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Shifting the Bell Curve: The Benefits and Costs of Raising Student Achievement

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1. Introduction

In this paper, I estimate the benefits and costs of nationwide implementation of a promising intervention for raising student achievement. I use standard benefit–cost techniques to estimate the increase in earnings, increased tax revenues, value of less crime, and reductions in welfare costs attributable to nationwide implementation of rapid assessment, a promising intervention for raising student achievement in math and reading. Results suggest that social benefits would exceed total social costs by a ratio of 28, fiscal benefits to the federal government would exceed costs to the federal treasury by a ratio of 93. Social benefits would exceed costs to each state treasury by a ratio no lower than 286, and fiscal benefits would exceed costs to each state treasury by a ratio no lower than 5, for all but two state treasuries. Sensitivity analyses suggest that the findings are robust to a 5-fold change in the underlying parameters.

1.1. Effects on educational attainment and earnings

While it is well-established that basic skills in math and reading predict educational attainment and earnings (Currie & Thomas, 2001; Murnane, Willet, & Levy, 1995; Neal & Johnson, 1996; O’Neill, 1990; Winship & Korenman, 1999), only one analysis has accounted for the reciprocal effects of cognitive skills and schooling (Winship & Korenman, 1999). Using data from the National Longitudinal Survey of Youth (NLSY), involving a national sample of 12,686 individuals, Winship and Korenman (1999) found that a 1.5 S.D. difference in basic math and reading skills is ultimately associated with a 1.945 year difference in educational attainment and a 53.7% difference in annual earnings, controlling for a host of covariates including ability.

Thus, a growing body of research indicates that strong preparation in math and reading, captured by math and reading test scores, can overcome socioeconomic disadvantages and “... is the major determinant of differences in educational attainment” between advantaged and disadvantaged young people (Bowen, Kurzweil, & Tobin, 2005, p. 224). This conclusion is not altered even after considering the affordability of college. There is no evidence that students are being forced to enroll in inexpensive colleges that are inappropriate for their level of preparedness (Bowen, 2000). Instead, students from high and medium-high income families who have low SAT scores and high school grades are being replaced by highly prepared students from low income families (Hoxby, 2000). Less than 8% of all students are prevented from enrolling by their inability to pay (Avery & Hoxby, 2004; Carneiro & Heckman, 2003) and federal Pell grants have no significant impact on enrollment (Kane, 1999), leading Bowen et al. (2005) to conclude that “family finances have a fairly minor direct impact on a student’s ability to attend a college” (p. 91). Math and verbal SAT scores “are much more important factors in the college [application] process than financial variables such as family income” (Spies, 2001, p. 17).
Furthermore, once students from disadvantaged socioeconomic backgrounds enroll, they do not underperform their more advantaged counterparts (controlling for SAT scores), suggesting that expansion of the college population to include a greater proportion of disadvantaged students would not depress the earnings of college graduates, as long as this expansion is the result of improved academic preparation—as envisioned by the proposed intervention: “When we [regress rank-in-class on SAT scores], we find that (perhaps as expected) SAT scores explain much of the variation in rank-in-class” (Bowen et al., 2005, p. 118). The significance of academic preparation, as measured by SAT scores, extends to graduation rates: When SAT scores are controlled, there is only a 4.7 percentage point difference in graduation rates between students in the top and bottom income quartiles (Bowen et al., 2005). Furthermore, after controlling for SAT scores, there is no difference between advantaged and disadvantaged students in their rates of attainment of lucrative law and business degrees (Bowen et al., 2005). In summary, these findings suggest not only that student achievement in reading and math is highly predictive of future educational attainment and earnings, but interventions that target reading and math achievement are promising ways to improve educational attainment and earnings.

2. Rapid assessment

The difficulty is identifying an effective way to raise student achievement. However, a promising approach involves the implementation of systems where student performance in math and reading is rapidly assessed 2–5 times per week. The concept of rapid assessment is embodied by Reading Assessment,2 a popular program designed to encourage students to read books at appropriate levels of difficulty while alerting teachers to learning difficulties and encouraging teachers to provide individualized tutoring or small group instruction. This is achieved through a system of frequently assessing each student’s reading comprehension and monitoring each student’s reading level. First, books in the school’s library are labeled and shelved according to reading level. Second, students select books to read based on their interests and their reading levels, according to the results of the STAR Reading test, a norm-referenced computer-adaptive test (Renaissance Learning, no date). This helps students to avoid the frustrating experience of choosing a book that is too difficult. After finishing a book, the student takes a computer-based quiz, unique to the book, that is intended to monitor basic reading comprehension (Rapid Assessment Corporation has created more than 100,000 quizzes). Similarly, Math Assessment is a popular program that provides individualized, printed sets of math problems, a system of assessing student performance on those problems, and a scoring system where students and teachers receive rapid, frequent feedback on student performance upon completion of every set of problems.

A detailed review of research regarding the effectiveness of rapid formative assessment is available elsewhere (Yeh, 2007). To summarize, two large randomized experiments, involving a total of 2643 students, evaluated the effectiveness of the Reading Assessment program over 9-month periods (Nunnery, Ross, & McDonald, 2006; Ross et al., 2004). The average effect size was 0.279 S.D., suggesting that a 1.5 S.D. improvement in student achievement might be obtained over a period of 5 years.

3. Costs of rapid assessment

A detailed cost analysis of Reading Assessment and Math Assessment, two widely implemented variants of rapid assessment whose characteristics match the characteristics of effective feedback systems, is available elsewhere (Yeh, 2007). Large fixed costs of $22,809.60 incurred by every building of 500 students at startup, including costs of software, teacher and administrator training, and scanners, were amortized over the life of the program, assumed to be 7 years. Ongoing costs include fees that provide access to 100,000 book quizzes for every student, plus access to Math Assessment grade level libraries tagged to state standards for grades 1 through 7, as well as multiple subject area libraries for the secondary grades (pre-algebra, algebra 1, algebra 2, geometry, probability and statistics, pre-calculus, calculus, basic math, chemistry, and physics). The annual cost in 2006 dollars, including both fixed and ongoing costs, averaged $22.27 per student, or $28.31 per student adjusted for the opportunity costs of teacher training time and opportunity costs created by large upfront fixed costs.3

The effect size for rapid assessment (0.319 S.D. per year) suggests that improving student achievement by 1.5 S.D. for every American student could be achieved by implementing rapid assessment in grades 1 through 5. However, it is likely that the effects of a 5-year intervention would fade over time without booster shots every year. Furthermore, student mobility, the influx of English language learners, and the need to close achievement gaps by the No Child Left Behind deadline of 2014 create a need for ongoing intervention to bring all students up to grade level. Implementing the intervention in grades 1 through 12 would serve to maintain gains by students in grades 1 through 5, accommodate the needs of immigrants and English language learners, and boost the achievement of students who have already advanced beyond grade 5. Thus, it would be desirable to implement the intervention throughout grades 1–8 for all students, and through high school for the bottom 40% of all students. Therefore, the expected annual cost per student is $28.31, incurred from ages 6 through 13, and $11.32 incurred from ages 14 through 17, or a total of $226.19 after discounting at a rate of 3.5% to age 6, when the intervention begins.

3.1. Extra college costs

For the majority of students who receive the proposed intervention, a 1.945 increase in years of schooling associated with a 1.5 S.D. increase in AFQT test scores creates costs to society of 1.945 years of college plus foregone wages. Weighted by the proportion of students enrolled in degree-granting public, private

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3 Cost figures reflect the actual operating experience of schools in a typical district, verified by the researcher through classroom observation of operating procedures as well as teacher and administrator interviews in 8 schools (spanning elementary, middle, and high school levels). While a school of 500 students taking 2–5 assessments per week in math and reading suggests that 2000–5000 assessments are processed weekly, the burden on teachers is minimal because students scan their own bubble sheets, the software scores each assessment, and summary reports are available to teachers and administrators electronically.

2 This section is adapted from a paper (Yeh, 2007) comparing the effects of rapid assessment with the effects of increased educational expenditure, vouchers, charter schools, and increased educational accountability.

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nonprofit, and private for profit institutions (National Center for Education Statistics, 2007a), the annual expenditure is $27,036 per full-time equivalent student (National Center for Education Statistics, 2007b, 2007f, 2007g), adjusted for inflation. Lost wages for individuals whose attainment is "some college" equal $28,383 per year, adjusted for inflation (Day & Newburger, 2002). The total cost is $107,790 for 1,945 years, incurred at ages 19 and 20.

However, in the absence of the intervention, 9.3% of all students would have dropped out and would not have obtained a high school diploma or a general educational development (GED) certificate within 8 years of their on-time high school graduation date (Mishel & Roy, 2006). Current Population Survey data suggest that the employment-to-population ratio among 16- and 17-year-old high school dropouts ranges from 30.3% to 35.2% (Herman, 2000), suggesting that the average dropout endures a lengthy period during which he or she is not working before finding a job (which in many cases is only part-time). Thus, a conservative estimate is that dropouts average a 1-year period where they are not working before obtaining full-time employment. An intervention resulting in a 1.945 year increase in schooling might therefore incur costs of one year of college plus one year of lost wages ($19,045) for individuals whose attainment is "not high school graduate" (Day & Newburger, 2002), equal to a total of $46,081, incurred at age 18.

The probability-weighted average across all individuals receiving the intervention is an annual cost of $4286 at age 18, $48,883 at age 19, and $48,883 at age 20, or a total of $62,117 after discounting at a rate of 3.5% to age 6, when the intervention begins. The costs are shared among private individuals, the federal government, and state governments.

Public degree granting institutions derive 13.7% of revenues from federal funds and 27.3% from state funds (National Center for Education Statistics, 2007c). The comparable figures for private not-for-profit institutions are 13.7% federal and 1.1% state funds, and for private for-profit institutions, 4.4% federal and 0.7% state funds (National Center for Education Statistics, 2007d, 2007e). Thus, at age 18, the expected value of the federal share of college costs is $337.83 and the state share is $470.71, weighted by the 0.093 probability of incurring the cost (that is, the probability that in the absence of the intervention an individual would have dropped out of high school instead of attending college) and weighted by the proportions of students enrolled in degree-granting public, private nonprofit, and private for profit institutions (National Center for Education Statistics, 2007a, 2007c, 2007d, 2007e). At ages 19 and 20, the expected value of the federal share of college costs is $3204.17 and the state share is $4464.45, weighted by the 0.907 probability of incurring the cost (that is, the probability that in the absence of the intervention an individual would have graduated from high school and begun working full-time, either immediately or after completing some college or a college degree, instead of completing an additional 1.945 years of college or postsecondary schooling), and weighted by the proportions of students enrolled in degree-granting public, private nonprofit, and private for profit institutions (National Center for Education Statistics, 2007a, 2007c, 2007d, 2007e).

3.2. Benefits of the proposed intervention

The average American student completes 13.3 years of schooling (Organization for Economic Cooperation & Development, 2006), equal to 1.3 years of college. The proposed intervention would increase the average number of years of schooling by 1.945 and increase annual earnings by 53.7%. The total increase in earnings over a 44-year working career from ages 21 through 64 was calculated based on Census Bureau estimates of average annual earnings for individuals at each age whose educational attainment is "some college" (Day & Newburger, 2002). After accounting for historical gains in annual real wages of 2.5% (Sullivan, 1997) and discounting to age 6 using a 3.5% discount rate, the total equal to $769,297 per individual receiving the proposed intervention.

Income figures were adjusted using state-specific Keynesian multipliers to account for consumption-induced increases in total income (Baumol & Blinder, 2003). The multiplier takes the form:

$$\Delta Y = \frac{\Delta y}{1 - c(1 - t) + m}$$

where $\Delta Y$ is the cumulative change in permanent income due to the Keynesian multiplier effect, $\Delta y$ is the initial change in permanent income due to the intervention, $c$ is the propensity to consume out of permanent income, $t$ is the effective state and federal personal income tax rate, $m$ is the propensity to import out of permanent income.

The average propensity to consume out of permanent income over the most recent 10-year period for which data are available (1997–2006) is 0.941 (Bureau of Economic Analysis, 2007b). Over the 10-year period from 1997 through 2006, the propensity to import out of permanent income is 0.144 (Bureau of Economic Analysis, 2007a). Combined effective tax rates were calculated for each state based on an average effective federal personal income tax rate of 0.228 (Congressional Budget Office, 2001) and effective state personal income tax rates from The Urban Institute-Brookings Institution Tax Policy Center (2004), resulting in state-specific multipliers. Weighted by each state’s population of first grade students, total income would increase by an annual amount equal to $6.5 trillion for the 3,663,005 students in each first grade cohort that would benefit from the intervention.

3.3. Value of less crime

The value of reduced crime may be estimated from existing data regarding victim, property, and incarceration costs per crime, and econometric analyses relating educational attainment and the incidence of crime (Lochner & Moretti, 2004). Annual arrests by age group for eight major categories of crime were drawn from the Uniform Crime Reports (U.S. Department of Justice, 2006), adjusted for under-surveys (the Department of Justice survey only covers 72% of the population of the United States), then converted to per capita rates. The reduction in arrests per capita at age 19 associated with a 1.945 year increase in educational attainment was calculated based on Lochner and Moretti’s (2004) econometric analysis, then multiplied by the number of crimes per arrest (from victim surveys) and the cost per crime. The arithmetic mean across the categories of crime to derive the social benefit per capita of the reduction in crime at age 19 was used in the proposed intervention. To estimate the value of less crime at each age throughout a lifetime, the age-19 figure was adjusted to reflect the relative proportion of crimes committed at each age over the course of a lifetime. The age-specific figures were then discounted at 3.5% to age 6, when the intervention begins, to derive an estimate of the total social value of less crime attributable to the proposed intervention, equal to $9794 per individual receiving the intervention.

For the purpose of calculating the purely fiscal savings to state and federal treasuries, a separate calculation isolated the portion of the total social benefit of reduced crime attributable to savings in incarceration costs, following the methodology outlined above. The annual incarceration cost per inmate is $25,935 (Stephan, 2004), adjusted for inflation. This cost was multiplied by the incarceration rate and average time served per offender for eight major categories of crime (Farrington et al., 2004; Lochner &
Moretti, 2004). Age-specific savings in incarceration costs were calculated based on arrest data from the Uniform Crime Reports, adjusted for under-survey and crimes per arrest, and multiplied by Lochner and Moretti’s estimated reduction in arrest rates associated with a 1.945 year increase in schooling, then discounted to age 6, equal to a total of $253.90 per individual receiving the intervention, 10% saved by the federal treasury and 90% by state treasuries (Stephan & Karberg, 2003).

3.4. Welfare savings

The value of welfare savings may be estimated from Census Bureau data relating the incidence of poverty and educational attainment (U.S. Census Bureau, 2006). Age-specific reductions in poverty rates were estimated based on the projection that a 1.945 year increase in schooling shifts each individual in the categories of “less than high school,” “high school,” “some college,” and “bachelor’s or higher” into the next category of educational attainment. The corresponding reductions in poverty rates were used to calculate age-specific savings out of current per capita federal and state welfare costs of $702.25 (The Lewin Group & the Nelson A. Rockefeller Institute of Government, 2004). The savings were apportioned by the average federal and state shares.

Since the $702.25 figure excludes food stamps, projected age-specific food stamp savings were calculated separately, based on the average monthly benefit of $94.32 (U.S. Department of Agriculture, 2007) multiplied by 7.73 average months per spell, calculated from participation spells over the 1990–1999 period (Cody, Gleason, Schechter, Satake, & Sykes, 2005) multiplied by the age-specific probability of food stamp receipt, and multiplied by the age-specific percentage reduction in poverty resulting from the proposed intervention. All figures were adjusted to reflect that each woman will bear an average of 2.05 children during her childbearing years (Martin et al., 2006). Adjusted for the ratio of females to males (50.8 to 49.2), each adult is associated with an average of 1.04 children. Thus, each individual in the intervention group would be associated during adulthood with an average of 1.04 children and, thus, the per capita welfare savings must be multiplied by 2.04 during adult childbearing years (ages 22–40) to account for the link between adult and child poverty and welfare consumption.

The age-specific welfare savings were discounted at 3.5% to age 6, when the intervention begins, and apportioned by state and federal shares for the purpose of estimating the savings by state and federal treasuries.

3.5. Tax savings

Gains in federal tax revenue were estimated based on an average effective federal personal income tax rate of 0.228 (Congressional Budget Office, 2001) multiplied by the increase in income for the 3,663,005 students in each first grade cohort who would benefit from the intervention.

Gains in state tax revenues were estimated based on the gains in state personal income tax and state sales tax revenues attributable to the intervention, using state-specific effective tax rates from The Urban Institute-Brookings Institution Tax Policy Center (2004). State sales tax revenues were estimated by multiplying the gain in disposable income generated by each state’s cohort of first grade students by 0.941, the average propensity to consume out of disposable income (Bureau of Economic Analysis, 2007b), and each state’s average effective sales tax rate. Actual revenues would exceed this amount if the additional income is taxed at upper income tax brackets.

4. Benefit–cost analysis

A benefit–cost ratio may be calculated for society as a whole, disregarding the distribution of the benefits and costs across particular individuals, the federal government, and state or local governments. This calculation includes the increased earnings and value to society of reductions in crime, as well as all costs (cash, opportunity, and college costs) that are attributable to the intervention. A second calculation may be performed to estimate the fiscal benefits and costs to the federal treasury, under the assumption that the federal government pays for the intervention. This provides useful information to federal policymakers in judging whether governmental outlays for the intervention would be recouped through increased federal taxes and the federal share of reduced welfare and incarceration costs resulting from the projected increases in educational attainment and earnings. This tells federal policymakers whether the intervention “pays for itself” if the federal government foots the bill for the K-12 costs plus the federal share of college costs.

A third set of calculations may be performed to estimate the social benefits (increased earnings and value of less crime) that would be purchased if each state government paid the K-12 costs plus the state share of college costs out of the state treasury. A fourth set of calculations may be performed to estimate the fiscal benefits and costs to each state treasury, under the assumption that each state government paid the K-12 costs plus the state share of college costs out of the state treasury. This provides useful information to state policymakers in judging whether governmental outlays for the intervention would be recouped through increased state taxes and state shares of reduced welfare and incarceration costs resulting from the projected increases in educational attainment and earnings. This calculation tells state policymakers whether the intervention “pays for itself” if each state foots the bill for the intervention.

4.1. National social benefit–cost ratio

For the nation as a whole, the net social benefits (increased earnings and value of less crime, minus all social costs), total $6.3 trillion annually in present value terms, if the intervention is applied to each successive cohort of first grade students. The social benefit–cost ratio (social benefits divided by social costs) is 28.47, meaning that society gains $28.47 in social benefits for every dollar of social resources consumed. These resources include the K-12 costs of the proposed intervention to raise student achievement as well as the value of foregone earnings and the cost of college for the extra 1.945 years of schooling that each individual would attain as a result of the intervention.

4.2. Federal treasury benefit–cost ratio

A more limited calculation can assist federal policymakers to determine whether the fiscal benefits would exceed the fiscal costs that would be incurred if the federal government paid for the proposed intervention. The federal government would gain $1.5 trillion annually in increased federal personal income tax revenues, saved welfare costs, and reduced costs of incarceration. The benefit–cost ratio for the federal government is 93, meaning that the federal treasury would gain $93 in personal tax revenues, savings in the federal portion of welfare costs, and savings in the federal portion of incarceration costs, for every dollar spent on the proposed intervention, including increased federal expenditures if each student attends college for 1.945 additional years.
4.3. State social benefit–cost ratios

The lowest state-specific social benefit–cost ratio is 286, in Oregon, meaning that the residents in each of the 50 states would gain a minimum of $286 per dollar spent on the proposed intervention. This figure exceeds the national social benefit–cost ratio (28.47) because the cost to each state treasury excludes the extra costs of college borne by college students and their parents as a result of the intervention.

4.4. State fiscal benefit–cost ratios

A more limited calculation for each state can assist state policymakers to determine whether the fiscal benefits would exceed the fiscal costs that would be incurred if state governments (instead of the federal government) paid for the proposed intervention. For example, Minnesota’s treasury would net $4.3 billion annually, over and above the costs of the intervention to the state treasury, due to increased sales and personal income tax revenues, reduced welfare costs, and reduced costs of incarceration. The fiscal benefit–cost ratio for the State of Minnesota is 13.5, meaning that Minnesota’s treasury would gain $13.50 for every dollar spent on the proposed intervention. Excluding Alaska and New Hampshire, which do not levy sales taxes or taxes on earned income, the state benefit–cost ratios are no lower than 5, in Texas, meaning that all but two state treasuries would reap a minimum of $5.00 for every dollar spent on the proposed intervention (Table 1).

5. Sensitivity analysis I

A sensitivity analysis provides information about the degree to which the results are sensitive to hypothetical changes in the underlying parameters. This is especially important in benefit–cost analysis, which is heavily based on estimations and projections of future outcomes. Note that the preceding analyses arbitrarily assumed that in grades 6 through 12 the effect size for testing feedback drops to zero. During these grades, the analyses assumed that the intervention serves primarily to hold the ground that was gained during grades 1 through 5 (and, secondarily, to boost the achievement of immigrant students who arrive after grade 5). The results suggest that the benefit–cost ratios are robust to this conservative assumption.

6. Sensitivity analysis II

A key assumption is that schools do not need to purchase additional computers and printers in order to implement rapid assessment. This assumption is based on research implying that virtually all classrooms will have access to at least one online computer by the year 2006 (Parsad & Jones, 2005), plus the ability of all online computers to print from a high capacity printer in a school’s media center (Reilly, no date), and was verified through interviews with teachers and observations of classrooms where rapid assessment was used. However, if each classroom requires new equipment, an entire system, including a computer, monitor, keyboard, mouse, software, service plan and printer, may be purchased from Dell for $1015. Assuming that a complete system is purchased for every classroom of 20 students and is amortized over a 7-year period, the annual cost per student is $7.25, raising the total cost of rapid assessment to $35.56 per student. This would reduce each state’s fiscal benefit–cost ratio, but each state treasury (except for Alaska and New Hampshire) would reap a minimum of $4.90 for every dollar spent on the proposed intervention.

7. Sensitivity analysis III

A second assumption, based on interviews with teachers and observations of classrooms where rapid assessment is used, is that the rapid assessment software saves more teacher time (primarily time that would otherwise be spent grading math homework and assessing reading comprehension) than is consumed in nonstructural tasks such as supervising student use of the computer, scanner and printer. However, if teachers do not save time and, instead, lose 15 min per day (or 1.25 h per week), the annual cost is $81.06 per student, assuming 20 students per teacher and an annual teacher salary of $51,880 (U.S. Department of Education, 2005). The total cost for rapid assessment increases to $109.37 per student. This would reduce each state’s fiscal benefit–cost ratio, but each state treasury (except for Alaska and New Hampshire) would reap a minimum of $4.50 for every dollar spent on the proposed intervention.

8. Sensitivity analysis IV

A simple way to examine the robustness of the results calculated above is to examine how the benefit–cost ratios were calculated. The ratio for each state was calculated according to the following equation:

\[ BC_i = \frac{\text{IncTax}_i + \text{SalesTax}_i + \text{WelfSavi}_i + \text{IncarcSavi}_i}{\text{Cost}_i} \]

where \( BC_i \) is the benefit–cost ratio for the \( i \)th state, \( \text{IncTax}_i \) is the gain in personal income tax revenue in the \( i \)th state, \( \text{SalesTax}_i \) is the gain in sales tax revenue in the \( i \)th state, \( \text{WelfSavi}_i \) is the savings in welfare costs in the \( i \)th state, \( \text{IncarcSavi}_i \) is the saved incarceration costs in the \( i \)th state, \( \text{Cost}_i \) is the cost to the state treasury of the proposed intervention in the \( i \)th state.

Inspection of this equation indicates that the fiscal benefits of the proposed intervention exceed the costs to each state treasury unless all of the benefits of the proposed intervention are overestimated by a factor of 5, or the costs of the proposed intervention are underestimated by a factor of 5, or some combination thereof (excepting Alaska and New Hampshire).

9. Sensitivity analysis V

Sensitivity analysis V examines the projection based on Winship and Korenman’s (1999) regression analysis that annual earnings would increase by 53.7% and schooling would increase by 1.945 years in response to a 1.5 S.D. increase in AFQT scores. This projection underlies the projected increase in personal income and sales tax revenues, which account (on average) for 99.6% of the total projected fiscal gain to each state treasury. Therefore, the projected increase in earnings is the single most critical assumption, other than the assumption regarding the effect size of the proposed intervention. If instead earnings increase by only half of the projected amount, the average person in the treatment group would still gain a present value sum of $384,649 in lifetime earnings.

After recalculating the benefit–cost ratios, the smallest ratio drops to 2.5, in Texas, meaning that the fiscal benefits of the proposed intervention exceed the costs to each state treasury, unless all of the benefits of the proposed intervention are overestimated by a factor of 2.5, or the costs of the proposed intervention are underestimated by a factor of 2.5, or some combination thereof (excepting Alaska and New Hampshire).

The outcome of this hypothetical change is that the benefit–cost ratio for society would fall to 14.31, but society would still gain $14.31 of benefits for every dollar spent on the proposed intervention.
intervention. The benefit–cost ratio for the federal government would fall to 46.46, but the federal government would still gain $46.46 for every dollar spent on the proposed intervention. Thus, the basic conclusion – that the proposed intervention provides benefits that exceed the costs – is relatively insensitive to a drastic change in projected gains in earnings.

10. Discussion

The results suggest that the benefits of the proposed intervention would greatly exceed the costs, and that it is feasible and cost-effective for either the federal government or individual state governments to raise student achievement and earnings – perhaps
dramatically. Cost-effectiveness analyses suggest that the proposed intervention is substantially more cost-effective than 10 alternative approaches for raising student achievement, including voucher programs, charter schools, a 10% increase in existing patterns of educational expenditures, increased educational accountability, comprehensive school reform, teacher certification by the National Board for Professional Teaching Standards, a proposal to replace the bottom quartile of novice teachers with new teachers, raising teacher quality by requiring new candidates to meet a minimum SAT score of 1000, class size reduction, and high quality preschool (Yeh, 2007, 2008a, 2008b, 2008c, in press-a, in press-b).

It is useful to compare the results reported here with Levin et al.’s (2007) estimate of the fiscal benefits and costs of five leading interventions for raising high school graduation rates. Levin et al. drew upon raw Current Population Survey data to estimate differences in annual earnings by level of education, gender and ethnicity. Their figures imply that while black males who are high school graduates earned, on average, 48.7% more than high school dropouts. The comparable figure for white females is 111.5%, for black males 61.5%, and for black females, 42%. These figures are not directly comparable with Winship and Korenman’s (1999) estimate that a 1.5 S.D. gain in AFQT scores is associated with a 53.7% increase in annual earnings, averaged across gender and ethnicity, because Winship and Korenman controlled for covariates including ability and accounted for the reciprocal effect of cognitive skills and schooling. However, the figures reinforce the conclusion that increases in educational attainment have powerful effects on earnings.

In any case, Levin et al. (2007) estimated that the fiscal benefits of the five interventions to improve high school graduation rates exceed the fiscal costs by a ratio of 2.5 to 1. This ratio is half of the lowest fiscal benefit–cost ratio that I estimated, above (for Texas), and is equal to the lowest fiscal benefit–cost ratio that was calculated in Sensitivity Analysis V, which investigated the outcome of shrinking the Winship and Korenman (1999) estimate by 50%. The differences in the estimated benefit–cost ratios for the two sets of interventions are attributable to a combination of differences in assumptions regarding effects on earnings, differences in the estimated cost-effectiveness of the interventions, and differences in analytical techniques.

Perhaps the largest difference is that the intervention that is proposed and examined in this paper would be applied to every student in grades 1 through 8, and through grade 12 for the lowest performing 40% of all students. As a result, the intervention would benefit considerably more students than interventions targeted only to potential high school dropouts. Since 9.3% of all 8th-grade students drop out and fail to graduate within 8 years of their on-time graduation date (Mishel & Roy, 2006), interventions designed to reduce the dropout rate would benefit a maximum of 9.3% of all 8th-grade students, whereas the proposed intervention potentially could benefit every student, including gifted and talented students (Ysseldyke, Tardrew, Betts, Thill, & Hammegan, 2004).

Existing research suggests hypotheses about the causal mechanisms underlying the proposed intervention and why the intervention appears to be effective with both high and low achieving students. Research suggests that this type of intervention allowed teachers to individualize and target instruction, provide more tutoring, reduce drill and practice, improve student readiness for—and spend more time on—critical thinking activities, resulting in a more balanced curriculum (Yeh, 2006). Teachers reported that the assessments provided a common point for discussion, increased collaboration among teachers to improve instruction and resolve instructional problems, and supported both new and experienced teachers in implementing sound teaching practices (Yeh, 2006). The individualized curriculum and rapid feedback on progress reportedly gave students the feeling that they were successful and in control of their own learning, engaging students who previously disliked reading and math, including dyslexic children and children in special education, reducing stress and improving student achievement (Yeh, 2006).

These findings are significant because existing research indicates that a student’s perceived control over his or her academic performance is strongly predictive of academic achievement (Brookover, Beady, Flood, Schweitzer, & Wisenbaker, 1979; Brookover et al., 1978; Coleman et al., 1966; Crandall, Katkovky, & Crandall, 1965; Kahlenstein & Nowicki, 1997; Keith, Pottebaum, & Eberhart, 1986; Skinner, Wellborn, & Connell, 1990; Teddlie & Stringfield, 1993). There is a feedback loop between performance and control beliefs, with high performance leading to subsequent perceptions of control, so that early achievement strongly influences later achievement, and does so primarily by increasing students’ sense of personal control (Musher Eizenman, Nesselroade, & Schmitz, 2002; Ross & Broh, 2000; Skinner et al., 1990). In summary:

When children believe that they can exert control over success in school, they perform better on cognitive tasks. And, when children succeed in school, they are more likely to view school performance as a controllable outcome (Skinner et al., 1990, p. 22).

It appears that when students see that they are making academic progress, they become excited about learning (Yeh, 2006). This enthusiasm translates into greater effort and further improvements in achievement, which further strengthens student engagement (Yeh, 2006).

Arguably, the vast majority of alternative interventions and policies for improving student achievement—including voucher programs, charter schools, higher standards, increased accountability, increased expenditure per pupil, comprehensive school reform, reduced class size and improvements in teacher quality—fail to directly address the need to improve student engagement in academic work. Instead, these interventions increase pressure on teachers and students, increase resources, change the organization of schools, or improve the quality of instruction. Direct comparisons show that these alternatives are far less cost-effective than the proposed rapid assessment intervention (Yeh, 2007, 2008a, 2008b, 2008c, in press-a, in press-b).

If performance feedback builds students’ self-esteem, confidence, and desire to perform at a high level, then lack of adequate feedback is perhaps the most important cause of low student achievement, and may explain why an intervention that provides rapid performance feedback can be an extremely cost-effective way to achieve the goal of improving student engagement and achievement.

References


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