a school has been measured as the sum of all marks gained by its pupils in all papers sat (SCMKS). The output of SFC has been measured as the number of year 12 students gaining this qualification. The output of UB has been measured as the number of students gaining four Cs or better in UB.
examinations. Note that students scoring 300 marks or more in five subjects in UB examinations were awarded an “A” Bursary, those scoring between 250 and 299 marks a “B” Bursary and those scoring at least four C grades were deemed to be qualified to matriculate at a New Zealand University; that is, they qualified for university entrance, although some universities required a higher standard for admission to some courses.

Secondary schools use teachers, pupils and other resources to produce the above outputs. These major categories of inputs have been captured by seven input variables. These are the number of pupils in year 13 (YR13ROLL), the number of pupils in year 12 (YR12ROLL), the number of pupils in year 11 (YR11ROLL), the number of pupils in other years (OTHERS), teacher salaries (TCHSAL), administrative expenses (ADMIN) and expenditures on learning resources (LRES). The last three variables are measured in New Zealand dollars.

Two environmental variables have also been included in the models. One of the variables captures the isolation of a secondary school from main population centres. It can easily be argued that the isolation of a school will affect its efficiency in converting inputs into outputs. For example, a rural school may find it harder than an urban school to hire academically qualified teachers. To account for the fact that variation in the degree of isolation across schools may affect their productive performance, an isolation index variable (ISOLATN) has been included in the models. The New Zealand Ministry of Education constructs this index for each school on the basis of a school’s distances from the population centres of (a) 5,000 (b) 20,000 and (c) 100,000 people. The higher the value of this index, the more isolated is the school.

There is evidence that the socio-economic status of the community catered for by a school affects its efficiency (see Alexander, Haug and Jaforullah (2010)). This may be because there is a strong positive correlation between quality of students taught by a school and the socio-economic status of the community. A socio-economic status indicator (SES) is computed by the Ministry of Education based on information on a number of dimensions, including the proportion of households in the school’s catchment area in the bottom 20% of an equivalised income scale, the proportion of parents with no qualifications, the proportion of parents in elementary occupations and the proportion of parents receiving a welfare benefit, as well as measures of household crowding and the proportion of students from disadvantaged ethnic minorities. This indicator runs from 0 to 599 with 599 indicating a school with the highest proportion of poor students. This indicator has been included in the models as the second environmental variable (i.e. SES).

In solving the models, the environmental variables, ISOLATN and SES, have been included in the group of outputs rather than inputs, that is, they have been treated as non-discretionary output variables, which are outside the control of a school management. According to Coelli et al. (2005, pp. 192-193), environmental variables that have negative effects on efficiency should be treated as non-discretionary output variables and environmental variables that have positive effects on efficiency should be treated as non-discretionary input variables. Alexander, Haug and Jaforullah (2010) have found in their analysis of NZ secondary schools that SES has negative effects on a school’s efficiency, that is, the higher the value of SES, the lower is the efficiency of a school. The ISOLATN variable is also expected to have negative effects on efficiency. The larger the value of ISOLATN, the more isolated a school is and this may put a school in a disadvantageous position as it may find it hard to attract good highly qualified teachers.

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2 An equivalised income scale is one which makes adjustments for household size and composition when comparing incomes.
Summary statistics on the input, output and environmental variables are presented in Table 1. The values of the variables vary across schools and they also vary over time except the ISOLTN variable. Since the data set is a panel data set, locations of the schools remain unchanged over time giving rise to the ISOLTN variable having a constant mean value over time. It seems socio-economic status of the school communities changed over the time period under study which is plausible.

**Table 1**

Mean and standard deviation (s.d.) of the variables used in this study.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UB</td>
<td>32.44</td>
<td>33.04</td>
<td>32.55</td>
<td>32.24</td>
<td>30.94</td>
</tr>
<tr>
<td>s.d.</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>SCMKS</td>
<td>33,964.76</td>
<td>34,292.51</td>
<td>33,106.54</td>
<td>33,164.36</td>
<td>32,537.26</td>
</tr>
<tr>
<td>s.d.</td>
<td>1.01</td>
<td>1.01</td>
<td>1.01</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>SFC</td>
<td>72.98</td>
<td>75.87</td>
<td>78.12</td>
<td>80.37</td>
<td>78.52</td>
</tr>
<tr>
<td>s.d.</td>
<td>296.53</td>
<td>293.25</td>
<td>293.39</td>
<td>293.62</td>
<td>293.69</td>
</tr>
<tr>
<td>Environmental variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISOLTN</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
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<tr>
<td>s.d.</td>
<td>123.84</td>
<td>124.05</td>
<td>124.09</td>
<td>123.87</td>
<td>123.88</td>
</tr>
<tr>
<td>SES</td>
<td>296.53</td>
<td>293.25</td>
<td>293.39</td>
<td>293.62</td>
<td>293.69</td>
</tr>
<tr>
<td>s.d.</td>
<td>2,394,475</td>
<td>2,440,065</td>
<td>2,570,659</td>
<td>2,653,110</td>
<td>2,617,898</td>
</tr>
<tr>
<td>s.d.</td>
<td>1,219,267</td>
<td>1,271,832</td>
<td>1,358,857</td>
<td>1,424,736</td>
<td>1,414,907</td>
</tr>
<tr>
<td>TCHSAL ($)</td>
<td>81.56</td>
<td>86.11</td>
<td>88.50</td>
<td>86.47</td>
<td>84.29</td>
</tr>
<tr>
<td>s.d.</td>
<td>64.70</td>
<td>68.69</td>
<td>71.28</td>
<td>72.59</td>
<td>74.03</td>
</tr>
<tr>
<td>YR13ROLL</td>
<td>118.19</td>
<td>121.20</td>
<td>121.54</td>
<td>119.07</td>
<td>117.45</td>
</tr>
<tr>
<td>s.d.</td>
<td>85.53</td>
<td>91.93</td>
<td>98.68</td>
<td>94.84</td>
<td>96.89</td>
</tr>
<tr>
<td>YR12ROLL</td>
<td>140.59</td>
<td>140.41</td>
<td>139.53</td>
<td>139.35</td>
<td>139.92</td>
</tr>
<tr>
<td>s.d.</td>
<td>98.93</td>
<td>97.79</td>
<td>99.45</td>
<td>101.41</td>
<td>103.40</td>
</tr>
<tr>
<td>OTHERS</td>
<td>341.44</td>
<td>343.52</td>
<td>346.66</td>
<td>350.44</td>
<td>359.34</td>
</tr>
<tr>
<td>s.d.</td>
<td>177.39</td>
<td>179.00</td>
<td>187.71</td>
<td>194.16</td>
<td>204.95</td>
</tr>
<tr>
<td>ADMIN ($)</td>
<td>236,736</td>
<td>241,645</td>
<td>257,508</td>
<td>273,119</td>
<td>303,175</td>
</tr>
<tr>
<td>s.d.</td>
<td>178,913</td>
<td>152,812</td>
<td>157,882</td>
<td>186,215</td>
<td>261,546</td>
</tr>
<tr>
<td>LRES ($)</td>
<td>2,580,385</td>
<td>2,644,439</td>
<td>2,822,209</td>
<td>2,949,011</td>
<td>2,993,963</td>
</tr>
<tr>
<td>s.d.</td>
<td>1,332,963</td>
<td>1,401,162</td>
<td>1,506,105</td>
<td>1,600,459</td>
<td>1,685,327</td>
</tr>
</tbody>
</table>

**Empirical Results**

The four linear programming problems (4)-(7) have been solved for each secondary school in the sample of 333 schools to estimate their total factor productivity change and its two components — efficiency change and technical change. The models have been solved by using the computer software DEAP Version 2.1 developed by Coelli (1996). Since the detailed results are too extensive to report in full, only the main summary results are discussed here.

Solutions to the models provide a measure of efficiency for each secondary school in the sample in each year of the period of 1997-2001. The efficiencies of individual schools in a particular year are computed with respect to the production frontier in that year. A summary of these efficiencies is provided in Table 2. It shows the mean efficiency of the 333 secondary schools in the sample in different years along with standard deviation, minimum efficiency, maximum efficiency, the percentage of schools that are fully efficient (or 100 per
cent efficient) and mean technical efficiency of the bottom 10 percent of schools with the lowest technical efficiency in 1997.

Table 2 shows that the average efficiency of the New Zealand secondary schools varied over time and so did the percentage of schools that were fully efficient. A close examination of the results relating to individual schools also reveals that the composition of the set of fully efficient schools also varied from year to year. The ranking of the schools in terms of technical efficiency also changed from year to year. Some insight into the extent to which schools’ rankings changed from year to year can be formed by computing the Spearman rank correlation coefficient between rankings of schools in two consecutive years. The last column of Table 2 reports the values of this coefficient for different pairs of consecutive years. The ranking of schools in terms of efficiency changed the most between 1997 and 1998. The mean efficiency, minimum technical efficiency and the percentage of fully efficient schools declined in 1998 from 1997. These figures are significantly higher over the period 1999-2001 than in 1998. Compared to the previous year, changes in efficiency are positive in 1999 and 2000 indicating that the secondary schools on average improved their efficiency in using their inputs in those years. Schools at the lower end of efficiency distribution seem to have improved their efficiency in those years compared to the previous year. The improvement in schools’ efficiency in resource use in 1999 and 2000 compared to the previous year is reflected in the efficiency change index having a value greater than one in those years (see Table 3). These positive efficiency changes boosted TFP of schools on average in those years while negative changes in technical change put downward pressure on it (see Table 3). Table 3 shows that, over the study period 1997-2001, NZ secondary schools on average experienced a slight deterioration in total factor productivity of about 1% per annum mainly because they experienced minor technical regression. However, it seems that they did not suffer any deterioration in their technical efficiency on average over this period.

### Table 2

Technical Efficiency (TE) in New Zealand Secondary Schools

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean TE</th>
<th>Standard deviation</th>
<th>Minimum TE</th>
<th>Maximum TE</th>
<th>Percentage of fully efficient schools</th>
<th>Mean TE of the bottom 10% of schools</th>
<th>Rank correlation between year t and year t-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.86</td>
<td>0.13</td>
<td>0.39</td>
<td>1.0</td>
<td>23.72</td>
<td>0.61</td>
<td>-</td>
</tr>
<tr>
<td>1998</td>
<td>0.83</td>
<td>0.12</td>
<td>0.36</td>
<td>1.0</td>
<td>15.92</td>
<td>0.68</td>
<td>0.66</td>
</tr>
<tr>
<td>1999</td>
<td>0.85</td>
<td>0.13</td>
<td>0.44</td>
<td>1.0</td>
<td>18.92</td>
<td>0.67</td>
<td>0.71</td>
</tr>
<tr>
<td>2000</td>
<td>0.87</td>
<td>0.12</td>
<td>0.49</td>
<td>1.0</td>
<td>22.22</td>
<td>0.73</td>
<td>0.72</td>
</tr>
<tr>
<td>2001</td>
<td>0.86</td>
<td>0.12</td>
<td>0.48</td>
<td>1.0</td>
<td>21.92</td>
<td>0.71</td>
<td>0.72</td>
</tr>
</tbody>
</table>

The solutions to the models also allow us to determine whether the TFP of the individual secondary schools changed over time or not and to identify the sources of any change. A careful examination of the detailed results for individual schools reveals that 113 out of 333 secondary schools experienced TFP improvement or at least did not suffer any deterioration in their productive performance on average during the study period of 1997-2001. On average, their total factor productivity increased at a rate of 4.6 per cent per year. The other 220 secondary schools suffered deterioration in their productive performance on average over the time period studied. Some schools improved their productivity in some years only to experience deterioration in other years.
Table 3
Annual average efficiency, technical and TFP changes of all schools combined compared to the immediate past year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Efficiency change</th>
<th>Technical change</th>
<th>TFP change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1998</td>
<td>0.971</td>
<td>1.018</td>
<td>0.989</td>
</tr>
<tr>
<td>1999</td>
<td>1.022</td>
<td>0.981</td>
<td>1.003</td>
</tr>
<tr>
<td>2000</td>
<td>1.020</td>
<td>0.960</td>
<td>0.979</td>
</tr>
<tr>
<td>2001</td>
<td>0.985</td>
<td>1.007</td>
<td>0.993</td>
</tr>
<tr>
<td>Mean over all years</td>
<td>0.999</td>
<td>0.991</td>
<td>0.991</td>
</tr>
</tbody>
</table>

Of the 113 schools that improved or did not suffer deterioration in productivity on average, 47 experienced positive changes in both efficiency and technology, 59 experienced positive change in efficiency but suffered technical regression and 7 experienced negative change in efficiency but positive change in technology. If we classify these schools into State and Integrated, we find that 86% of these schools are State schools and 14% are Integrated schools. Considering the fact that 81% of the schools in the sample are State schools and the rest are Integrated, we may conclude that State schools have done better in improving TFP than Integrated schools. If these 113 schools are classified according to the gender of pupils in a school, we find that 7% of them are boys’ schools, 8% are girls’ schools and 85% are co-educational. The sample used consists of schools of which 12% are boys’, 15% are girls’ and 73% are co-educational schools. Therefore, co-educational secondary schools were more successful on average in improving TFP than single-sex schools over the period of 1997-2001.

Of the 220 secondary schools that suffered decline in TFP on average over the period of 1997-2001, 117 schools suffered negative changes in both efficiency and technology, 82 schools experienced negative changes in technology but experienced positive changes in efficiency or prevented their efficiency from deterioration and 21 schools maintained their technology or improved it but suffered negative changes in efficiency.

When changes in TFP of individual schools were averaged over all secondary schools in the sample and all the years of the sample period of 1997-2001, it was found that the TFP of the secondary schools in New Zealand as a whole declined by about 1% per annum over the years from 1997-2001.

Conclusion

Attempts have been made in this study to examine how the productivity of individual New Zealand secondary schools has changed over time. This information is likely to be useful to the Government, school managers and parents and guardians of pupils. A panel data set was obtained from the New Zealand Ministry of Education on 333 secondary schools covering the time period of 1997-2001. Malmquist productivity index (discussed earlier in details) was estimated and decomposed into its two components, an efficiency change index and a technical change index, for each of the schools in the sample. An analysis of the results for individual secondary schools suggests that only 113 out of the 333 schools in the sample improved or maintained their TFP during this time. The others suffered deterioration in their TFP.

From the viewpoint of the secondary school sector as a whole, efficiency change has been positive only in two years, 1999 and 2000, and technical change has also been positive in only two years, 1998 and 2001. TFP change has been positive in only one year, 1999. The overall outcome over all schools and all years has been a decline in TFP of about 1% per annum.
The results discussed above suggest that the policies of the New Zealand Government pursued over the period 1997-2001 under “Tomorrow’s Schools” have had mixed effects on the productive performance of secondary schools. It seems that the policies had favourable effects on the technical efficiency of the schools that were in the bottom 10 percent of the sampled schools in 1997 in terms of technical efficiency. This may have happened because the problems with these schools were picked up by ERO soon enough and they were required to address them. It is also found that 113 out 333 secondary schools (or 34 percent of the schools) improved their TFP at an annual rate of 4.6 percent during the time period. Overall, however, the policies did not work well. From the viewpoint of all schools together, TFP declined by about one percent per annum over this time period.

This study identifies the schools which need to be targeted by the Government’s efforts to improve schools’ productivity. The managers of these schools also need to rethink and revise their current policies. These schools could possibly benefit from studying the management practices of their peers, which are also identified by the present study.

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Reference List


