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Article

The Value of High School Graduation in the United States: Per-Person Shadow Price Estimates for Use in Cost–Benefit Analysis

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Abstract: One way for jurisdictions with limited analytic resources to increase their capability for doing cost–benefit analysis (CBA) is to use existing shadow prices, or “plug-ins”, for important social impacts. This article contributes to the further development of one important shadow price: the value of an additional high school graduation in the United States. Specifically, how valuable to a student, government, and the rest of society in aggregate is a high school graduation? The analysis builds on the method developed by the Washington State Institute for Public Policy and presents numerical updates and extensions to their analysis. For the U.S., the estimated net present value (the social value) using a 3 percent real discount rate of this shadow price is approximately \$300,000 per each additional graduate. In appropriate circumstances, this value can be “plugged-in” to CBAs of policies that either directly or indirectly seeks to increase the number of students who graduate from high school.

Keywords: cost–benefit analysis; high-school graduation; shadow price; social value of education; plug-in value

1. Introduction

Returns on investments in education can be measured in a number of ways. Cost–benefit analysis (CBA) is a particularly appropriate methodology to measure the returns to different levels of educational investment because it attempts to assess the relative efficiency of alternative policies comprehensively from an aggregate social perspective (Boardman et al. 2018). From the societal perspective, one of the most important questions in the evaluation of educational policy in the United States (U.S.) is: what are the impacts (both costs and benefits) of various “sheepskin effects” (Hungerford and Solon 1987; Jaeger and Page 1996; Wolf and McShane 2013)? Many consider the high school graduation diploma as one of the most important credentials (Neal 1997; Ferrer and Riddell 2001). How valuable to a student, government, and the rest of society in aggregate is a high school graduation?

Answering the question about the social value of high school graduation is not straightforward for a number of reasons. Most importantly, almost all investments in educational increments in either quantity or quality have multidimensional, long run, non-linear, and hard-to-measure impacts (Hanushek 2009). Relatedly, it is hard to distinguish between impacts of various schooling increments as against those that actually flow from innate cognitive and non-cognitive abilities of individuals, independent of their educational attainment level (Hanushek et al. 2015). As analysts and policymakers seek to isolate the causal impact of education, it is necessary to separate out the impacts that flow from these innate abilities in valuing returns to education. Again, however, some of these endowments are

difficult to measure convincingly in monetary terms (cost–benefit analysis requires comprehensive use of a money metric). Additionally, because impacts are spread over many years, the costs and benefits of education need to be discounted to present values in order to appropriately compare alternative public investments. Because of this long period of time over which education can have impacts, the selection of the discount rate can have a significant impact on estimates of the net value of educational investments (Moore et al. 2004). In the United States, the value of graduation is particularly important from a practical policy perspective because, in spite of increases in graduation rates over time, there is still significant variation across U.S. states, and among various minority groups and income levels nationally, in high school graduation rates (Belfield and Levin 2007; Murnane 2013; Papay et al. 2015). The variability in high school graduation rates across demographic groups in the United States is considerably greater than that observed in other wealthy democracies (Hanushek 2009). Although the focus of CBA is on efficiency, these variations also have important distributional and social consequences.

2. The Use and Locus of CBA in the United States: The Value of Plug-Ins

CBA was first widely applied in the United States for water resource projects (Hammond 1966; Hanley and Spash 1993). The development of stated preference methods to assess willingness to pay (WTP) for public goods facilitated CBA's broader application to environmental policy (Arrow et al. 1993). Even broader application of CBA has resulted from a series of Executive Orders issued over many years by a number of presidents. These executive orders now require federal administrative agencies to apply CBA to proposed major rules through Regulatory Impact Analyses (Copeland 2011). Major regulatory rules in areas such as behavioral health and accommodation of disabilities have further amplified the importance of CBA in the evaluation of social policies. Outside the United States, the governmental agency use of CBA or related methods is well established in most regions of the world and is now mandated by quite a few national governments for at least some kinds of major projects or programs (Boardman and Vining 2017).

Under U.S. federalism, in contrast to unitary governmental systems, state governments largely determine policy development in policy areas such as education and child welfare. Inevitably, therefore, they are the appropriate locus for policy analysis in these areas. Facing strong fiscal pressures, many states have sought to improve the efficiency of their programs by mandating, or at least encouraging, CBA in specific policy contexts (White and Landingham 2015). Unfortunately, however, the CBAs that state agencies have produced have often been minimalist or even perfunctory, partly because many states have lacked the analytical resources to conduct sophisticated analyses that measure impacts affecting both program participants and non-participants, such as taxpayers and employers. However, over the last twenty years, the Washington State Institute for Public Policy (WSIPP), which is an agency of the Washington state legislature, has pioneered the systematic application of CBA at the state level. The WSIPP broad CBA template has been applied to various areas of social policy beyond its initial application to criminal justice policies (Aos et al. 2006). An important assessment of the application of CBA to social policy has identified the WSIPP framework as exemplary in terms of method, impact and, importantly, practicality (Weimer and Vining 2009). Subsequently, the MacArthur Foundation and the Pew Charitable Trusts have combined to support states and sub-state localities in adopting the WSIPP approach and in adapting it to local data through the Results First Initiative (RFI). The RFI now assists 21 states, including Minnesota, Connecticut, and Oregon, as well as ten counties spread across the country (Pew-MacArthur 2019).

The WSIPP approach has three specific features that make it a practical tool for policy analysts (Washington State Institute for Public Policy 2018). First, it employs meta-analyses of relevant existing empirical studies to provide evidence for predicting the impact of policy alternatives (Lee and Aos 2011). These reviews primarily focus on evaluations of the implementation of policies in other jurisdictions, but they also assess price elasticities and other parameters that facilitate predicting the consequences of more novel policies. Second, recognizing that the assessment of almost all social policies involves a

greater number of uncertain parameters, it presents results using Monte Carlo simulations that convey the level of certainty in the prediction of net benefits. Third, it develops “shadow prices” (estimates of the social costs or benefits of policy impacts not traded in efficient markets) for a number of important impacts of social policies and applies them consistently across policy areas. All three factors, especially the availability of transferable shadow prices, lower the analytical cost of applying CBA to new policies because analysts in other jurisdictions can “plug them into” their own analyses. As well as lowering analytic costs, the availability of plug-ins promotes consistency in analyses across both policy areas and jurisdictions (Boardman et al. 1997).

In this article we build on one of the important shadow prices initially developed by WSIPP: the social value of a policy-induced high school graduation in the United States. We update the WSIPP estimate to the year 2019 and make three additional contributions. First, we compile information from a number of diverse sources and use them to assess the credibility of shadow price estimates of high school graduation and, to some extent, further levels of educational attainment (because most of them are themselves dependent on high school completion). Second, we present the results of the updating using a range of different social discount rates. We do so because some jurisdictions recommend or mandate a specific discount rate. Third, we discuss the potential role of various assumptions about productivity change, primarily those related to technological progress, on the potential value of increments in education over time (Black and Lynch 2001). Apart from its direct impact on individual productivity, education indirectly underlies many other aspects of productivity increases, such as those on management quality (Black and Lynch 2004). Fourth, we consider benefits of education that do not accrue to those employed but rather to the rest of society—external benefits. In aggregate, we show how a shadow price of high school graduation can be estimated and used for many social policy investment analyses.

3. The Value of High School Graduation in Assessing Education and Other Social Policies

In a review of the application of CBA across a range of social policy areas, Vining and Weimer (2010) argue that academic researchers should strive to provide greater assistance to practicing policy analysts in their efforts to monetize the efficiency impacts of policies in terms of present-value dollars. As analysts at the state and sub-state levels usually face severe resource constraints, their capability for doing CBA is greatly increased by the availability of shadow prices that they can plug into their analyses. Over the last decade, researchers and government agencies have developed a number of useful, but hard-to-measure, shadow prices (Boardman et al. 2018, chp. 17). Some of these shadow prices are useful across many different policy areas: the willingness of individuals to pay for reductions in mortality risks that underlie the shadow price for avoided death—the value of a statistical life—falls into this category (Viscusi 2018). Alternatively, these shadow prices may be primarily useful in a particular policy arena. The victim and criminal justice system costs that provide shadow prices for avoided crimes and standardized unit costs that facilitate monetizing inputs and impacts of substance abuse interventions both fall into this latter category (McCollister et al. 2010, 2017, 2018).

The social value of an additional high school graduation is potentially an important shadow price in a number of different areas of social policy. Most obviously, it is useful in the analysis of school-level policies that can directly affect the graduation rate, but the value of high school graduation can also be an important impact of juvenile justice, substance abuse, foster care, and mental health policies. These policies, although not directly aimed at improving the chances of high school graduation, can nonetheless often affect it. Even policies that affect early childhood development, such as preschool, nutrition, and child protection programs, can also affect educational attainment later in life (Burger 2010). The availability of a shadow price for high school graduation thus increases the feasibility of conducting CBA in a wide range of social policy areas.

4. Steps in Estimating a High School Graduation Shadow Price for the United States

In this article, we draw upon both WSIPP work and Boardman et al. (2018) to derive a current estimate of the total social value of a high school graduation. Boardman et al. (2018) updated the earlier WSIPP graduation shadow price by incorporating more recent earnings data. They also presented shadow prices for several different social discount rates. Here we reprise, review, and update the steps needed to derive a high school graduation shadow price and show how these kinds of shadow prices can be derived using information from a number of diverse sources.

Developing a shadow price for high school graduation involves nine steps. Performing all of them produces an estimate of the present value of net benefits that accrue directly to those graduating and indirectly to the rest of society. Step (1) is to predict earning increments for people with increasing levels of educational attainment over their working lives. Step (2) is to add an estimate of the value of fringe benefits to earnings in order to estimate the full economic value of compensation (“full compensation”) to individuals, as this is the appropriate measure of employee benefits from employment over employees’ working career. Step (3) is to adjust the expected value of full compensation for the effect of predicted real economic growth over a life cycle. Step (4) is to adjust the estimates to take account of mortality risk during the working lives of individuals. Step (5) is to net out the effects of educational attainment on earnings from those deriving from individuals’ initial cognitive and other endowments, as we are interested in the causal impact of the former. Step (6) is to discount earning gains to 2019 dollars in order to obtain current estimates of the present values of both costs and benefits, and of net benefits. Step (7) is to specify some alternative paths to further higher levels of education that are contingent on high school graduation and that thus only become available with achievement of graduation. Step (8) is to adjust estimates to take into account the costs of education. The final and ninth (9) step is to consider the potential external impacts (positive or negative externalities) that flow from changed productivity (which are expected to be an increase) over time; these are the benefits and costs that accrue to other members of society. In order to structure the discussion that follows, Table 1 summarizes the nine steps as well as the major sources for deriving each step (columns one and two respectively). In the third column, the table comments on some weaknesses of the currently available data and methods at each step. As well, it summarizes some “wish list” items for further research that would confirm, improve, or augment the estimates we provide here (which are italicized in the table).

Table 1. Steps in Estimating High School Graduation Shadow Price.

Step	Task	Sources	Comment/Prefer
1	Predict earnings over life-cycle by level of education	Community Population Survey for the years 2002–2014	Current projections based on historical experience. <i>Consider recent demographic and economic trends; make estimates conditional on specific demographic characteristics.</i>
2	Adjust earnings for fringe benefits to get full compensation	United States Bureau of Labor Statistics (2017)	Current projections based on historical experience. <i>Consider implications of gig economy.</i>
3	Adjust full compensation for predicted real economic growth over life cycle	Washington State Institute for Public Policy (2018)	Current projections based on historical experience. <i>Rather condition value on assumed values of real economic growth.</i>
4	Adjust estimates to take account of mortality risk during working life	United States Life Tables (Arias 2014)	Assumes mortality risk independent of education. <i>Make mortality risk conditional on educational attainment.</i>
5	Net out effects of cognitive and other endowments from education attainment	Heckman et al. (2015)	Relies on complex econometric estimates. <i>Seek additional estimates for robustness.</i>
6	Discount stream of gains from high school graduation for time to obtain present value	Various discount rates including OMB's 3 and 7 percent; Moore et al. (2004); Boardman et al. (2018)	Assumes retirement at age 65 ignoring benefits beyond working life. <i>Adjust time horizon to account for work beyond 65.</i>
7	Specify probabilities of alternative educational paths following high school graduation	Current Population Survey ()	Assumes current educational paths. <i>Specify path ratios by state or local jurisdiction.</i>
8	Adjust estimates to take account of the costs of education	National Center for Education Statistics	Assumes recent costs. <i>Update cost ratios and estimates frequently.</i>
9	Take account of possible impacts from increased productivity on the rest of society	Acemoglu and Angrist (2000); Breton (2010); Belfield et al. (2011)	Assumes productivity spillovers continue over working life and ignores improvements in consumption efficiency. <i>Consider ways of integrating consumption efficiency into estimates.</i>

We now explain the basis for each of the nine steps and the major sources for each of them. These data are not perfect (as is normally the case!). So, in the spirit of fostering the dissemination of shadow prices that might be usable in other CBA studies, we discuss both the weaknesses and potential improvements or augments to the value of the high school graduation shadow price.

(1) Life-Cycle Earnings by Educational Level

Conceptually, the social valuation of all increments to education begins with its effect on the productivity of individuals: better-educated workers are generally more productive, so that their labor produces greater value to the economy. Most of the value of that increased productivity accrues to employed individuals themselves, but some accrues to other members of society. The starting point for assessing productivity, therefore, is earnings, which depend on wages set by the marginal contribution of the worker to the value of output. Incremental earnings for higher levels of education reflect greater productivity.

WSIPP used data from the Community Population Survey (CPS) for the years 2002–2010 to estimate average earnings by age cohorts for people with four distinct levels of education: less than high school diploma, high school diploma, some college (including associates degrees), and four-year college or more advanced degree. In this analysis, we are primarily interested in high school graduation, but briefly discuss other levels of attainment because the various sequential levels are inextricably linked. As explanatory variables, the WSIPP model included both age and the square of age (a quadratic function), as well as indicators for years. Boardman et al. (2018) added data for years 2011–2014 and also re-estimated the model. Following WSIPP, they used the total value of personal earnings (PEARINVAL) as the dependent variable. It was derived from the March Supplement updated to 2016 dollars, using the U.S. Bureau of Labor Statistics (BLS) implicit price deflator. These earnings were weighted using basic standard socio-demographic probability factors (the variable MARSUPWT). The CPS data included individuals with no earnings and, therefore, the estimates took account of expected labor force participation (LFP) over individuals' normal working years. Boardman et al. (2018) ignored

part-time earnings, assumed on-time college graduation, and assumed zero earnings for both those aged 18 and 19 (for those with some college) and for those aged 18 to 21 (for those with a college degree). For age groups, Boardman et al. (2018) set the age 24 earnings at the real value estimated from the 2014 CPS; in other words, they used 24 as the reference point age in their model. They then predicted earnings for ages over 24 using the estimated equations. Earnings for those younger than 24 years were also taken for each group from the 2014 CPS.

This approach assumes that the estimates of the effects of age and education on earnings in recent years provide good predictions of these effects in the future. Demographic trends, such as the ageing of the population, and economic trends, such as increasing use of artificial intelligence and robots, may eventually change the underlying relationships between education and earnings. Accurately predicting such trends and their impacts is beyond the capabilities of social science. Fortunately, the discounting process we discuss in step 6 places greater weight on nearer term impacts less affected by trends. Nonetheless, the possibility of major shifts in the structure of the economy introduces uncertainty beyond that accounted for the sort of evidence-based analysis we present here.

Note that it would be possible to develop the relationships of earnings to age conditional on demographic characteristics as well as education attainment. For example, it could be that, specifically, in the U.S. context, the earnings of African Americans and other minorities depend more on high school graduation than do the earnings of whites. As most competent CBAs seek to measure benefits as the aggregation of the benefits and costs borne by individuals with standing, the higher earnings would be relevant for assessing the efficiency of a policy that differentially increases the graduation rate of African Americans. Most analysts would regard this finding as worth reporting. However, the corollary is that the effect of education on earnings is not as large as for whites. Would the politico-bureaucratic environment allow analysts to value other groups' high school graduations less than for African Americans? These valuation questions are not purely hypothetical as is shown by the proposal of the Environmental Protection Agency to value mortality risk reductions more for younger than older people (Aldy and Viscusi 2007).

(2) Adding Fringe Benefits to Estimate the Value of Total Compensation

Earnings do not fully capture the cost of labor to firms and therefore differences in earnings alone underestimate the value of gains in productivity to society. Additionally, firms not only pay wages, but also usually provide additional employment benefits, such as health insurance and retirement contributions. Estimates of the value of productivity gains from educational increments to the employed should be based on total compensation; that is, on dollar earnings plus the estimated dollar value of all fringe benefits. There is a significant difference in the value of earnings and total compensation to individuals. The WSIPP derived an average ratio of total compensation to wages of 1.441, using BLS data on the percent of total compensation paid to civilian workers as wages. Boardman et al. (2018), however, estimated the ratio of total earning to wages to be somewhat higher at 1.462. They then multiplied wages for an education level and projected age category by this ratio (United States Bureau of Labor Statistics 2017).

Using contemporary estimates of the value of fringe benefits to predict future total compensation may introduce error in out-year predictions if the structure of the economy changes. For example, many so-called gig jobs, such as Uber and Lyft driving, do not provide the sort of fringe benefit packages commonly offered by conventional firms. If the proportion of the workforce in the gig economy grows, then the contemporary estimates of fringe benefits are likely to lead to overestimates of full compensation in future years. (3) Adjusting for Predicted Real Growth in Total Compensation

over Time Both earnings and fringe benefits can be expected to grow in real terms over time as technological improvements increase the productivity of workers to some extent, either immediately or eventually. However, there is considerable evidence that technological change has differential effects on the value of labor for workers at different levels of education (Moretti 2004). For example,

technological change that induces plant automation almost certainly reduces the relative value of the labor of less-educated workers compared to that of more-educated workers (Doms et al. 1997; Riddell and Song 2017). Predictions of future earnings and total compensation, therefore, should try to take account of secular changes in productivity related to technological change and other related factors.

In terms of making plausible predictions about future productivity, the devil is in the implementation details. The most straightforward approach to predicting changes in future (real) earnings is to assume that the rate of change will continue to follow recent trends. WSIPP analysts estimated growth rates in real earnings and the ratio of total compensation to earnings based on time series analyses of annual data over the last six U.S. business cycles (a relatively long time period). Boardman et al. (2018) used the WSIPP estimates for the real annual growth rate in earnings. Most relevantly to this analysis, they estimated the change to be negative at -0.0062 for those without a high school diploma as against positive 0.0053 for those with a high school diploma. They also used the WSIPP estimate of 0.00041 for the annual growth rate in the total compensation to earnings ratio. Using these assumptions, they projected average real total compensation by age. Their estimates are averages at particular ages and, therefore, took into account an estimated LFP rate at particular ages; that is, they accounted for the zero earnings of those who are not employed. Workforce participation is predicted to decrease at older ages for all educational levels, so average earnings eventually decrease even for more highly educated groups that are predicted to enjoy positive real growth in wages. As with earnings and total compensation, predicting real wage growth assumes historical continuity.

Table 2 pulls together these three initial steps in order to summarize the ratios of earnings for high school graduates, those with some college, and college graduates relative to the earnings of those who have not graduated from high school. These further levels of education are relevant to this analysis because almost all further education requires high school completion. Table 2 further disaggregates these ratios to the ages 30, 40, 50 and 60. As one would expect, given our discussion and the evidence, those ratios are consistently larger for a higher level of educational attainment at any age. Also as one would expect, the ratios increase in size with age. For example, on average at age 30 years those who graduate from high school—but obtain no further education—earn 1.54 times more than those who do not graduate from high school. This ratio grows to 2.25 by age 60. In sum, high school graduation pays off for employees. Furthermore, the individual gains from high school graduation (perhaps surprisingly) are somewhat equally spread over a working life, even though one might expect them to decline more quickly than they would at any higher level of education.

Table 2. Ratio of Earnings of Some College or College Completion Relative to No High School Completion at Selected Ages.

Years of Age	High School Graduate	Some College	College Degree or Higher
30	1.54	1.76	2.97
40	1.74	2.10	3.65
50	1.97	2.52	4.54
60	2.25	3.07	5.82

(4) Adjusting Estimated Earnings to Account for Predicted Early Mortality

Table 2 demonstrates that productivity gains accrue over the whole working lives of individuals. As a starting point, it is reasonable to assume that people continue to work to the assumed standard age of retirement. However, some people die before they reach retirement age, unfortunately terminating the productivity gains that derive from education or anything else. To take account of the risk of premature mortality, each year of earnings is weighted by the probability of surviving to the next year. As these probabilities are solely based on age, they do not take account of important demographic differences, such as gender (Arias 2014). Further, and most relevant to this analysis, using undifferentiated survival probabilities assumes that mortality risk is not causally related to

education level. There is certainly a positive association between better health and higher levels of education (Goldman and Smith 2011; Deaton 2015). However, the *causal* relationship of education on health—including mortality—is much more complex. Nonetheless, a higher education level almost certainly contributes to greater longevity and other positive behaviors and outcomes (the “health gradient”) though there is likely some reciprocal causality with better health contributing to educational attainment (Haas 2006). Ignoring this, almost certainly results in a bias that underestimates the productivity gains deriving from education (Cutler and Lleras-Muney 2010). However, the impact of these mortality differences is likely to be less important for young age cohorts. Furthermore, the impacts of the mortality difference on the present value of productivity gains are likely to be relatively small because of discounting.

(5) Netting out the (Non-Educational) Causal Effects

Superior cognitive, non-cognitive, health, and other endowments may make some individuals more productive than others at any level of education. Fortunate individuals with better cognitive and health endowments may very well have had earnings like others at their education level, even if they had not attained that level. Consequently, the difference in total compensation between high school non-completion versus completion risks overestimating the causal effect of moving from a lower to a higher level of educational attainment. Based on earlier analysis by Heckman et al. (2015), WSIPP provided an estimate of the causal effect of cognitive and other endowments versus those that can be reasonably be attributed to educational attainment. More recently, Boardman et al. (2018) employed the same causal factors as employed by WSIPP and applied them to high school graduates relative to those that did not graduate. They applied a causal effect of 50 percent to the present value of total compensation gains for those graduating from high school relative to the gains of those who drop out. In other words, half of the compensation gains were attributed to cognitive and other endowments rather than to educational attainments. Along the same lines, they imputed causal effects of 56 and 42 percent to the gains from some college relative to high school graduation and college degree or higher relative to some college, respectively.

Estimating the causal effect of educational attainment from observational data is challenging, requiring a number of modeling assumptions and the application of sophisticated econometrics. Additional efforts employing different data and methods would be welcome to increase the robustness of estimates of the causal effects of educational attainment.

(6) Discounting the Predicted Compensation Streams

When policies have costs and benefits that vary over time, CBA values them in terms of their present values, and ultimately in terms of the net present value (NPV). Present values of policies with long time horizons are quite sensitive to the selected social discount rate level. Estimates based on people’s willingness to trade current for future consumption (the marginal rate of pure time preference) tend to be lower than estimates based on the opportunity cost of public investment (the marginal rate of return on private investment), although the gap has been narrowing; estimates can also be modified based on optimal growth models (Moore et al. 2013).

The present value of the benefits of high school graduation is found by discounting the benefits over the 18–65-age range. Note that, although this age range is conventionally used to define the working life, there is actually considerable variation. As long as there is no systematic relationship between educational attainment and length of working life, this variation will have only a small impact on the shadow price estimates. However, if there is a relationship, such as much later retirement by those with higher educational attainment, then there could be a more substantial effect on the shadow price. Specifically, if those with higher educational attainment tend to work longer, then the estimated shadow price will be too small.

We do so initially separating the individual (private) benefits from the external (public) benefits as this facilitates replication or further adjustments. Table 2 which we discuss below in detail shows

calculations including 3 percent and 7 percent, the dual discount rates recommended by the Office of Management and Budget (OMB) for use in regulatory CBAs ([United States Office of Management and Budget 2003](#)).

(7) Specifying Pathways across Different Educational Levels

In a world where high school graduation was the only sheepskin effect, the difference in the present value of lifetime productivity of those who have—as against those who have not—graduated from high school would appropriately measure the total productivity gains from education. However, the completion of high school is a required gateway for most of the options for further levels of education and, therefore, for additional gains in productivity that are essentially contingent on achieving high school graduation.

WSIPP used percentage estimates of expected value of these mostly sequential options that were specific to Washington State. Their percentages were 26, 38, and 36, respectively, for the three levels of educational attainment. To develop a U.S. national estimate, [Boardman et al. \(2018\)](#) used data from the CPS. Using it, they estimated that, conditional on earning a high school diploma, 34 percent of those who graduated obtained no further formal education, 31 percent went on to obtain some college, and 35 percent continued on to earn a bachelor's degree or higher. In sum, they estimated that nationally 66 percent of graduating high school students pursued some additional higher education, which is, not surprisingly, somewhat lower than the 74 percent found in Washington State.

As will be clear from the differences in probabilities between the Washington state and national educational pathways, the national shadow price can differ from that estimated for particular states. The pathways may also differ among local jurisdictions. Ideally, analysts should use the particular pathway probabilities relevant to the affected population of the policy being assessed. As these probabilities can be readily altered, this is one adjustment that most analysts would be able to make provided they have local data on educational paths available.

A more fundamental adjustment would be to relax the assumption that all post-secondary education occurs immediately after high school graduation. In practice, some adults will go on to obtain higher education after some period of employment. Estimates of the frequency of later attainment, as well as the assumption that later attainment has the same effect on productivity as earlier attainment, would allow these less traditional paths to be built into the shadow price estimate.

(8) Adjusting Estimates to Account for Educational Costs

Education involves both an opportunity cost for the student and imposes real resource costs on society. The WSIPP analysis assumed that the marginal cost of completing high school is zero—that is, there would be negligible real resource savings by schools from each additional drop out. However, [Boardman et al. \(2018\)](#) estimated the opportunity cost to students from undertaking incremental study by assuming zero earnings for ages 18 and 19 for those who obtained some college and for ages 18 through 21 for those who obtained a college degree or higher. They calculated that the present value of the resource cost of education by discounting an average annual cost of college of \$19,281 for two-year colleges for those with some college and \$28,043 for four-year colleges over these age ranges ([Ginder et al. 2016](#)). As with educational path probabilities, these costs can be readily updated by calculating the present value of annual incremental changes and subtracting their present value from shadow price.

(9) Adjusting Estimates to Account for Externalities

The higher earnings resulting from greater productivity can also create important external benefits (we assume there are no external costs or that they are already netted out). High school graduation raises what would otherwise be relatively low wages. As a consequence, it can reduce participation in crime, improve consumption and fertility choices, and enhance intra-family productivity. The evidence shows it normally does ([Haveman and Wolfe 1984](#); [Wolfe and Haveman 2001](#); [McMahon 2018](#)). The WSIPP analysis drew upon a number of studies to specify a range of external benefits, expressed

as a fraction of total compensation and estimate that range as being between 0.13 and 0.42 (Acemoglu and Angrist 2000; Breton 2010). WSIPP considered 0.37 to be the modal value of these external benefits (Belfield et al. 2011).

Taking account of the externalities of educational attainment raises a number of shadow price estimation questions. First, is it reasonable to assume that externalities are proportional to total compensation across the income range? We think it is reasonable that external benefits, such as reductions in crime, would come disproportionately from increases in total compensation going to lower income individuals. Second, there might be non-market benefits, or “internalities,” that increase with education. For example, educational attainment almost certainly enables people to be more informed consumers. More speculatively, it is possible that educational attainment contribute to more effective participation in public affairs that increases the overall efficient use of resources. Evidence-based answers to these questions would have value in policy analysis beyond the estimation of the shadow price of high school graduation.

5. Shadow Price Estimates under Different Parameter Assumptions

Table 3 summarizes our main results. It shows a number of different estimates of the net benefits of a single high school graduation under a number of assumptions and scenarios. The most important finding is, as Table 3 shows, that a high school graduation provides net benefits, even at the highest discount rate shown. The first column of Table 3 shows the alternative potential social discount rates, which range from 2 percent to 7 percent. Columns 2 and 3 show estimates of the shadow price of a policy-induced high school graduation in the United States under each of the shown discount rates. The top number in each cell of columns 2 and 3 is the point estimate using the modal values discussed above. The second and third numbers, alternatively, show means and the standard deviations from the Monte Carlo simulations, which each employed 1000 trials. The simulations introduce uncertainty into the productivity measure by assuming that the causal factors are normally distributed with the same standard deviations as those utilized by WSIPP.

Table 3. U.S. High School Graduation Estimates: Alternative Discount Rates and Specifications, Point Estimates and Monte Carlo Means (and Standard Deviations) in 1000s of 2019 Dollars.

Real Discount Rate (1)	Productivity with Education Costs (2)	Productivity with Education Costs and Externalities (3)
2%	304	435
	300	407
	(60.3)	(82.2)
3%	228	332
	228	313
	(45.8)	(62.9)
4%	173	255
	171	238
	(37.6)	(51.7)
5%	131	216
	128	198
	(30.5)	(41.7)
6%	99	154
	98	142
	(25.4)	(34.4)
7%	75	121
	74	111
	(20.0)	(27.0)

Source: Adapted from Table C17.1, Boardman et al. (2018, p. 508) with additional calculations by authors.

For each of the discount (column 1), column 2 shows the shadow prices only including productivity gains and educational costs accruing to individuals'—essentially, the private returns of high school graduation. Most relevantly from a CBA perspective, column 3, following the WSIPP estimation procedures, provides estimates that include the estimated positive externalities—the aggregate social returns from graduation. The value of these positive externalities are estimated as being proportional to increased earnings, according to a triangular distribution over the range 0.13 to 0.42, with a modal value of 0.37.

Not surprisingly, the selected (real) discount rate from column 1 of Table 3 have a substantial impact on the ultimate (dollar) estimated value of the shadow prices shown in the cells of both columns 2 and 3. The U.S. Office of Management and Budget (OMB), which reviews the RIAs for major rules issued by administrative agencies, recommends that analyses use discount rates of either 3 percent or 7 percent in calculating present values (both of these rates are shown in column 1 of Table 3). The value of any shadow price at the lower 3 percent rate is almost three times its value at the higher 7 percent rate (obviously it is even higher at the lowest 2 percent rate). It is worth mentioning that CBAs of social programs often avoid overtly discussing the discount rate because they focus on, and often only report, the costs and benefits that occur on a one program-year basis. However, when an immediate impact, like high school graduation, actually casts a long shadow into the future, some unstated discount rate is implicitly embedded in the shadow price. So, although the impact of the discount rate is hidden, its value importantly affects the resulting estimate and the issue is only hidden, not eliminated. So preferably the implicit discount value should be revealed and discussed explicitly.

6. The Value of an Additional Graduate

As an illustration of the use of the high school graduation shadow price, we suppose that we are conducting a CBA of a program that is predicted to result in an additional 100 students graduating from high school (as explained below, we deliberately focus on a program that graduates only a relatively small number of additional students). We use the 3 percent discount, the lower of the two recommended OMB social discount rates. We also include positive externalities to estimate the shadow price for the additional 100 graduations, using either of the top two numbers in column 3 of Table 3. The estimated shadow price value of a *single* graduate including external benefits using the point estimate is \$332,000. Consequently the social monetized value of an additional hundred graduations produces a benefit estimate of \$33.2 million (\$332,000 times 100).

Alternatively, analysts could use a shadow price derived from the Monte Carlo simulations. The shadow price value of a single graduate (again including external benefits) based on the Monte Carlo simulations is slightly lower at \$313,000. This estimate takes into account several important parameter uncertainties. Using this approach, shown as the second number in the column 3 of Table 3 (and again using 3 percent) produces a slightly lower aggregate benefit estimate of \$31.3 million, rather than \$33.2 million.

As CBAs of social policies often involve many uncertain parameters, most analysts believe it is more appropriate to predict a distribution of net benefits using the Monte Carlo simulation approach rather than use a point estimate. For example, CBA analysts would likely think one should be uncertain about the exact number of additional graduations under any particular policy alternative (Weimer et al. 2019). Thus, to include the benefit of high school graduations in their CBA, analysts would draw a value from some assumed distribution of the number of graduations. If they drew a distribution using column 2 numbers and a 3 percent discount rate, they would get a mean value of \$275,000 with a standard deviation of \$58,800. This distribution takes account of the uncertainty in both the predicted impact and its shadow price, along with other modeled uncertainties.

7. Conclusions

The availability of a shadow price for valuing additional U.S. high school graduations increases the feasibility of conducting a range of social policy CBAs. It increases feasibility not only of education

policies, but also of policies in public health, criminal justice, child welfare, and other areas that can affect the likelihood of high school graduation. WSIPP played an important role in drawing on existing academic research and available data to develop this important shadow price. We analyze the steps in the WSIPP methodology and, following Boardman et al. (2018), update and expand on their approach to provide up-to-date shadow prices under a number of varying assumptions. A plausible shadow price for a high school graduation is inherently valuable in applying CBA to various areas of U.S. social policy, but, as we discuss throughout the article, we can improve the estimates of the value, especially for particular groups of interest. Additionally, we encourage other social scientists to identify and develop additional shadow prices, especially for social policy arenas. Reducing the cost of doing CBA through increasing the availability of such “plug-in” values will potentially contribute to better public policy in social policy in the future.

We note one important limitation of the shadow prices presented in this article. These shadow prices of high school graduation only take into account minimal demographic characteristics of the high school population. For example, we do not differentiate between returns accruing to males and females. The relative value of male versus female shadow prices is not clear *ex ante* because there are quite a number of potentially offsetting effects. Women currently do earn less than men controlling for education level, but the ratios of total compensation at different education levels could be larger or smaller for women than for men. In most jurisdictions, women have lower mortality rates than men, but offsetting this, women also tend to have lower labor force participation rates, which reduce aggregate societal benefits. Women are less likely to commit crimes, so their incremental education may generate smaller positive externalities than men. However, as women are usually more directly involved in socialization of children, their education is likely to yield larger other kinds of positive externalities. CBA assess efficiency so different gender shadow prices would be appropriately used for men and women if available, but in addition, these differences would also increase the importance of embedding the CBA in a broader analysis that also takes account of the differences from an equity perspective.

It is worth noting three more specific caveats about the estimated shadow price of high school graduation. First, unlike some other shadow prices, this shadow price is quite specific to the U.S. and is not readily transferrable to other countries. This is in contrast to other well-developed shadow prices derived from U.S. sources, such as the value of statistical life or the shadow price for valuing changes in mortality risks, which can be usefully transferred to other countries by taking account of baseline risks and income levels (Hammitt and Robinson 2011). The value of an incremental high school graduation shadow price depends fundamentally on data and assumptions based on the U.S. labor and educational market contexts. The good news is that analysts in non-U.S. jurisdictions could readily employ the general methodology employed here to develop customized shadow prices for educational attainment that are specific to their jurisdiction of interest.

Second, and relatedly, this shadow price is only applicable to incremental changes in U.S. graduation rates. It can reasonably be used in a range of CBAs of local social policies that individually do not substantially affect the distribution of educational attainment in the U.S. as a whole, but it would not be reasonable to use the shadow price to answer the question about the social benefits of achieving nearly universal graduation from high school in the United States—that is about a non-marginal output change in graduation levels. Large changes in the distribution of attainment would almost certainly change the relative returns to the higher levels of educational attainment that primarily drive the value of the shadow price.

Third, because the shadow price we recommend relies on a large number of empirical estimates of parameters that cannot be known with certainty, its value should be viewed as inherently uncertain; the standard errors from the Monte Carlo simulations provide only a rough gauge of this uncertainty. Predictions of the values of the full compensation parameter implicitly assume that the structure of the U.S. economy will remain roughly the same over the next generation. Estimates of the causal impacts of educational attainment rely on econometric procedures that can be prone to giving misleading results. Estimating the value of the wide range and kind of positive externalities of education inevitably

requires reliance on a large number of assumptions and diverse empirics. For example, it is certainly a strong assumption that these externalities are proportional to compensation over the entire range of worker compensation. Yet, a CBA cannot provide a good assessment of the relative efficiency of public policies if important effects are simply ignored. In these circumstances, valuing these impacts with an uncertain, but plausible, shadow price is better from a CBA perspective than is ignoring them. This would be the effect of setting the shadow price of these externalities effectively to zero by leaving the impact out of the analysis (Weimer 2015). Nonetheless, because of the various limitations and caveats, the shadow price we propose should be viewed as plausible, but approximate.

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