

Class size: reducing average class size by one student in one grade, 9-12 Pre-K to 12 Education

Benefit-cost estimates updated December 2023. Literature review updated January 2013.

Current estimates replace old estimates. Numbers will change over time as a result of model inputs and monetization methods.

The WSIPP benefit-cost analysis examines, on an apples-to-apples basis, the monetary value of programs or policies to determine whether the benefits from the program exceed its costs. WSIPP's research approach to identifying evidence-based programs and policies has three main steps. First, we determine "what works" (and what does not work) to improve outcomes using a statistical technique called meta-analysis. Second, we calculate whether the benefits of a program exceed its costs. Third, we estimate the risk of investing in a program by testing the sensitivity of our results. For more detail on our methods, see our [Technical Documentation](#).

Program Description: Washington State's prototypical school funding formula allocates funding for an average class size of 28.74 students in grades 9 through 12 (RCW 28A.150.260). We estimate the benefits and costs of reducing high school average class sizes by one student.

Benefit-Cost Summary Statistics Per Participant

Benefits to:

Taxpayers	\$118	Benefit to cost ratio	\$2.22
Participants	\$278	Benefits minus costs	\$244
Others	\$148	Chance the program will produce	
Indirect	(\$100)	benefits greater than the costs	54%
Total benefits	\$444		
Net program cost	(\$200)		
Benefits minus cost	\$244		

The estimates shown are present value, life cycle benefits and costs. All dollars are expressed in the base year chosen for this analysis (2022). The chance the benefits exceed the costs are derived from a Monte Carlo risk analysis. The details on this, as well as the economic discount rates and other relevant parameters are described in our [Technical Documentation](#).

Meta-Analysis of Program Effects

Outcomes measured	Treatment age	No. of effect sizes	Treatment N	Adjusted effect sizes and standard errors used in the benefit-cost analysis						Unadjusted effect size (random effects model)	
				First time ES is estimated			Second time ES is estimated			ES	p-value
				ES	SE	Age	ES	SE	Age		
High school graduation	16	77	1000	0.002	0.003	16	0.002	0.003	18	0.002	0.583
Test scores	16	77	1000	0.002	0.008	16	0.002	0.007	17	0.002	0.781

Meta-analysis is a statistical method to combine the results from separate studies on a program, policy, or topic in order to estimate its effect on an outcome. WSIPP systematically evaluates all credible evaluations we can locate on each topic. The outcomes measured are the types of program impacts that were measured in the research literature (for example, crime or educational attainment). Treatment N represents the total number of individuals or units in the treatment group across the included studies.

An effect size (ES) is a standard metric that summarizes the degree to which a program or policy affects a measured outcome. If the effect size is positive, the outcome increases. If the effect size is negative, the outcome decreases.

Adjusted effect sizes are used to calculate the benefits from our benefit cost model. WSIPP may adjust effect sizes based on methodological characteristics of the study. For example, we may adjust effect sizes when a study has a weak research design or when the program developer is involved in the research. The magnitude of these adjustments varies depending on the topic area.

WSIPP may also adjust the second ES measurement. Research shows the magnitude of some effect sizes decrease over time. For those effect sizes, we estimate outcome-based adjustments which we apply between the first time ES is estimated and the second time ES is estimated. We also report the unadjusted effect size to show the effect sizes before any adjustments have been made. More details about these adjustments can be found in our [Technical Documentation](#).

Detailed Monetary Benefit Estimates Per Participant						
Affected outcome:	Resulting benefits: ¹	Benefits accrue to:				
		Taxpayers	Participants	Others ²	Indirect ³	Total
High school graduation	Criminal justice system	\$0	\$0	\$1	\$0	\$2
Test scores	Labor market earnings associated with test scores	\$118	\$278	\$146	\$0	\$542
Program cost	Adjustment for deadweight cost of program	\$0	\$0	\$0	(\$100)	(\$100)
Totals		\$118	\$278	\$148	(\$100)	\$444

¹In addition to the outcomes measured in the meta-analysis table, WSIPP measures benefits and costs estimated from other outcomes associated with those reported in the evaluation literature. For example, empirical research demonstrates that high school graduation leads to reduced crime. These associated measures provide a more complete picture of the detailed costs and benefits of the program.

²"Others" includes benefits to people other than taxpayers and participants. Depending on the program, it could include reductions in crime victimization, the economic benefits from a more educated workforce, and the benefits from employer-paid health insurance.

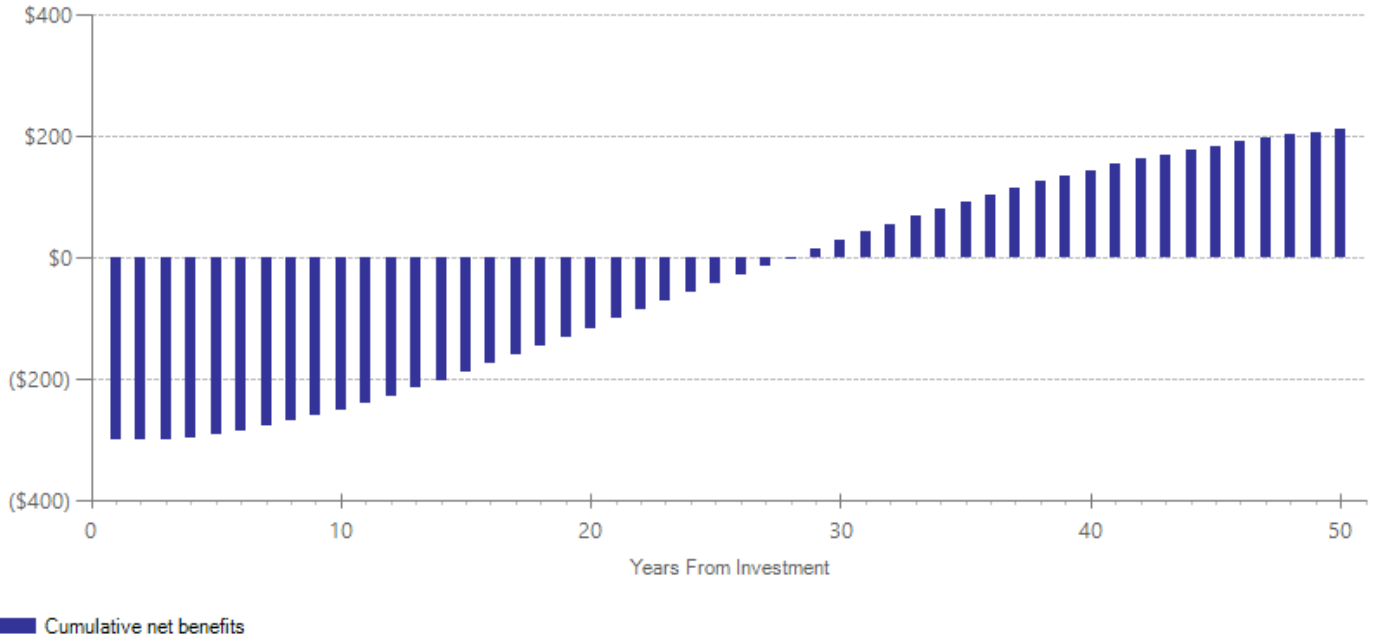
³"Indirect benefits" includes estimates of the net changes in the value of a statistical life and net changes in the deadweight costs of taxation.

Detailed Annual Cost Estimates Per Participant					
	Annual cost	Year dollars	Summary		
Program costs	\$160	2011	Present value of net program costs (in 2022 dollars)		(\$200)
Comparison costs	\$0	2011	Cost range (+ or -)		0%

The cost estimate accounts for state and school district teacher compensation, marginal operating, and capital costs. Annual teacher costs are calculated using the 2011-12 average total (state and local) salary for Washington certificated teachers reported in the Office of Superintendent of Public Instruction School District Personnel Summary Profiles. The calculation includes salaries and benefits as well as central administration and special education costs. Assumptions for capital cost calculations were provided by legislative staff, with one exception: the interest rate on bonds is from the Federal Reserve's November 2012 state and local rate. Aos, S., & Pennucci, A. (2013). *K-12 class size reductions and student outcomes: A review of the evidence and benefit-cost analysis* (Doc. No. 13-01-2201). Olympia: Washington State Institute for Public Policy.

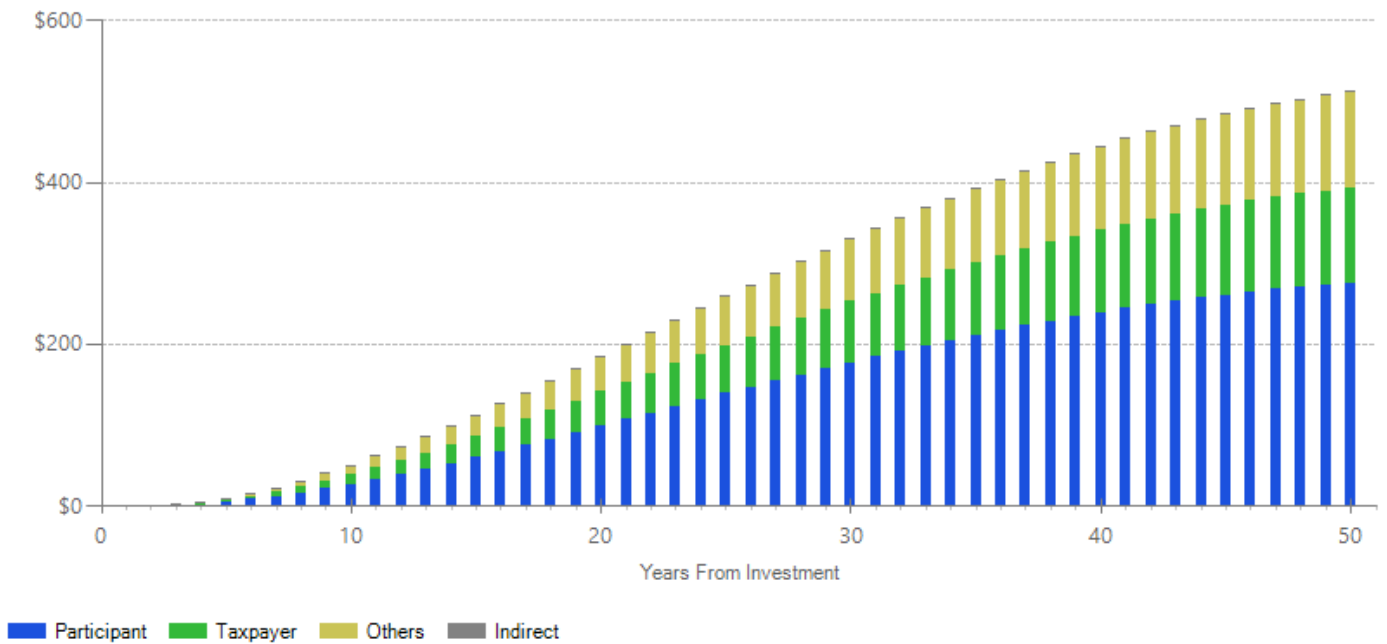
The figures shown are estimates of the costs to implement programs in Washington. The comparison group costs reflect either no treatment or treatment as usual, depending on how effect sizes were calculated in the meta-analysis. The cost range reported above reflects potential variation or uncertainty in the cost estimate; more detail can be found in our [Technical Documentation](#).

Benefits Minus Costs Over Time (Cumulative Discounted Dollars)

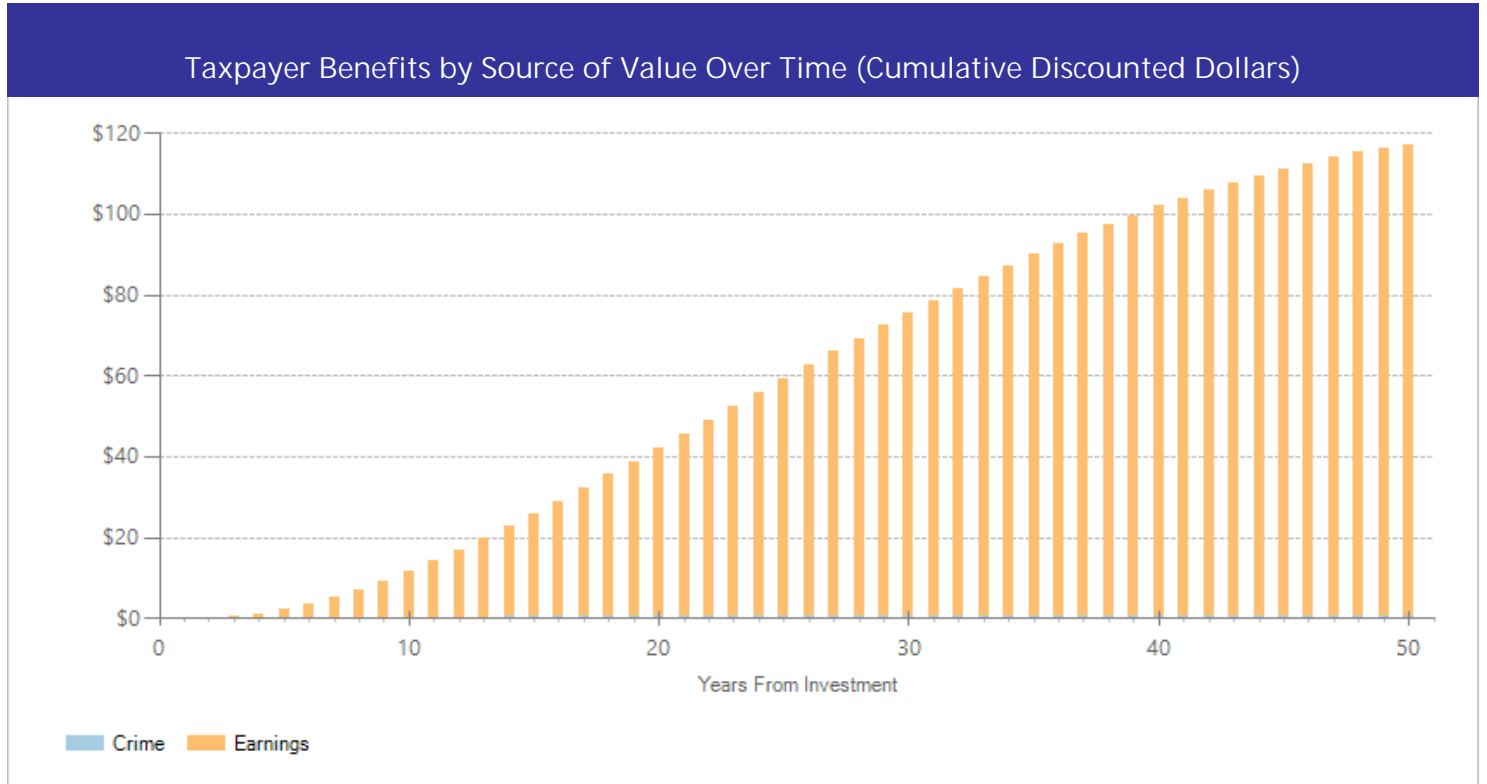


The graph above illustrates the estimated cumulative net benefits per-participant for the first fifty years beyond the initial investment in the program. We present these cash flows in discounted dollars. If the dollars are negative (bars below \$0 line), the cumulative benefits do not outweigh the cost of the program up to that point in time. The program breaks even when the dollars reach \$0. At this point, the total benefits to participants, taxpayers, and others, are equal to the cost of the program. If the dollars are above \$0, the benefits of the program exceed the initial investment.

Benefits by Perspective Over Time (Cumulative Discounted Dollars)



The graph above illustrates the breakdown of the estimated cumulative benefits (not including program costs) per-participant for the first fifty years beyond the initial investment in the program. These cash flows provide a breakdown of the classification of dollars over time into four perspectives: taxpayer, participant, others, and indirect. "Taxpayers" includes expected savings to government and expected increases in tax revenue. "Participants" includes expected increases in earnings and expenditures for items such as health care and college tuition. "Others" includes benefits to people other than taxpayers and participants. Depending on the program, it could include reductions in crime victimization, the economic benefits from a more educated workforce, and the benefits from employer-paid health insurance. "Indirect benefits" includes estimates of the changes in the value of a statistical life and changes in the deadweight costs of taxation. If a section of the bar is below the \$0 line, the program is creating a negative benefit, meaning a loss of value from that perspective.



The graph above focuses on the subset of estimated cumulative benefits that accrue to taxpayers. The cash flows are divided into the source of the value.

Citations Used in the Meta-Analysis

- Akerhielm, K. (1995). Does class size matter?. *Economics of Education Review*, 14(3), 229-241.
- Altinok, N., & Kingdon, G. (2012). New evidence on class size effects: A pupil fixed effects approach. *Oxford Bulletin of Economics and Statistics*, 74(2), 203-234.
- Angrist, J.D., & Lavy, V. (1999). Using Maimonides' Rule to estimate the effect of class size on scholastic achievement. *The Quarterly Journal of Economics*, 114(2), 533-575.
- Blatchford, P., Martin, C., Moriarty, V., Bassett, P., & Goldstein, H. (2002). *Pupil adult ratio differences and educational progress over reception and Key Stage 1* (Research Report No. 335). London: Department for Education and Skills.
- Bonesrønning, H. (2003). Class size effects on student achievement in Norway: Patterns and explanations. *Southern Economic Journal*, 69(4), 952-965.
- Bressoux, P., Kramarz, F., & Prost, C. (2008). *Teachers' training, class size and students' outcomes: Learning from administrative forecasting mistakes* [IZA Working paper]. Bonn: Institute for the Study of Labor.
- Browning, M., & Heinesen, E. (2007). Class size, teacher hours and educational attainment. *The Scandinavian Journal of Economics*, 109(2), 415-438.
- Buddin, R., & Zamarro, G. (2009). Teacher qualifications and student achievement in urban elementary schools. *Journal of Urban Economics*, 66(2), 103-115.
- Burke, M. & Sass, T. (2011). *Classroom peer effects and student achievement*. Boston, MA: Federal Reserve Bank of Boston.
- Chetty, R., Friedman, N., Hilger, N., Saez, E., Schanzenbach, D., & Yagan, D. (2010). *How does your kindergarten classroom affect your earnings?* Evidence from Project STAR.
- Cho, H., Glewwe, P., & Whitley, M. (2012). Do reductions in class size raise students' test scores? Evidence from population variation in Minnesota's elementary schools. *Economics of Education Review*, 31(3), 77-95.
- Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2010). Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *Journal of Human Resource*, 45(3), 655-681.
- Clotfelter, C.T., Ladd, H.F., & Vigdor, J.L. (2006). Teacher-student matching and the assessment of teacher effectiveness. *The Journal of Human Resources*, 41(4), 778-820.
- Croninger, R.G., Rice, J.K., Rathbun, A., & Nishio, M. (2007). Teacher qualifications and early learning: Effects of certification, degree, and experience on first-grade student achievement. *Economics of Education Review*, 26(3), 312-324.

- Dearden, L., Ferri, J., & Meghir, C. (2002). The effect of school quality on educational attainment and wages. *The Review of Economics and Statistics*, 84(1), 1-20.
- Dee, T.S., & West, M.R. (2011). The non-cognitive returns to class size. *Educational Evaluation and Policy Analysis*, 33(1), 23-46.
- Dobbelsteen, S., Levin, J., & Oosterbeek, H. (2002). The causal effect of class size on scholastic achievement: Distinguishing the pure class size effect from the effect of changes in class composition. *Oxford Bulletin of Economics and Statistics*, 64(1), 17-38.
- Eberts, R.W., & Stone, J.A. (1987). Teacher unions and the productivity of public schools. *Industrial and Labor Relations Review*, 40(3), 354-363.
- Ecalte, J., Magnan, A., & Gibert, F. (2006). Class size effects on literacy skills and literacy interest in first grade: A large-scale investigation. *Journal of School Psychology*, 44(3), 191-209.
- Feinstein, L., & Symons, J. (1999). Attainment in secondary school. *Oxford Economic Papers*, 51(2), 300-321.
- Ferguson, R.F., & Ladd, H.F. (1996). How and why money matters: An analysis of Alabama schools. In H. F. Ladd (Ed.), *Holding schools accountable: Performance based reform in education* (pp. 265-298). Washington, DC: Brookings Institution.
- Fredricksson, P., & Öckert, B. (2008). Resources and student achievement – Evidence from a Swedish policy reform. *The Scandinavian Journal of Economics*, 110(2), 277-296.
- Fredriksson, P., Öckert, B., & Oosterbeek, H. (2012). *Long-term effects of class size*. Uppsala: IFAU.
- Fuchs, T., & Wößmann, L. (2007). What accounts for international differences in student performance? A re-examination using PISA data. *Empirical Economics*, 32(2), 433-464.
- Goldhaber, D. D., & Brewer, D. J. (1997). Why don't schools and teachers seem to matter? Assessing the impact of unobservables on educational productivity. *The Journal of Human Resources*, 32(3), 505-523.
- Grissmer, D. W., & Flanagan, A. (2006). *Improving the achievement of Tennessee students: Analysis of the National Assessment of Education Progress*. Santa Monica, CA: RAND.
- Hægeland, T., Raaum, O., & Salvanes, K. G. (2005). *Pupil achievement, school resources and family background* (IZA Discussion Paper No. 1459). Bonn, Germany: Institute for the Study of Labor.
- Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics*, 95(7- 8), 798-812.
- Hoxby, C. M. (2000). The effects of class size on student achievement: New evidence from population variation. *The Quarterly Journal of Economics*, 115(4), 1239-1285.
- Iacovou, M. (2002). Class size in the early years: Is smaller really better?. *Education Economics*, 10(3), 261-290.
- Jakubowski, M., & Sakowski, P. (2006). *Quasi-experimental estimates of class size effect in primary schools in Poland* (Working Paper?). Poland: Warsaw University, Faculty of Economics.
- Jepsen, C., & Rivkin, S. (2002). *Class size reduction, teacher quality, and academic achievement in California public elementary schools*. San Francisco: Public Policy Institute of California.
- Krieg, J. M. (2006). Teacher quality and attrition. *Economics of Education Review*, 25(1), 13-27.
- Krueger, A. B. (1999). Experimental estimates of education production functions. *The Quarterly Journal of Economics*, 114(2), 497-532.
- Lee, J.-W., & Barro, R. J. (2001). Schooling quality in a cross-section of countries. *Economica*, 68, 465-488.
- Lee, J., & Reeves, T. (2012). Revisiting the impact of NCLB high-stakes school accountability, capacity, and resources: State NAEP 1990-2009 reading and math achievement gaps and trends. *Educational Evaluation and Policy Analysis*, 34(2), 209-231.
- Li, M. (2007). Bayesian proportional hazard analysis of the timing of high school dropout decisions. *Econometric Reviews*, 26(5), 529-556.
- Long, M. C. (2006). *Secondary school characteristics and early adult outcomes* (Working Paper No. 2006-06). Seattle: University of Washington, Daniel J. Evans School of Public Affairs.
- Milesi, C., & Gamoran, A. (2006). Effects of class size and instruction on kindergarten achievement. *Educational Evaluation and Policy Analysis*, 28(4), 287-313.
- Molnar, A., Smith, P., Zahorik, J., Palmer, A., Halbach, A., & Ehrle, K. (1999). Evaluating the SAGE program: A pilot program in targeted pupil-teacher reduction in Wisconsin. *Educational Evaluation and Policy Analysis*, 21(2), 165-177.
- NICHD Early Child Care Research Network. (2004). Does class size in first grade relate to children's academic and social performance or observed classroom processes?. *Developmental Psychology*, 40(5), 651-664.
- Pirog, M. A., & Magee, C. (1997). High school completion: The influence of schools, families, and adolescent parenting. *Social Science Quarterly*, 78(3), 710-724.
- Pong, S.-i., & Pallas, A. (2001). Class size and eighth-grade math achievement in the United States and abroad. *Educational Evaluation and Policy Analysis*, 23(3), 251-273.
- Ready, D. D., & Lee, V. E. (2006). Optimal context size in elementary schools: Disentangling the effects of class size and school size. In T. Loveless & F. M. Hess (Eds.), *Brookings papers on education policy, 2006/2007* (pp. 99-135). Washington, DC: Brookings Institution.
- Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, 73(2), 417-458.
- Rumberger, R. W., & Thomas, S. L. (2000). The distribution of dropout and turnover rates among urban and suburban high schools. *Sociology of Education*, 73(1), 39-67.
- Steele, F., Vignoles, A., & Jenkins, A. (2007). The effect of school resources on pupil attainment: A multilevel simultaneous equation modelling approach. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 170(3), 801-824.
- Todd, P. E., & Wolpin, K. I. (2007). The production of cognitive achievement in children: Home, school and racial test score gaps. *Journal of Human Capital*, 1(1), 91-136.
- Urquiola, M. (2006). Identifying class size effects in developing countries: Evidence from rural Bolivia. *The Review of Economics and Statistics*, 88(1), 171-177.
- Valdenaire, M. (2006). *Do younger pupils need smaller classes? Evidence from France* (Preliminary Draft). Paris: Paris- Jourdan Sciences Economiques.
- Waldfogel, J., & Zhai, F. (2008). Effects of public preschool expenditures on the test scores of 4th graders: Evidence from TIMSS. *Educational Research and Evaluation*, 14, 9-28.
- Wilson, K. (2001). The determinants of educational attainment: Modeling and estimating the human capital model and education production functions. *Southern Economic Journal*, 67(3), 518-551.

- Washington State Institute for Public Policy (2013). *The Institute's state-level fixed effects analysis of NAEP and CCD data is reported in this Technical Appendix*.
- Goldhaber, D., & Anthony, E. (2007). Can teacher quality be effectively assessed? National board certification as a signal of effective teaching. *The Review of Economics and Statistics*, 89(1), 134-150.
- Goldhaber, D., Liddle, S., Theobald, R., & Walch, J. (2010). *Teacher effectiveness and the achievement of Washington's Students in Mathematics* (CEDR Working Paper 2010-06). Bothell: University of Washington Bothell, Center for Education Data & Research.
- Hanushek, E. A. (1992). The trade-off between child quantity and quality. *Journal of Political Economy*, 100(1), 84-117.
- Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2), 371-406.
- Huang, F. L., & Moon, T. R. (2009). Is experience the best teacher? A multilevel analysis of teacher characteristics and student achievement in low performing schools. *Educational Assessment, Evaluation and Accountability*, 21(3), 209-234.
- Jacob, B. A., & Lefgren, L. (2008). Can principals identify effective teachers? Evidence on subjective performance evaluation in education. *Journal of Labor Economics*, 26(1), 101-136.
- Jepsen, C., & Rivkin, S. (2002). *Class size reduction, teacher quality, and academic achievement in California public elementary schools*. San Francisco: Public Policy Institute of California.
- Kane, T. J., Rockoff, J. E., & Staiger, D. O. (2008). What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review*, 27(6), 615-631.
- Koedel, C., & Betts, J. R. (2007). *Re-examining the role of teacher quality in the educational production function*. Unpublished manuscript, University of Missouri-Columbia, Department of Economics.
- Krieg, J. M. (2006). Teacher quality and attrition. *Economics of Education Review*, 25(1), 13-27.
- Kukla-Acevedo, S. (2009). Do teacher characteristics matter? New results on the effects of teacher preparation on student achievement. *Economics of Education Review*, 28(1), 49-57.
- Ladd, H. F., Sass, T. R., & Harris, D. N. (2007). *The impact of national board certified teachers on student achievement in Florida and North Carolina: A summary of the evidence prepared for the National Academies Committee on the evaluation of the impact of teacher certification by NBPTS*. Unpublished manuscript.
- Leak, J. A., & Farkas, G. (2011). *Effects of teacher credentials, coursework, and certification on student achievement in math and reading in kindergarten: An ECLS-K study*. Evanston, IL: Society for Research on Educational Effectiveness.
- Leigh, A. K. (2010). Estimating teacher effectiveness from two-year changes in students' test scores. *Economics of Education Review*, 29(3), 480-488.
- Ost, B. (2009). *How do teachers improve? The relative importance of specific and general human capital*. Unpublished manuscript, Cornell University, Ithaca, NY.
- Pil, F. K., & Leana, C. (2009). Applying organizational research to public school reform: The effects of teacher human and social capital on student performance. *Academy of Management Journal*, 52(6), 1101-1124.
- Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *The American Economic Review*, 94(2), 247-252.
- Subedi, B. R., Swan, B., & Hynes, M. C. (2011). Are school factors important for measuring teacher effectiveness? A multilevel technique to predict student gains through a value-added approach. *Education Research International*, 2011. doi: 10.1155/2011/532737
- Xu, Z., Hannaway, J., & Taylor, C. (2009). *Making a difference? The effects of Teach for America in high school* (Working Paper 17. Revised). Washington, DC: The Urban Institute, National Center for Analysis of Longitudinal Data in Education Research.

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