Estimating the Social Value of Higher Education: Willingness to Pay for Community and Technical Colleges*

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Abstract: Much is known about private financial returns to education in the form of higher earnings. Less is known about how much social value exceeds this private value. Associations between education and socially-desirable outcomes are strong, but disentangling the effect of education from other causal factors is challenging. The purpose of this paper is to estimate the social value of one form of higher education. We elicit willingness to pay for the Kentucky Community and Technical College System (KCTCS) directly and compare our estimate of total social value to our estimates of private value in the form of increased earnings. Our earnings estimates are based on two distinct data sets, one administrative and one from the U.S. Census. The difference between the total social value and the increase in earnings is our measure of the education externality and the private, non-market value combined. Our work differs from previous research by focusing on education at the community college level and by eliciting values directly through a stated-preferences survey in a way that yields a total value including any external benefits. Our preferred estimates indicate the social value of expanding the system exceeds private financial value by at least 25 percent with a best point estimate of nearly 90 percent and exceeds total private value by at least 15 percent with a best point estimate of nearly 60 percent.

Keywords: social returns, education externalities, community college, contingent valuation, earnings

JEL classifications: I2 Education, H4 Publicly-Provided Goods, H23 Externalities

1 Introduction

A great deal is known about private returns to education for the individual in the form of higher earnings. Less is known about the social value of education over and above the private, individual, market value, but interest in the difference is great. The purpose of this paper is to estimate the social value of one form of higher education. We elicit willingness to pay for the Kentucky Community and Technical College System (KCTCS) directly through a stated preference, contingent valuation survey and compare our estimate of total social value to estimates of private, individual value in the form of increased earnings. Our estimates of increased individual earnings are based on two distinct data sets for Kentucky, one administrative and one from the U.S. Census. We estimate the education externality by subtracting the education benefits to individuals, both financial and non-market, from the estimated total social value. In our preferred estimates, the social value of expanding the system exceeds private financial value by at least 25 percent with a best point estimate of approximately 90 percent. Total social value exceeds total private value by at least 15 percent with a best point estimate of about 60 percent if private value of non-market value is assumed to be half as much as private financial value.

Our work differs from previous research by focusing on higher education at the community college level and by using unique administrative data on community college students. Community colleges are important because they account for about one-third of all post-secondary enrollments and nearly one-half of all enrollments in public post-secondary institutions (U.S. Department of Education, 2008). They are considered the "Ellis Island of American higher education," providing a route to higher incomes for many lower income individuals (College Board, 2008). President Barack Obama held a

White House Summit on Community Colleges and identified them as one of the keys to the future of the country (White House, 2010). Another way in which our work differs is by eliciting values directly through contingent valuation in a way that yields a total value that includes any spillover benefits in the form of increased productivity or enhanced quality of life for others in the area as well as expected increased earnings.

The rest of the paper is organized as follows. The next section reviews estimates of the private value of higher education. Sections 3 and 4 describe the elicitation of willingness to pay for higher education and expansion of KCTCS, section 5 presents estimates of the total social value, and section 6 presents the estimates of private financial value. Section 7 compares the estimates of total social value to private financial values with the difference being the education externality and private, non-market value combined. Section 8 compares the estimates of benefits of KCTCS expansion to the costs and includes a sensitivity analysis. Conclusions and discussion make up section 9.

2 Individual, Private Value of Education

Workers with higher education typically have higher earnings. Card (1999) summarizes a vast literature on individual returns to education with discussions of various estimation techniques. Straightforward, single equation estimates show that an additional year of schooling raises yearly earnings five to ten percent. More complex estimation strategies attempt to determine the causal effect of education on earnings by separating the effects of ability and other factors that can be correlated with schooling from the effect of schooling. These analyses use multiple equations and/or special

populations such as identical twins and tend to find higher returns - at or above ten percent.[1]

The private value of education is not limited to higher labor market earnings for the individual.[2] Grossman (2006) suggests that education leads individuals to be more efficient in producing the commodities they consume directly. Better health is thought to make up a large share of the nonmarket return. Cutler and Lleras-Muney (2008) analyze the large and persistent association between education and health and suggest that the value of increased life expectancy due to education raises the private, individual returns to education substantially. Becker and Murphy (2007) consider various differences between the impacts of education in the household and the market. They argue that due to accumulation of general skills that are especially useful in the modern household, the returns to education in the household sector may have grown more than in the market over the last 40 years. Oreopoulos and Salvanes (2009) explore how education affects measures of lifetime well-being for individuals. They too present evidence of substantial non-pecuniary (nonmarket), private returns. In this study we estimate the private financial gains, i.e. the discounted present value of expected gain in earnings less the costs of schooling to the individual. Attributing all the difference between total social value and private financial gains to an education externality would

[1] Heckman, Lochner, and Todd (2006) scrutinize this research based on the Mincer (1974) equation and estimate more general, nonparametric earnings models that allow for earnings to vary by year after completion (nonlinearity) and allow for the nonstationarity of earnings over time. Their analysis shows (1) assuming linearity leads to a downward bias to the return, (2) taking into account taxes has little impact on the return estimates, (3) taking into account tuition costs of schooling lowers the return to college by a few percentage points, and (4) psychic costs, in addition to money costs, can be a barrier to college education. Their work emphasizes that the private returns to education are substantial.

[2] Wolfe and Haveman (2002) identify and describe intrafamily productivity, marital choice efficiency, health of children, crime reduction, charitable giving, and social cohesion as schooling outcomes that are part of nonmarket private returns and social returns.

tend to bias the estimate of any externality upward. To address this issue, we divide the difference based on information from other studies in order to estimate the education externality.

All returns discussed so far accrue to individuals, who are part of society. Our interest, however, is in estimating the extent to which the value of education exceeds the value to the individual, i.e., the extent to which social value exceeds the private value.

The idea that education generates benefits beyond the private gains to individuals is fundamental (Oreopoulos and Salvanes, 2011). Higher education can lead people to live in ways that contribute more to public health (Kenkel, 1991; Wheeler, 2008; Lochner, 2011b), behave in ways that produce less crime (Lochner and Moretti, 2004; Lochner, 2011a, Demming, 2011; Meghir, Palme, and Schnable, 2012), and act in ways that contribute more to civic activity and good governance (Friedman, 1962; Dee, 2004; Milligan, Moretti, and Oreopoulos, 2004; Glaeser and Saks, 2006). Within labor markets, higher education can lead to greater productivity through agglomeration economies and higher rates of economic growth (Moretti, 2004a; Moretti, 2004b; Rosenthal and Strange, 2008; Winters, 2012). Moretti (2004b) notes, however, that there is little consensus among studies in the size of the education externality. He concludes his review by saying that the empirical literature is too young to draw definitive conclusions about the size of the education externality. Lange and Topel (2006) critically review the existing studies on social returns to education and the evidence that the "Macro-Mincerian" (social) return is greater than the "Micro-Mincerian" (private) return.[3] Their assessment of cross-country studies using aggregate data is that evidence of education externalities is inconclusive. Their own spatial equilibrium model of local

[3] See also Turner et al. (2007) and Yamarik (2008).

wage determination suggests that insufficient weight has been given to endogeneity issues in analyses of wages in cities and states in the United States. Correlations of proposed instrumental variables with the value of local amenities for the marginal worker are of particular concern. Lange and Topel (2006) draw the conclusion that the results do not provide a strong reason to believe in the importance of productivity externalities from education. They also discuss the signaling model of education that implies the spillover effect is negative and conclude signaling is a minor contributor to the returns to schooling.

Compared to the enormous volume of research on the private financial returns to education, evidence on spillovers or externalities associated with education, while growing, is small. Research appears to indicate positive externalities for quality of life in the form of better area health, less crime, and better governance. However, much of this evidence is recent and is sensitive to the choice of instrumental variables. We use an alternative approach that elicits the total social value of education directly.

3 Eliciting Willingness to Pay for Higher Education

To obtain estimates of the value individuals place on goods and services, we typically look to market prices. However, social outcomes related to education, such as better quality of life and higher productivity and growth in an area, are goods not explicitly traded in the market. Contingent valuation is a survey-based, stated preference methodology used for placing monetary values on goods with public benefits or goods which are difficult to value in the marketplace (Carson, 2012). Contingent valuation creates a scenario in which individuals are asked to state their willingness to pay (WTP)

for the good or service described. In essence, the contingent valuation method elicits a demand curve for a good valued by consumers but not traded in the market.

In this study, we estimate the total value of Kentucky Community and Technical College System (KCTCS) education using contingent valuation. Although market transactions take place for individuals who attend KCTCS, those transactions alone do not necessarily represent the total value of KCTCS. Some of the benefits of education presumably accrue to society as a whole and not just to individuals taking classes. Capturing the total social value of the system requires an estimation of the combined benefits that accrue to the individual and, if an education externality exists, society as a whole. This total value is estimated by sampling the population of Kentucky and offering individuals the opportunity to state their total value for KCTCS. This total value includes any benefit the survey respondent may receive personally if the individual attends KCTCS, and it also includes any other benefits the individual may receive such as better public decision making or higher area-level productivity.

4 Eliciting Willingness to Pay for the Kentucky Community and Technical College System

We elicit willingness to pay by administering a survey to a sample of Kentucky residents. The first section of our survey instrument includes questions designed to assist respondents in thinking about their experience with and knowledge of KCTCS. In the second section, respondents are asked to allocate a fixed increment in state budget dollars to various state program areas. This section reminds respondents that increased spending in one budget area has opportunity costs and includes a statement that their responses will help administrators make decisions that reflect the views of the people of Kentucky. We

also asked questions designed to stimulate respondent thinking about the different types of benefits they might receive from KCTCS. The third section contains the valuation scenario along with questions regarding response certainty. To obtain valuations, the survey asked individuals if they would be willing pay a specified dollar amount for a 10 percent expansion in KCTCS. We focus on a 10 percent expansion because it is plausible to think about expanding the system by 10 percent and because it is the change for which we have the best data. In the last section, demographic information was collected in order to allow us to analyze willingness to pay by respondent characteristics such as gender, age, income, and education levels.

The survey described the expansion in terms of the number of programs offered through the community and technical college system, and it was presented in the context of changing budget priorities by state government. The proposed 10 percent expansion would increase the number of programs offered from 96 to 105, increase the output of associate's degrees, diplomas, and certificates by 10 percent, and be accompanied by an accommodating increase in the number of faculty, staff, and structures. The survey was used to create a hypothetical referendum in which respondents had a chance to vote on the proposed expansion. While various valuation formats exist, our study follows Arrow et al. (1993) and uses the dichotomous choice referendum format. The respondent was told that if the referendum passed, there would be a one-time increase in taxes. The respondent was asked the following question:

> "Would you vote for the referendum to expand the Kentucky Community and Technical College System by *10%* here and now if you were required to pay a one time *$T* out of your own household budget?"

where *T* was an amount from the following set: 400, 250, 200, 150, 125, 100, 75, and 25. Only one tax amount was presented to each respondent, but different amounts were presented to different individuals so that the value of KCTCS expansion could be estimated. The values of the tax were chosen based on input from focus groups and from data received from testing the survey.[4]

Knowledge Networks, now part of the marketing research firm GfK, administered the survey in June and July 2007. The survey data was collected using two samples. The first sample consisted of respondents in Kentucky drawn from Knowledge Networks' nationally representative web panel. For this sample, the survey was administered online. The second sample was based on a white pages phone number, random sample of Kentucky households. Addresses were matched to phone numbers and the mail sample was distributed proportionally across the state. The response rate from the web panel was 74 percent (275/370), and the response rate from the mail survey was 29 percent (2,681/9,196). The response rate for the survey overall was 31 percent (2,956/9,566). The number of usable observations for this study is 1,023.[5] The lower response rate of the mail version is not unusual for a complex survey like this one. However, it leads to the question of whether the mail-based sample suffers from non-response bias, despite

[4] Two professionally moderated focus groups consisting of Kentuckians were conducted to ensure that respondents' understanding and interpretation of the survey questions matched the intention of the survey authors. One group consisted of eight members of the Donovan Scholar Program, who are individuals over age 65 who were attending selected classes at the University of Kentucky. The second focus group consisted of eight returning students who were attending the Maysville Community and Technical College. Focus groups were recorded and the results were used to refine elements of the survey. The complete survey instrument is available on line at http://cber.uky.edu/pdf/CBER_UL_KCTCSReport_10-2007.pdf.

[5] Knowledge Networks invited 370 members of its web panel to participate in the web-based sample. 275 responded yielding a response rate of 74 percent. The mail-based sample consisted of an initial mailing of 10,000 households. 804 were undeliverable. A total of 2,681 surveys were returned for a response rate of 29 percent (2,681/9,196). Not all 2,956 web and mail observations are usable due to: a wording error on two versions of the survey (1,486), protestors who did not vote for the referendum and indicated in a follow up question "my household should not have to pay more taxes to fund the expansion" (261), and item nonresponse for variables in the logit regression (186). The number of remaining usable observations from the web (109) and mail (914) surveys is 1,023.

the good professional practices of Knowledge Networks. Although we cannot say anything about unobservables, the demographic characteristics of the high-response rate, web-based sample, the lower response rate mail-based sample, and the values from Census data are all similar.

Table 1 compares demographic information for the two sets of survey respondents and for the U.S. Census Bureau's 2007 American Community Survey (ACS). Compared to the ACS, the KCTCS survey sample is quite similar. The similarity of these observable characteristics suggests, but does not demonstrate, that non-response bias is not an issue.[6]

Table 1 about here.

Another potential issue is bias due to the hypothetical nature of a constructed market. Concerns exist about the validity of the contingent valuation method and the reliability of values elicited using it; see Kling, Phaneuf, and Zhao (2012) and Hausman (2012). Chief among those concerns is the possibility that respondents will not take the hypothetical nature of the survey seriously. Because no money changes hands, there is doubt that the hypothetical responses reflect what people would do if they actually had to pay money based on their decisions. Response to this concern has produced research on criterion validity in which hypothetical purchase decisions and real purchase decisions are compared. The hypothetical and real scenarios vary only in the fact that some respondents are asked if they *would* pay hypothetically, while others are asked if they *will* pay for real. Hypothetical bias occurs if contingent valuation respondents state they are

[6] Another indication, and one that might tell something about unobservable characteristics, is that when we control for whether an observation comes from the high response web survey or the lower response mail survey, the coefficient on the dummy variable for the web survey is not statistically different from zero. This result will be reported in Table 3 below for the logit analysis of the contingent valuation referendum responses.

willing to pay (typically) more for a good than they would be willing to pay in an actual purchase scenario. Hypothetical bias is not inevitable, but results of earlier studies indicate that it can be present (Blumenschein et al., 1997; List and Gallet, 2001; Little and Berrens, 2004; Harrison, 2006).

Several approaches have shown promise in eliminating hypothetical bias in estimating willingness to pay using contingent valuation (Cummings and Taylor, 1999; Champ and Bishop, 2001; Poe et al., 2002; Blumenschein et al., 2008).[7] In this study, we use follow up questions about how certain the respondents are that they will really pay to calibrate responses. Experiments in the classroom and the field by Blumenschein et al. (1998, 2008) using this follow up certainty question mitigation method produce calibrated hypothetical responses that are similar to comparable real responses.[8] In this current study, we report our estimates of willingness to pay for higher education based on responses calibrated for certainty in this way. For comparison we also report estimates based on counting all "yes" responses as true "yes" responses.

5 Results and Estimates of Total, Social Value

[7] Kling et al. (2012) assess the state of contingent valuation with emphasis on related research during the last twenty years. In addition to certainty statements, they report on successful avoidance of hypothetical bias by making the contingent valuation consequential. In other words, if respondents believe their responses will influence policy, then they report what they would really do. We do not include a consequentiality script. However, we do include the statement that responses will help administrators make decisions that reflect the views of the people of Kentucky in the second section of the survey instrument about budget choices, and we do ask for a vote in a referendum format.

[8] For example, Blumenschein et al. (2008, Fig. 2, p. 127) show a plot of price against percentage buyers for a field experiment in which a health management program was offered to individuals for real. Similar "demand curves" are shown for contingent valuation of the same good for both all "yes" responses and for calibrated "yes" responses. The calibration is that only "definitely sure yes" responses are classified as true "yes" responses. The demand curve for all "yes" responses is noticeably (and statistically) higher than the real demand curve. The hypothetical demand curve based on certainty-calibrated "yes" responses is virtually and statistically indistinguishable from the real demand curve. In other words, any hypothetical bias is not detectable after the calibration.

Each respondent is presented only one tax price, *T*, for the expansion of KCTCS, and the respondent makes a decision about willingness to pay that amount. In this referendum style contingent valuation respondents do not reveal the exact value of their willingness to pay. Instead, respondents answer "yes" if their willingness to pay is greater than *T* and "no" otherwise.[9] Because a total of eight different tax prices were used for different respondents, the sample average willingness to pay can be estimated. To analyze responses, we estimate a logit regression:

$$\Pr(\text{Yes}) = 1/(1 + e^{(-XB)}) \qquad (1)$$

where the dependent variable is the certainty-adjusted, yes/no vote response, and X includes the tax faced by the respondent, T, and a set of controls for age, sex, race, income, education, and experience with KCTCS. Mean WTP is estimated by $-(1/b_T)\ln(1 + e^z)$ where b_T is the estimated coefficient on the variable associated with the amount of the tax and *z* represents the effect of all of the other covariates evaluated at their means, including the constant. This estimate is appropriate when individual WTP is non-negative (Johansson 1995).[10] The result is an estimate of the total, social value (private value plus any spillovers) of an average household in the Commonwealth of Kentucky for a 10 percent increase in the size of KCTCS.

Table 2 about here

Table 2 gives the definitions and summary statistics for each variable used in the logit regression of contingent valuation responses. In addition to demographic

[9] Iterative valuation techniques tend to offer more precise estimates of willingness to pay but the precision comes at a cost. The iterations alter the incentives of respondents to reveal their willingness to pay. In addition, the initial round of valuation in iterative settings may contain unintended information that consequently alters an individual's valuation; see Whitehead (2002).

[10] Epstein (2003) evaluates the case for using contingent valuation and notes that, in general, possible negative values should not be ignored. Although some households may place a low or zero value on higher education, there was no indication of negative values in the focus groups.

characteristics there are three variables related to information about KCTCS. Twenty seven percent have taken a class from KCTCS, 53 percent have a family member who has taken a class, and 27 percent know an employee of KCTCS.[11] For households that were taking classes from KCTCS (less than 1 percent of our sample) or planning to take classes, the elicited value will be an underestimate of their total social value because it will be a value net of schooling costs. Their elicited value will be their expected gain in earnings (and nonmarket productivity) plus the value of productivity spillovers from others and quality of life spillovers less the tuition and other costs they expect to pay. For households that do not take classes from KCTCS, the elicited value will be their total social value and will be the value of the externalities related to productivity and quality of life aspects such as improved public health, less crime, and better citizenship. Previous studies have estimated education externalities separately using different methodologies whereas the contingent values elicited capture the total value of benefits of all types taken together.

Table 3 about here

Results from logit regressions of the referendum responses are shown in Table 3. To avoid potential hypothetical bias and produce a conservative estimate, only definitely sure "yes" responses are coded as true "yes" responses; other responses are coded as "no"

[11] Two additional variables are used to control for version of the survey. Based on a split sample study design some respondents were presented with a referendum and tax amount to prevent either a 10 or 25 percent reduction in the KCTCS and were also given a "cheap talk" exhortation to avoid hypothetical bias; see Cummings and Taylor (1999). Because we focus on the 10 percent expansion and use the follow up certainty questions to mitigate hypothetical bias and we want to control for any combined reduction, cheap talk effect, we include the two variables for reduction/exhortation. Because of a wording error on the survey we do not have parts of our sample that permit clean tests for the effects of cheap talk or reductions separately, but we control for their combined effects. See footnote 17 for a discussion of the implications for sample size.

responses. The calibration matters because of the 564 "yes" responses, only 272 are definitely sure they would really be willing to pay the increase in taxes.

The coefficient of the tax amount is negative and statistically significant. The effect of an increase of $50 is estimated to reduce the probability of voting "yes" by four percentage points. Income matters, especially at higher levels. The "marginal effect" of moving from the under $25,000 base category to the $60,000-99,000 category is an increase of 13 percentage points and moving from that category to the top income category adds approximately another 13 percentage points. Education tends to increase the probability of support, but the effects are imprecisely estimated. Support for KCTCS tends to increase with age and is strongest in the two oldest age groups. The probability of support is 21 percentage points higher for respondents age 65 and over compared to younger individuals in the 18 to 29 category. One interpretation of the stronger support among older respondents is that it is an indication of an education externality. Individuals 65 and older are less likely to earn certificates, diplomas, or degrees and reap the private benefits of higher earnings; their stronger support is more likely to be due to spillovers from less crime, for example. Support is greater for respondents whose family members have attended KCTCS and for those who know someone who works for KCTCS. The coefficient indicating that individuals were part of the web survey is not statistically different from zero at conventional levels.[12] Willingness to pay is estimated from the responses to the contingent valuation referendum.[13]

[12] The results reported above are based on the pooled sample that includes responses from the web and mail surveys. We stratified and estimated logits of the yes/no responses for the web and mail subsamples. Differences across the two are not significant at the 5 percent level.

[13] In addition to asking about willingness to pay for expansion of the KCTCS, we asked respondents about perceived benefits they receive from education. We asked respondents to allocate points to the various benefit categories. Respondents were told that allocating more points to a given category indicated that they believed education provided more benefit in the given category. Allocating no points to a given

Willingness to pay for the 10 percent expansion of the KCTCS is estimated using the Johansson (1995) formula (shown above) evaluated at the means of the variables. The parametric demand curve is estimated based on calibration with definitely sure "yes" coded as "yes" and equal to one and all three other responses coded as "no" and equal to zero. The parametric demand curve using this calibration to eliminate hypothetical bias is shown as the solid line in Figure 1. The mean WTP based on this calibration is $55.84. The 90 percent confidence interval estimated using the delta method is [$41.75, $69.92]. This WTP per household is our preferred estimate of the total social value of a 10 percent expansion of the KCTCS.[14] It includes the private individual returns through earnings

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category indicated that they believed education produced no benefits to the given category. If responses are grouped, individual, private benefits in the form of "wages of attendees" and "health of attendees" are at least about 24 percent of the total. Spillover productivity benefits in the form of "economic development," "technology," and "wages of non-attendees" are about 39 percent. If "crime" and "better public decision making" and "health of non-attendees" are added to spillover productivity benefits, they are about 68 percent of the total. Despite a separate category for "local purchases," respondents may be considering the local impact of a nearby community college rather than the local spillover benefits from enhanced human capital. They may be thinking about the cash inflow from state-provided payrolls and expenditures and the impact on local sales. See Siegfried, Sanderson, and McHenry (2007) for an exemplary discussion that makes a clear distinction between distributional impacts and efficiency spillovers associated with colleges and universities.

In Appendix Table A1 we report logit results that include two variables that combine the points allocated to quality of life (Crime, Better Public Decision Making, and Health of Non-Attendees) and productivity growth (Economic Development, Technology, and Wages of Non-Attendees). We also explored variables for the effect of a KCTCS campus being located in the county of residence, population density of the county of residence, and years the respondent has lived in Kentucky. None of these variables were statistically significant at conventional levels. The coefficient on Tax Amount, the key variable for estimating mean WTP, is influenced little by their inclusion. A set of dummy variables for regions in Kentucky was included in preliminary regressions, but they were jointly statistically insignificant and were dropped with little effect on remaining variables.

[14] If the sample is restricted to only respondents who were asked about a 10 percent expansion, the two control variables for cheap talk and reductions combined can be eliminated. This greatly reduces the sample size from 1023 to 526 and slightly reduces the estimate of mean WTP from $55.84 to $51.67. If the means from ACS 2007 are used where available instead of the means from our sample in evaluating the logit, the estimate of mean WTP is increased slightly from $55.84 to $57.92 [43.05, 72.79]. The nonparametric point estimates of mean WTP are substantially higher. The Turnbull estimate is $72.66 with a 90 percent confidence interval of [62.02, 83.31] which overlaps the confidence interval for the parametric estimate [41.75, 69.92]. The Kriström estimate of $94.95 [86.28, 103.61] does not overlap. Although we believe our sample is representative overall, we have less confidence that it is representative for the cells for each of the eight tax amounts. The parametric estimates control for differences in income, age, education and other observable characteristics and are our preferred estimates.

and health as well as any spillovers to others through higher wages, better health, household productivity, less crime, and better government.

Figure 1 about here

Households with a family member who has attended KCTCS can be expected to be more likely to gain directly from its expansion and value the expansion more highly than households without a family member who has attended KCTCS.[15] When willingness to pay is estimated by evaluating at the means of all variables except for *Family Attended*, which is 1 for families with a member who has attended and 0 for families without a member who has attended, the mean WTP is greater for households that expect direct benefits. For households with a member who has attended, the mean WTP is $67.32. The 90 percent confidence interval estimated using the delta method is [$49.18, $85.45]. For households without a member who has attended, the mean WTP is $45.13 with a 90 percent confidence interval of [$32.19, $58.07]. The parametric demand curves for these two groups are also shown in Figure 1. They, too, are based on calibration for potential hypothetical bias.

According to the ACS, there were 1.66 million households in Kentucky in 2007. Our estimate of aggregate willingness to pay for Kentucky households is $92.7 million with a 90 percent confidence interval of [$69.3, $116.1]. This estimate includes the private returns and any education externality which is realized through higher productivity and overall quality of life for others. Our preferred estimate is based on number of households because the question asks how the respondent would vote if required to pay a one-time tax out of its household budget. However, it could be that a respondent who does not pay income tax might believe that he or she would not have to

[15] In this study, household and family are used interchangeably for simplicity.

pay. The Internal Revenue Service (Cain, 2011, p. 200) reports 1.45 million income tax filers from Kentucky in 2007. If we assume that respondents thought that only income tax filers would pay if the referendum passes (and one filer per household), the aggregate estimate would be $81.0 million with a 90 percent confidence interval of [$60.5, $101.4]. It should be noted, however, that the contingent valuation question does not limit the tax to be paid to an income tax.

Our calibration using definitely sure "yes" is based on correcting for hypothetical bias in valuing private goods. For example, in the field experiment described in Blumenschein et al. (2008) the good was a diabetes management program provided by a pharmacist to an individual patient. KCTCS expansion presumably is a partly-private and partly-public good. Calibration may be different for private and public goods because strategic behavior can bias estimates of WTP. Free riding could produce underestimates while hypothetical bias could produce overestimates. Carson and Groves (2007) make the case that a single issue, dichotomous choice, referendum format that respondents believe will have influence on public decisions will be incentive compatible. The meta-analysis by Little and Berrens (2004) provides evidence that referendum format for contingent valuation reduces hypothetical bias for public goods. For comparison, in Figure 1 the dashed line shows the parametric demand curve for all (unadjusted) "yes" responses. The mean WTP for all who say "yes" is $212.21. The 90 percent confidence interval estimated using the delta method is [$175.53, $248.89]. The estimate of aggregate willingness to pay for Kentucky households is $352.3 million with a 90 percent confidence interval of [$291.4, $413.2]. Clearly, our adjustment to account for potential

bias makes a difference. The mean WTP for all respondents who said "yes" responses is 3.8 times the mean WTP for respondents who said "yes" and are definitely sure.

6 Estimating Individual, Private Financial Value: The Gain in Earnings

We estimate the individual financial returns to community college degrees compared with a high school diploma for the residents of Kentucky. By individual financial returns we mean the discounted present value of expected gain in earnings less the costs of schooling to the individual. Although there has been extensive research on the individual financial returns to higher education, in general that research focuses almost exclusively on the nation as a whole. In order to measure the private financial benefits of expanding KCTCS to Kentucky residents, we use two approaches.

In our first approach, we use data for Kentucky residents from the 2000 U.S. Decennial Census. We use these data to estimate the increase in work-life earnings of individuals associated with increased education levels, with a particular focus on the gains from attending a college without earning a degree and from obtaining an associate's degree. Specifically, we calculate discounted present value of lifetime earnings levels for each education level, taking into account tuition cost of the education and foregone earnings.[16]

Before calculating lifetime earnings levels, we start by estimating a standard Mincer (1974) earnings equation:

$$\ln Y_i = \alpha_i + \beta S_i + \gamma X_i + \varepsilon_i \qquad (2)$$

[16] In order to be consistent with our estimates of total social value, all dollar amounts have been converted to 2007 dollars using the CPI-U.

where ln Y is the natural logarithm of annual earnings, S is a set of dummy variables for highest degree, X is a set of demographic characteristics such as potential experience, race/ethnicity, and marital status, ε is the unobserved error term, and *i* denotes an individual. Among the variables included in S is a dummy variable for individuals who have completed an associate's degree as their highest level of education.

When estimating equation (2) we restrict our sample to individuals between the ages of 20 and 60 who live in Kentucky, have at least a high school degree, and have positive work earnings for 1999 for a total of approximately 76,000 observations.[17] We also estimate the model separately for men and women. Table 4 contains the results from our estimation. The coefficients for education levels can be interpreted (approximately) as the percentage increase in annual earnings relative to individuals with a high school degree, the omitted group in the regression.[18] The table shows that males with an associate's degree have annual earnings that are 24.3 percent higher than high school graduates. Females with associate's degrees receive an earnings premium of 43.8 percent over high school graduates. The finding that women experience a larger percentage increase in earnings than men is consistent with previous results in the literature looking at returns to an associate's degree (Kane and Rouse, 1995; Jepsen, Troske, and Coomes, 2014).

Table 4 about here

In our second approach, we use administrative data from the Kentucky Community and Technical College System (KCTCS) matched with quarterly earnings

[17] We exclude individuals without a high school diploma from our analysis to ensure that the Census data are as comparable as possible with the administrative data from KCTCS.

[18] To be consistent with previous literature, we express our log coefficients in terms of percentages. However, the precise interpretation of a coefficient b in percentage terms is (e^b-1), where e is the exponential function. For comparison, a log coefficient of 0.4 is approximately 49 percent and a log coefficient of 0.2 is around 22 percent.

data from the Kentucky unemployment insurance program. We have data for the cohort of approximately 40,000 students aged 20 to 60 who entered KCTCS from summer 2002 to spring 2004. The advantage of these administrative data is that, in addition to having information on receipt of an associate's degree, we also have data on the receipt of a diploma or certificate – information not available in Census data.[19] Diplomas typically require a year or more of full-time study, and they cover a broad range of areas. Certificates usually require less coursework and they often target specific employers. The private financial gains to diplomas and certificates as well as attendance without receiving a degree, diploma, or certificate cannot be estimated with the Census data due to the lack of education categories for them.

Because the KCTCS data contain only individuals who enrolled in KCTCS, we estimate the effect of an award by comparing the quarterly earnings of KCTCS students after they left KCTCS with the quarterly earnings of the same KCTCS students prior to enrolling in KCTCS; we also compare students who received an award with students who attended KCTCS but did not receive an award. More formally, we estimate a student fixed effects earnings model analogous to the model used by Jacobson, LaLonde, and Sullivan (2005a, 2005b) in their analysis of community college returns for displaced workers. In their data, as in ours, most of the individuals who enroll in community college do so after initially entering the labor market and working for several years. The average age for an individual in our sample is 35.1 years. Therefore, the earnings before entering community college are likely representative of the earnings of an individual in

[19] According to our administrative data from the KCTCS, more than half of the highest degrees awarded are certificates and diplomas.

the absence of the community college education. Equation (3) shows our fixed effects model:

$$\ln Y_{it} = \beta S_{it} + \gamma X_{it} + \eta_i + \tau_t + \varepsilon_{it} \quad (3)$$

In this equation, ln Y is the natural logarithm of quarterly earnings, *i* denotes an individual, and *t* denotes the time (quarter). S contains three dummy variables which are equal to one for the highest award received in the current time period (quarter). The associate's degree is the highest award offered by KCTCS; diploma is the second-highest; and certificate is the third-highest. X is a set of time-varying student characteristics such as age, age-squared, and interactions with nonwhite, and η and τ are student and time fixed effects.[20]

Table 5 about here

The results from estimation of equation (3) are presented in Table 5. In this table, the coefficients for education levels can be interpreted as the percentage increase in quarterly earnings relative to quarterly earnings without a degree, diploma, or certificate. The table shows that males with an associate's degree have a quarterly earnings premium of 14.7 percent, and females with associate's degrees receive a quarterly earnings premium of 36.6 percent. For diplomas, the increase in quarterly earnings is 7.5 percent for men and 38.2 percent for women. Receiving a certificate has no statistically significant impact on earnings for men or women. Again, we find higher returns to associate's degrees for women than for men.

We convert the educational returns presented in Tables 4 and 5 to lifetime earnings amounts to facilitate comparison with our estimates of the total social value of KCTCS. First, we calculate the predicted annual earnings for high school graduates and

[20] For more detail on the data and estimation, see Jepsen, Troske and Coomes (2014).

recipients of certificates, diplomas, and associate's degrees using the estimates from equations (2) and (3). We calculate annual earnings for each age from 18 to 80. Then, we multiply the predicted earnings for each year by the likelihood of being employed with that level of experience. For each age, this likelihood is the survival rate (the probability of living to that age) multiplied by the probability of being employed conditional on living to that age. The lifetime earnings for each education level are simply the sum of predicted discounted real earnings at each age. Earnings are discounted at an annual rate of 3.5 percent, the real rate recommended by Moore et al. (2004) for intra-generational projects that are financed by taxes and not likely to displace private investment.

Table 6 about here

Table 6 shows earnings returns to an associate's degree compared to a high school degree in Kentucky assuming educational attainment at age 20.[21] The returns include the effects of work and survival probabilities and are calculated separately for men and women. Estimated lifetime returns to an associate's degree vary by data source. For women, the lifetime return based on Census data is approximately $79,000 compared with approximately $102,000 based on KCTCS data.[22] Similarly, the estimated benefits for men are $53,000 from the Census data and $79,000 from the KCTCS data. The lifetime returns – based on KCTCS data – for diplomas are about $113,000 for women and $33,000 for men. For certificates, the returns – based on KCTCS data– are roughly

[21] Our estimates of the value of a 10 percent expansion of the KCTCS system, however, are based on the distribution of ages when degrees, diplomas, and certificates are actually earned.

[22] The lifetime earnings estimates in Table 6 are based on the estimated values of earnings from equations (2) and (3). These estimated values are based on the coefficients for age (and age squared), highest degree, and the constant term, and all these coefficients differ between the Census and KCTCS data. Differences in the coefficients for age and the constant term explain why the estimated lifetime earnings returns to an associate's degree are higher in KCTCS data than in the Census data even though the coefficients for associate's degree are lower in the KCTCS data than in the Census data.

negative $6,000 for women and negative $600 for men due to costs of attendance (including foregone earnings), although the results are statistically insignificant at the 10 percent level. All other results are statistically significant at the one percent level. The results, particularly for the KCTCS data, show a dramatically larger increase in earnings for women compared with men. Jepsen, Troske, and Coomes (2014) show that much of this difference can be explained by differences in field of study. Still, these results are not surprising given the differences in regression coefficients by gender in Tables 4 and 5.

7 Comparing Total Social Value to Private Financial Values – the Difference is the Education Externality and Private Non-market Value Combined

From the contingent valuation we estimate the average household in Kentucky is willing to pay $55.84 for a 10 percent expansion of KCTCS with a 90% confidence interval of [$41.75, $69.92]. The total social value for all Kentucky households is $92.7 million with a 90 percent confidence interval of [$69.3, $116.1]. The estimate includes both those market and non-market benefits Kentuckians receive individually as well as benefits to all society in the form of reduced crime, healthier citizens, better public decision making, and greater productivity of other workers. The estimate accounts for potential hypothetical bias.

By comparing the estimated increase in individual financial returns from expanding the KCTCS system with the total returns that would result from expanding the system, we estimate what percentage of the increased total benefits would accrue directly to the additional students that would attend a KCTCS college in the form of financial and non-market gains if the system were expanded and how much of the increased total

benefits would accrue to all Kentuckians regardless of whether or not they attended a KCTCS college. We report our estimates of the externality as percentages of the private financial gains and total private gains after making assumptions about the size of the private non-market gains.

KCTCS awarded 6,480 associate's degrees in 2006-2007, so a 10 percent increase in KCTCS degrees would result in 648 additional people obtaining an associate's degree in a year.[23] Of the degrees awarded in 2006-2007, 64 percent were awarded to females and 36 percent were awarded to males. Assuming that the same percentages hold for a 10 percent expansion, the 648 additional degrees would be broken down into 435 degrees for women and 213 degrees for men. Using a similar assumption for diplomas and certificates leads to estimated increases of 145 diplomas for women and 85 diplomas for men, along with 689 certificates for women and 530 certificates for men. Because the proposed expansion is a one-time, 10 percent expansion, we calculate the private financial returns from a one-time, 10 percent expansion in the number of degrees, diplomas, and certificates awarded.[24]

We assume that these individuals will receive their degrees, diplomas, and certificates at the same ages at which recent KCTCS graduates have received their degrees. In other words, we use the distribution of ages of the graduates in the KCTCS administrative data rather than assuming that, say, all individuals who earn their

[23] We assume that an expansion of 10 percent would increase output by 10 percent because we do not have a strong argument for an alternative. Some programs may have excess capacity and could expand without more funds. Others, particularly the fast growing health fields, are restricted due to current funding for faculty and labs. Moreover, expansion of programs could induce some current students to switch to new programs rather than attracting more students. Switching would lead us to overestimate the gain. However, to the extent that the expansion leads to better matches with students and jobs, then there will be greater productivity that will offset some of the overestimate.

[24] Review of the focus group tapes confirmed that participants understood that the increase and payment were one-time.

associate's degrees begin work at age 20. In fact, the average age for associate's degree recipients is 30. Based on age of degree receipt, we then calculate each person's lifetime earnings by summing up the returns for each age from degree/diploma/certificate receipt until 80 years of age, based on calculations using the Decennial Census and KCTCS data reported in the previous section. We subtract the costs of tuition, books, fees, and foregone earnings and discount the flow of earnings to the present.[25] The estimates of aggregate earnings returns based on these calculations are shown in Table 7. Also shown are the effects of work and survival probabilities. If we sum the individual returns for these individuals, we find that the estimated increase in individual returns from a 10 percent expansion of KCTCS is approximately $53.4 million based on Census data and $56.9 million based on KCTCS data. Despite the different assumptions of the two estimates of private earnings benefits, the estimates from the Census are only about six percent lower than the estimates from the KCTCS data.[26]

Table 7 about here

To get our preferred estimate of the education externality we adjust the private financial value for taxes and attribute part of the difference between total social value and after-tax private financial value to private non-market value. Estimates of the private financial gain are reduced by 27 percent which is the average marginal tax rate on income

[25] For an associate's degree, the estimated costs are $8003 in direct costs of tuition, fees and books, and one year of foregone earnings, the average earnings of a high school graduate the year prior to degree receipt. The average of earnings foregone is $19,950. We assume that the costs for a diploma are 75 percent of the costs for an associate's degree, and the costs for a certificate are 50 percent of the costs for an associate's degree.

[26] The estimated private return for the Census data contains no controls for occupation. Because a worker's occupation varies with education level, we also estimate the private returns with Census data that include controls for occupation, and find that the private returns fall from $53.4 million to $42.0 million. This finding suggests that part of the private return of an associate's degree operates through changes in occupation. The KCTCS administrative data do not contain occupation information.

for Federal and Kentucky taxes combined for 2007.[27] It follows that the estimate of after-tax private financial value using Census data to estimate earnings gains is $14.4 million less than $53.4 million, or $39.0 million. Using KCTCS data, the after-tax private financial value is $41.5 million.

Estimates of the expected private financial returns depend on the discount rate. Table A2 in the Appendix gives estimates using discount rates of 2 percent and 5 percent along with the 3.5 percent used for the preferred estimates reported here. The estimate of before-tax private financial returns for a discount rate of 2 percent for the Census is $72.0 million; it is $52.6 million for after-tax private financial value. The point estimate of expected before-tax private financial returns for a 5 percent discount rate is $40.2 million; it is $29.3 million for after-tax private financial value.

To attribute part of the difference between total social value and private financial value to private non-market value, we draw upon previous research. Haveman and Wolfe (1984) catalog non-market effects, propose a procedure for estimating the value of those effects, and offer calculations that suggest that the non-market value might be as large as the market value. Most of the non-market value is within the household with some due to gains to children and spouse. Although we consider this case, our preferred estimate of the education externality is based on the assumption that the private non-market value is half of the private financial gain. Much of the non-market value is due to better own health according to Haveman and Wolfe (1984, p. 396) and McMahon and Oketch (2010, Table A4), who estimate that better own health accounts for roughly half of private non-market value. It follows that our preferred estimate of the private value of non-market

[27] The NBER website http://users.nber.org/~taxsim/marginal-tax-rates/ reports estimates of tax rates based on the TAXSIM model. Estimates of average marginal tax rates on income for Federal and Kentucky taxes combined are approximately 27% for 2007.

benefits is $19.5 million, total private value is $58.5 million, and the education externality is $34.2 million. The externality is 88 percent of the after-tax private financial value and 58 percent of the total private value.

Table 8 about here

The preferred estimate of the education externality associated with expansion of KCTCS also depends on other factors. Table 8 shows the sensitivity of the best point estimate of 58 percent to using KCTCS administrative data to estimate the short-run earnings gain, using the number income tax filers instead of the number of households, adding the social benefits of reduction in excess burden from additional tax revenue,[28] and calibration for potential hypothetical bias.[29] Consideration of these factors leaves unchanged the basic result that estimates suggest that education externalities in the form of enhanced quality of life and/or productivity exist and are probably substantial.[30]

8 Comparing Benefits to Costs and Sensitivity Analysis

[28] For our best estimate of before-tax private financial value of $53.4 million and a tax rate of 27 percent, the additional tax revenue is $14.4 million. Because of the additional revenue, other taxes could be reduced at the same level of expenditure or additional expenditures could be made without increasing taxes and excess burden could be reduced. Hines' (2008) review of the excess burden of taxes suggests the loss could be as high as 75%. Boardman et al. (2011) suggest that a rate of 23% is probably appropriate for income taxes. If we use a marginal excess burden rate of 30%, then the benefit of the additional $14.4 million revenue implies a reduction in excess burden of $4.3 million. Under the assumption that respondents did not consider this subtle benefit, the total social value increases to 97.0 million.

[29] All estimates shown in Table 8 are positive, but negative values are possible with other combinations of assumptions. For example, if private non-market value is the same size as private financial value and the 90% lower bound on total social value is used, the education externality is negative $8.7 million. We consider this combination unlikely.

[30] We also estimate a simple model to explore whether there is an area-wide education externality. The model is broadly similar to those found in Rauch (1993), Acemoglu and Angrist (2000), and Moretti (2004a), as well as the reviews by Moretti (2004b) and Lange and Topel (2006). However, no attempt is made to account for sorting. Focusing specifically on the associate's degree offered by KCTCS, a one percentage point increase in the percentage of individuals in an area with at least an associate's degree is associated with a 0.7 percent increase in earnings. Sorting has not been addressed, but this result hints that part of the private returns reported in Table 4 that reports earning equations using Census data is actually an education spillover. Results are shown in Appendix B.

In order to get an idea of the magnitude of the social value, it is useful to compare the value of a 10 percent expansion to the costs of a 10 percent expansion of KCTCS education. Information on costs was taken from the KCTCS budget. The revised 2006-2007 fiscal year budget shows that total expenditures for operating KCTCS were $633 million. If it is assumed that the cost of a 10 percent expansion would be equal to 10 percent of current operating costs, then an estimate of the total cost of the expansion is approximately $63.3 million. Comparing the preferred estimate of the total value of a 10 percent expansion ($92.7 million) with the total costs of a 10 percent expansion indicates that Kentuckians value the expansion by a positive amount. The estimated net social benefits are $29.4 million with a benefit-cost ratio of about 1.5. The $63.3 million cost is also below the 90 percent confidence interval for the total social value of $69.3 million. This estimate of the net social benefits increase in the system ignores any increase in buildings and other infrastructure costs since it is assumed that KCTCS could expand the number of students served without building any new buildings. According to KCTCS officials, the current value of KCTCS buildings is $401 million; a 10 percent increase in the number of buildings would be $40.1 million. If this increase in capital cost is added to the increase in operating expenditures, the net social benefits of expanding the system by 10 percent are - $10.7 million with a benefit cost ratio of about 0.9. Because a one-time expansion of KCTCS by 10 percent would likely be done at lower cost than a permanent expansion that required building permanent structures, the net benefits of expansion are probably positive. However, the assumptions made about costs should be kept in mind.[31]

[31] Assumptions made about estimates of total social value matter too. If the lower bound of the 90 percent confidence interval of willingness to pay ($69.3 million) is used, then net social benefits are -$34.1 million

9 Conclusions and Discussion

A great deal of evidence, especially in the form of higher earnings, strongly supports the existence of substantial individual, private returns to education including higher education. In this paper we have focused on education offered by community and technical colleges about which previous research offers less evidence than university education. Based on 2000 Census data we estimate that the increase in expected lifetime earnings (net of tuition and foregone earnings) for an associate's degree over only a high school education for an individual who is 20 taking into account differences in the probability of work and the probability of survival. The discounted present value of the net gain is approximately $53,000 for men and $79,000 for women measured in 2007 dollars. Based on the KCTCS data for the 2002-2004 cohort and for a shorter period of earnings growth, we estimate that the discounted present value of the increase in expected lifetime earnings (net of tuition and foregone earnings) over high school education is roughly $79,000 for men and $102,000 for women. These individual, private financial gains in earnings are sizable.

The typical approach to estimating the social value of education is to use instrumental variables. In contrast, we offer a first attempt at an alternative method. We estimate the total social value of a 10 percent expansion of KCTCS using a contingent valuation survey. Our estimate of the education externality is the difference between total social value and the individual, private financial gain associated with a 10 percent expansion of KCTCS after accounting for private, non-market gain. Our estimate of the total social value has the advantage that it captures all productivity and quality of life

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with a benefit cost ratio of about 0.7.

externalities as long as Kentucky residents who respond to our survey are informed and perceive them. However, our method of estimating the private value captures only the private financial gain. Our estimate of the education externality would be too large if we did not consider the value of private, non-market benefits that accrue to individuals.

As discussed in Becker and Murphy (2007) one of the advantages of additional education is that it raises individual productivity in household production. Some early work on household production has attempted to value the private non-market benefits. Michael (1973) and Haveman and Wolfe (1984) estimate the nonmarket value of education using a household production approach. Haveman and Wolfe's calculations suggest substantial nonmarket, private returns to education. More recently McMahon (2009) and McMahon and Oketch (2010) have used an income equivalent method based on the pioneering work of Haveman and Wolfe to estimate the value of private non-market benefits of higher education separate from the gain in earnings. Drawing on these studies we assume that the private value of non-market effects is half the size of the after-tax, private financial value.

Our estimate of the value of the education externality associated with expansion depends on a number of factors. One is the adjustment we make for potential hypothetical bias in contingent valuation. The estimates in which we have the most confidence are based on survey respondents who are definitely sure they would vote for a referendum that expands KCTCS and has a tax of a specified amount tied to it. If no hypothetical bias exists, then our best estimate of the externality would be 502 percent instead of 58 percent. Our estimate of the education externality also depends on the estimate for the private financial gain. Our preferred estimate of the private financial

gain uses Census data for associate degrees, and a 3.5 percent discount rate. Our preferred estimates of the total social value indicate social value exceeds the total private value by at least 15 percent with a best point estimate of nearly 60 percent.

In addition to the factors explicitly accounted for in our sensitivity analysis a number of other factors could affect our estimates of the education externality.[32] The estimates of private financial gain from the Census and KCTCS data may be too small and the externality too big. The Census estimate does not include the private financial returns to diplomas and certificates, and the KCTCS estimate is based on short-run rather than long-run labor market returns. On the other hand, we suspect that these estimates of the individual returns may be too large and the externality too small because the estimated financial returns are based on individuals who already have received an associate's degree, diploma, or certificate. Presumably the additional people who would receive a degree, diploma, or certificate if KCTCS were expanded would have a lower return than those who would be obtaining such outcomes without an expansion. Caution should be exercised in making inferences from our relatively small sample for one state, Kentucky. Educational attainment is lower in Kentucky and a larger sample representative of the U.S. might be expected to produce different results. We suspect the social value of expanding community and technical colleges might be lower in the rest of the nation where a larger share of the population has at least an associate's degree. The education externality is underestimated, however, if some of the benefits accrue outside of Kentucky.

[32] McMahon (2007) uses a dynamic model of endogenous growth to estimate education externalities that are direct effects as well as externalities that are indirect effects that play out over time in growth and development. We estimate the direct effects and do not attempt to include any indirect effects.

Our estimates of the education externality are a large percentage of the private financial return, but they are not implausible. Lochner and Moretti (2004) estimate that the size of the external effect of education through the single channel of reducing crime is 14 to 26 percent of the private return to schooling. Values for any improved public health, better government, or enhanced area-wide productivity could account for our higher estimate. The method is different and the estimate is for bachelor's degrees, but McMahon (2009, p. 240) finds that the education externality is 89 percent of the private financial return. Our estimate based on total social value could include the value of higher education as an in-kind transfer program in addition to the external effects already discussed such as productivity spillovers, less crime, and better government. Educational subsidies can be treated as a means of changing the income distribution, for example see Hanushek et al. (2003). Presumably our estimate of total social value captures this value also. The finding that respondents older than 50 are willing to pay more for the KCTCS expansion is consistent with valuing spillovers, transfers, or both.

Optimal financing of higher education depends on the existence and size of positive education externalities. If all the returns are to the individual in the market or in the household, then optimal financing likely only includes provision of unsubsidized loans. However, our estimates based on total social value suggest substantial external benefits for expansion of community and technical college education. These gains in quality of life or productivity, or as a transfer, suggest financing the expansion through subsidized loans or other forms of government support for students or institutions could be efficient. Hilmer (1998) provides evidence that higher fees at community colleges reduce the probability of enrollment. Subsidized loans or other forms of government

support that essentially reduce fees might be an efficient policy given our finding of substantial spillovers. Whatever the design, optimal financing of higher education should consider education externalities at the community and technical college level. Whether findings would be the same for a national total social value study or a total social value study of higher education in the form of bachelor's degrees is worth exploring.

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Table 1. Demographics of KCTCS Survey vs. American Community Survey 2007 for Kentucky

		Web-based Sample	Mail-based Sample	P-Value: Web vs. Mail	Total Sample	American Community Survey 2007
Gender	Female	52.50%	53.20%	0.899	53.14%	51.93%
Age	18-29	21.54%	19.96%	0.553	20.12%	21.69%
	30-39	10.40%	15.17%	0.15	14.69%	17.24%
	40-49	25.96%	19.43%	0.136	20.08%	19.56%
	50-64	28.49%	28.25%	0.594	28.27%	24.68%
	65+	13.61%	17.20%	0.471	16.84%	16.83%
Race	White	90.45%	89.39%	0.791	89.49%	90.37%
Education	Less than High School Diploma	8.67%	17.07%	0.023	16.26%	19.58%
	High School Diploma or Equivalent	45.29%	36.74%	0.132	37.56%	35.19%
	Some College	15.85%	18.65%	0.378	18.38%	20.71%
	Associate's Degree	10.45%	8.13%	0.585	8.35%	6.01%
	Bachelor's Degree	11.23%	11.21%	0.99	11.21%	11.43%
	Master's Degree or Beyond	8.51%	8.20%	0.086	8.23%	7.08%
Household Income	Under $25,000	36.39%	36.76%	0.622	36.72%	32.31%
	$25,000 - $39,999	19.72%	17.77%	0.414	17.97%	17.91%
	$40,000 - $59,999	22.09%	18.42%	0.247	18.79%	17.89%
	$60,000 - $99999	16.97%	18.82%	0.952	18.63%	19.96%
	$100,000 or more	4.82%	8.23%	0.062	7.89%	11.92%

Note: Both the KCTCS Survey statistics and the American Community Survey statistics are for those individuals 18 years old or over. The sample size for each variable in the web-based sample is 275. The total sample size is 2,892 for Gender, 2,827 for Age, 2,877 for Race, 2,867 for Education, and 2,725 for Household Income.

Table 2. Definitions of Variables and Summary Statistics

Variables	Mean	Description
Tax	162.2 [166.84]	Dollar amount individual would pay for change in KCTCS in 2007 dollars. Amounts were one of eight amounts: 25 (21%), 75 (21%), 100 (3%), 125 (2%), 150 (21%), 200 (2%), 250 (18%), 400 (14%).
Income $25-39K	0.22	1 if $25,000 ≤ household income ≤ $39,999, 0 otherwise
Income $40-59K	0.17	1 if $40,000 ≤ household income ≤ $59,999, 0 otherwise
Income $60-99K	0.16	1 if $60,000 ≤ household income ≤ $99,999, 0 otherwise
Income > $100K	0.08	1 if household income ≥ $100,000, 0 otherwise
Income Missing	0.05	1 if no response to household income question, 0 otherwise
High School Diploma	0.35	1 if earned high school diploma or equivalent, 0 otherwise
Some College	0.20	1 if attended some college, 0 otherwise
Associate's Degree	0.09	1 if earned associate's degree, 0 otherwise
Bachelor's Degree	0.13	1 if earned bachelor's degree, 0 otherwise
Master's Degree +	0.08	1 if earned master's degree or higher, 0 otherwise
Age 30-39	0.15	1 if 30 ≤ age ≤ 39, 0 otherwise
Age 40-49	0.22	1 if 40 ≤ age ≤ 49, 0 otherwise
Age 50-64	0.27	1 if 50 ≤ age ≤ 64, 0 otherwise
Age 65+	0.14	1 if age ≥ 65
Age Missing	0.02	1 if no response to age question, 0 otherwise
Female	0.55	1 if female, 0 otherwise
White	0.88	1 if white, 0 otherwise
Taken a Class	0.27	1 if respondents has taken a class from KCTCS, 0 otherwise
Family Attended	0.53	1 if a family member has attended KCTCS, 0 otherwise
Know Employee	0.27	1 if respondent knows someone that works for KCTCS, 0 otherwise
Web	0.10	1 if survey was web-based, 0 if mail-based
Cheap Talk Minus 10	0.22	1 if received cheap talk treatment & 10% reduction scenario, 0 otherwise
Cheap Talk Minus 25	0.24	1 if received cheap talk treatment & 25% reduction scenario, 0 otherwise

Note: The standard deviation for the non-categorical variable is shown in brackets. Means calculated using estimation sample, n = 1023. The number of respondents who said "yes" and were definitely sure is 272. This means that the dependent variable takes on a value of 1 for 0.27 of the sample.

Table 3. Logistic Regression Results with Dependent Variable equal to "Definitely Sure"

	Coefficient	Standard Error	Marginal Effect
Tax Amount	-0.0047***	0.0007	-0.0008***
Income $25K-39K	-0.0759	0.2938	-0.0131
Income $40K-59K	0.3645	0.2843	0.0675
Income $60K-99K	0.6662**	0.2854	0.1278**
Income > $100K	1.1486***	0.3247	0.2411***
Income Missing	-0.4103	0.453	-0.0648
High School Diploma	-0.0146	0.403	-0.0026
Some College	0.452	0.4131	0.0844
Associate's Degree	0.8397*	0.4644	0.1726
Bachelor's Degree	0.5855	0.4293	0.1124
Master's Degree +	0.3828	0.435	0.0716
Age 30-39	0.1975	0.4659	0.036
Age 40-49	0.4313	0.4461	0.0807
Age 50-64	0.8695**	0.4276	0.1602*
Age 65+	1.0286**	0.4488	0.2069**
Age Missing	-0.4142	1.1418	-0.0646
Female	-0.0363	0.1662	-0.0064
White	-0.2819	0.3525	-0.0527
Taken a Class	-0.231	0.2054	-0.0393
Family Attended	0.4527***	0.1737	0.0794***
Know Employee	0.3630**	0.1748	0.0662**
Web	0.0091	0.244	0.0016
Cheap Talk Minus 10	0.8032***	0.186	0.1553***
Cheap Talk Minus 25	0.7958***	0.1904	0.1550***
Constant	-2.1981***	0.6469	
Sample Size	1023		
Likelihood Ratio Statistic	157.24		
Pseudo R-squared	0.1327		

Note: The dependent variable "Definitely Sure" equals one for respondents definitely sure of their affirmative response and zero otherwise. Base categories for income, education, and age are respectively, Under $25,000, Less than a High School Diploma, Age 18-25. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Log Earnings Equations, 2000 U.S. Census Data for Kentucky

	Males	Females
Education		
Less than One Year of College	0.161***	0.178***
	(0.016)	(0.018)
Year or More of College, No Degree	0.117***	0.159***
	(0.012)	(0.014)
Associate's Degree	**0.243*** **	**0.438*** **
	(0.018)	(0.018)
Bachelor's Degree	0.555***	0.672***
	(0.012)	(0.016)
Master's Degree	0.570***	0.838***
	(0.019)	(0.020)
Professional or Doctoral Degree	0.975***	1.092***
	(0.023)	(0.035)
Experience		
Potential Years	0.0715***	0.0626***
	(0.002)	(0.002)
Potential Years Squared	-0.00138***	-0.00113***
	(0.000)	(0.000)
Socio-demographic		
Black	-0.233***	0.0157
	(0.018)	(0.020)
Married	0.419***	-0.0128
	(0.012)	(0.015)
Divorced	0.180***	0.114***
	(0.017)	(0.018)
Constant	9.029***	8.712***
	(0.014)	(0.018)
Observations	38583	37396
R-squared	0.244	0.141

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The omitted education category is high school diploma. The dependent variable is the log of annual earnings. All earnings data have been converted to 2007 dollars using the CPI-U.

Table 5. Log Earnings Equations with Individual and Time Fixed Effects, KCTCS Administrative Data.

	Males	Females
Education		
Associate's Degree	0.147***	0.366***
	(0.010)	(0.008)
Diploma	0.075***	0.382***
	(0.014)	(0.012)
Certificate	0.016	0.012
	(0.011)	(0.010)
Observations	454,793	488,477
Students	18,178	21,250
R-squared	0.6093	0.5266

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. These data include students who enrolled in KCTCS from 2002-2003. Earnings data are from 2000-2006. The dependent variable is the log of quarterly earnings. All earnings data have been converted to 2007 dollars using the CPI-U. The equation estimated includes variables for age, age squared, interactions with nonwhite in addition to individual and time (quarter) fixed effects.

Table 6. Individual Lifetime Financial Gain from KCTCS Degree, Diploma, or Certificate

	Males	Females
Census Data		
Associate's Degree	$52,723	$78,839
KCTCS Administrative Data		
Associate's Degree	$78,578	$101,877
Diploma	$32,973	$112,569
Certificate*	-$574	-$5,591

Note: The individual lifetime financial gains reported in this table are based on a discount rate of 3.5% and include work and survival probabilities. The gains are measured relative to estimated lifetime earnings of a high school graduate and assume that individual receives the degree, diploma, or certificate at age 20, as an example. In contrast, when the gains from a 10% expansion of the KCTCS system are estimated, they are based on the distribution of ages when degrees, diplomas, and certificates are actually earned in the KCTCS data. The average of the ages is approximately 30.

*The point estimates for the earnings gain for Certificates are based on coefficients in Table 5 that are not statistically different from zero at customary levels. The lifetime earnings gains are negative even though the coefficient estimates in Table 5 are positive because the gain in earnings is more than offset by the costs of attendance and foregone earnings.

Table 7. Predicted Lifetime Private Financial Returns for 10% Expansion to KCTCS, Kentucky.

Models	Males	Females	Total
Census – Associate's Degree			
With age-adjusted work and survival probabilities (preferred estimate)	**$13,673,484**	**$39,678,799**	**$53,352,283**
with age-adjusted work probabilities and controls for industry, occupation	$14,911,147	$27,098,668	$42,009,815
no adjustment for work probability or survival	$22,100,730	$71,693,046	$93,793,776
KCTCS			
With age-adjusted work probabilities			
Associate's Degree	$13,770,935	$36,997,643	$50,768,578
Diploma	$1,745,400	$13,677,407	$15,422,807
Certificate	-$3,704,385	-$5,539,422	-$9,243,808
TOTAL (preferred estimate)	**$11,811,950**	**$45,135,628**	**$56,947,577**
No adjustment for work probability or survival			
Associate's Degree	$20,396,128	$61,157,725	$81,553,853
Diploma	$3,840,695	$24,519,962	$28,360,657
Certificate	-$2,202,756	-$4,558,761	-$6,761,517
TOTAL	$22,034,068	$81,118,925	$103,152,994

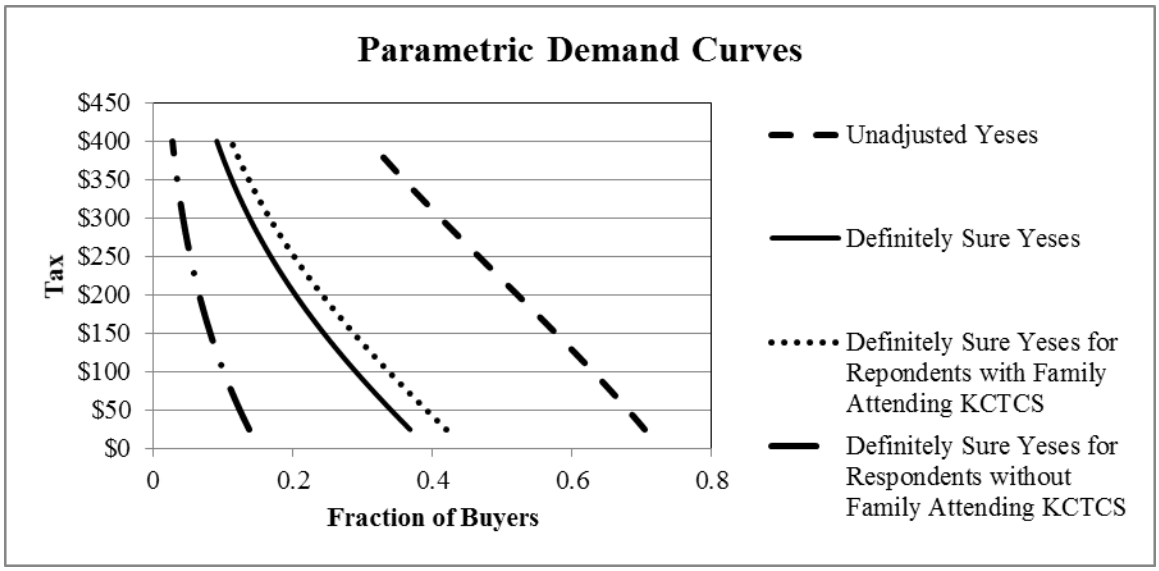
Note: The estimated return is measured as an increase in earnings relative to a high school graduate, in 2007 dollars. All predictions are discounted to the present using an annual rate of 3.5%; returns are less foregone earnings (1 year for Associate's Degree; 0.75 years for Diploma; and 0.5 years for Certificate) and the real cost of tuition, books, and fees ($8,003 for Associate's Degree; 0.75*8003 for Diploma; 0.5*8003 for Certificate).

Table 8: Sensitivity of the Estimated Difference between Total Social Value and Private Value of KCTCS Expansion

Case	Total Social Value (millions $)	Private Financial Value (millions $)	Private Non-market Value (millions $)	Total Private Value (millions $)	Education Externality (millions $)	Externality (% of Private Financial Value)	Externality (% of Total Private Value)
Preferred, Base*	**92.7**	**39.0**	**19.5**	**58.5**	**34.2**	**+88**	**+58**
Private Non-market Value, 100% of Private Financial Value	92.7	39.0	39.0	78	14.7	+38	+19
Private Non-market Value, 0	92.7	39.0	0	39	53.7	+138	+138
Lower 90% Bound on Total Social Value	69.3	39.0	19.5	58.5	10.8	+28	+18
Upper 90% Bound on Total Social Value	116.1	39.0	19.5	58.5	57.6	+148	+98
KCTCS Earnings Estimates instead of Census Earnings	92.7	41.5	20.8	62.3	30.4	+73	+49
2% Discount Rate on Earnings	92.7	52.6	26.3	78.9	13.8	+26	+17
5% Discount Rate on Earnings	92.7	29.3	14.7	44.0	48.7	+166	+111
Income Taxpayers instead of Households (number)	81.0	39.0	19.5	58.5	22.5	+58	+38
Reduction in Excess Burden not included in Total Social Value	97.0	39.0	19.5	58.5	38.5	+99	+66
No Calibration for Potential Hypothetical Bias	352.3	39.0	19.5	58.5	293.8	+753	+502

*The preferred estimate in 2007 dollars is based on the following: (1) the gain in private non-market value is 50 percent of the private, after-tax earnings gain, (2) the point estimate of the mean stated willingness to pay for the ten percent expansion of the KCTCS system, (3) the private after-tax earnings gain estimated from Census data for associate degrees, (4) a combined tax rate on earnings income of 27%, (5) a 3.5% discount rate for calculating the present value of expected after-tax earnings gain, (6) the number of households in Kentucky in 2007, (7) the elicited willingness to pay from respondents includes the social benefit of taxes on the earnings gain and the reduction in excess tax burden, and (8) the estimate of mean stated willingness to pay calibrated by considering only "yes" responses for which respondents are "definitely sure" they would pay.

Figure 1. Parametric Demand Curves for Ten Percent Expansion of KCTCS (definitely sure "yes" and all "yes"; family attended and family not attended)



The sample size for the the logit from which the demand curve is estimated is 1023 for both demand curves for the entire sample. For the Definitely Sure Yeses, only the 272 definitely sure "yes" responses were coded as 1; all others were 0. For the Undadjusted Yeses, all 564 "yes" responses were coded as 1 and all "no" responses were coded as 0. 542 families had a member who attended KCTCS; 481 families did not.

Appendix A

Table A1. Logistic Regression Results with Additional Independent Variables†

	Coefficient		Standard Error
Tax Amount	-0.0048	***	0.0007
HINC $25K-39K	0.0348		0.3023
HINC $40K-59K	0.3723		0.2969
HINC $60K-99K	0.7444	**	0.2956
HINC > $100K	1.2318	***	0.3362
HINC Missing	-0.2172		0.4675
HS Diploma	-0.1360		0.4165
Some College	0.3280		0.4342
Associate's Degree	0.6016		0.4866
Bachelor's Degree	0.4027		0.4500
Master's Degree +	0.2027		0.4606
Age 30-39	0.2332		0.4773
Age 40-49	0.4137		0.4622
Age 50-64	0.8766	*	0.4514
Age 65+	1.0347	**	0.4946
Age Missing	-0.4638		1.1530
Female	0.0050		0.1723
White	-0.2710		0.3722
Taken a Class	-0.2575		0.2145
Family Attended	0.4191	**	0.1816
Know Employee	0.2970		0.1854
Web	-0.0448		0.2464
Cheap Talk Minus 10	0.7994	***	0.1967
Cheap Talk Minus 25	0.8500	***	0.1912
Quality of Life	-0.0043		0.0073
Productivity Growth	-0.0009		0.0068
County	0.2154		0.1968
Population Density	-0.0001		0.0001
Years in Kentucky	-0.0014		0.0050
Constant	-1.9132	**	0.8047
Sample Size	949		
Likelihood Ratio Statistic	152.57		
Pseudo R-squared	0.1364		

†The dependent variable "Definitely Sure" equals one for respondents definitely sure of their affirmative response and zero otherwise. Base categories for income, education, and age are respectively: Under $25,000, Less than a High School Diploma, Age 18-25. Significance is shown as *** p<0.01, ** p<0.05, * p<0.1.

Table A2. Predicted Lifetime Private Financial Returns to KCTCS, 2007 dollars
Increase in present value of expected earnings compared to high school diploma

Models	Total
Total Social Return	$92,694,000
Census - Private Return, with age-adjusted work and survival probabilities	
2% discount rate	$71,965,639
3.5% discount rate	$53,352,283
5% discount rate	$40,185,626
KCTCS - Private Return, with age-adjusted work and survival probabilities	
2% discount rate	$79,359,228
3.5% discount rate	$56,947,577
5% discount rate	$40,586,713

Appendix B

Wages, Area-wide Education, and OLS Estimates of the Education Externality

How much higher are a given worker's earnings if he or she lives in an area with more educated individuals? This model can be illustrated by the following equation:

$$\ln Y_i = \alpha_i + \beta S_i + \gamma X_i + \delta AS_i + \varepsilon_i \qquad \text{(B1)}$$

where Y, S, and X are defined as in equation (2) and AS_i measures the level of schooling in the area. Examples of attempts to estimate equation (4) can be found in Rauch (1993), Acemoglu and Angrist (2000), and Moretti (2004a), as well as the reviews by Moretti (2004b) and Lange and Topel (2006).

As we discuss above, one of the problems with estimating equation (B1) is that there may be some unobserved factor about an area that is correlated with the average schooling in an area leading to a correlation between AS_i and ε_i and a biased estimate of δ. In their estimates both Acemoglu and Angrist (2000) and Moretti (2004a) account for this bias using instrumental variables although Lange and Topel (2006) have questioned the validity of their instruments. Given their concerns, and the lack of sufficient variation in the available instruments for Kentucky data, we do not attempt to adjust for any possible bias in our estimates. We present them only to allow a comparison between our estimates of δ found using Kentucky data with the existing estimates using national data.

Table B1 contains the results from a model that estimates spillover effects using the data from the 2000 Decennial Census for Kentucky. (Because the regional education level does not vary within student in the KCTCS administrative data, the spillover effect is contained in the student fixed effect. Therefore, we do not estimate spillover effects with the KCTCS data.) An area is measured as one of the 30 Public Use Microdata Areas

(PUMA) in Kentucky; see Blomquist et al., 2007) for details. The PUMAs in Kentucky have a universe population of between 100,000 and 200,000 persons. The sample size after filtering out individuals less than 25 years of age varies from between 3,000 and 8,000 per PUMA.

Table B1 about here

For consistency with previous results, estimates are provided separately for men and for women. So that we can easily compare our estimates with previous estimates, we measure AS_i three ways. In columns (1) and (4) AS_i is measured as the average years of schooling among residents in an area, which corresponds to the measures used by Rauch (1993) and Acemoglu and Angrist (2000). We compute the average years of schooling for all residents 16 years old and older. In columns (2) and (5) we measure AS_i as the percentage of individuals in the area with at least a bachelor's degree, which corresponds to the measure used by Moretti (2004a). In columns (3) and (6) we measure AS_i as the percentage with at least an associate's degree, which corresponds to the measure used in this paper.

We find a strong association between the level of schooling in an area and an individual's earnings for all three measures. Looking at the results in columns (1) and (4) we see that a one year increase in the average education in an area is associated with an 8 percent increase in earnings for both men and women. This is slightly higher than Rauch's (1993) estimates of 2.8 to 5.1 percent, but corresponds closely to the OLS estimate of 7.3 percent reported in Acemoglu and Angrist (2000). In columns (2) and (4) we see that a one percent increase in the percent of residents with a college degree is associated with a 0.7 percent increase in earnings, which is within the 0.6 to 1.2 percent

range reported by Moretti (2004a). Our OLS estimates are similar to estimates found elsewhere in the literature even though we do not have instrumental variables to control for potential sorting by location.

Next, we compare the estimates of the effect of individual education on earnings results reported in Table 4 with the result in Table B1 when we include measures of educational attainment in an area. The results in column (3) and (6) in Table B1 show that a one percentage-point increase in the percentage of individuals with at least an associate's degree is associated with a 0.7 percent increase in earnings. In addition to these education spillovers, a person who receives an associate's degree receives a private return of approximately 21 percent for men and 41 percent for women (according to Table B1.) These estimated private returns are slightly lower that the private returns reported in Table 4 (24 percent and 44 percent). We have not controlled for the potential endogeneity of education, but this pattern of results suggests that part of the private return in Table 4 is actually an education spillover.

Table B1. Log Earnings Equation with Area-wide Education, 2000 U.S. Census Data for Kentucky

	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
Individual Education						
Less than One Year of College	0.143***	0.145***	0.143***	0.161***	0.164***	0.163***
	(0.0156)	(0.0156)	(0.0156)	(0.0179)	(0.0179)	(0.0179)
Year or More of College, No Degree	0.0865***	0.0866***	0.0846***	0.132***	0.132***	0.131***
	(0.0117)	(0.0118)	(0.0117)	(0.0141)	(0.0142)	(0.0141)
Associate's Degree	**0.209*** **	**0.222*** **	**0.209*** **	**0.416*** **	**0.416*** **	**0.414*** **
	(0.0184)	(0.0184)	(0.0184)	(0.0183)	(0.0183)	(0.0183)
Bachelor's Degree	0.488***	0.484***	0.480***	0.610***	0.605***	0.603***
	(0.0127)	(0.0128)	(0.0128)	(0.0159)	(0.0161)	(0.0161)
Master's Degree	0.508***	0.501***	0.497***	0.791***	0.783***	0.782***
	(0.0192)	(0.0193)	(0.0193)	(0.0197)	(0.0199)	(0.0198)
Professional or Doctoral Degree	0.898***	0.887***	0.884***	1.029***	1.015***	1.014***
	(0.0231)	(0.0223)	(0.0233)	(0.0351)	(0.0352)	(0.0352)
Region Level Education						
Average Years of Schooling	0.0796***			0.0823***		
	(0.00377)			(0.00447)		
Percent Bachelor's or More		0.00739***			0.00746***	
		(0.00038)			(0.00045)	
Percent Associate's or More			**0.00739*** **			**0.00728*** **
			(0.00036)			(0.00042)
Experience						
Potential Years	0.0702***	0.0709***	0.0700***	0.0616***	0.0621***	0.0621***
	(0.00157)	(0.00157)	(0.00157)	(0.00176)	(0.00176)	(0.00176)
Potential Years Squared	-0.00136***	-0.00137***	-0.00137***	-0.00112***	-0.00113***	-0.00114***
	(0.0000374)	(0.0000374)	(0.0000374)	(0.0000426)	(0.0000427)	(0.0000427)
Socio-demographic						
Black	-0.234***	-0.233***	-0.236***	0.0122	-0.0169	-0.0141
	(0.0178)	(0.0178)	(0.0178)	(0.0197)	(0.0198)	(0.0198)
Married	0.440***	0.437***	0.438***	0.0123	0.00822	0.00816
	(0.0123)	(0.0123)	(0.0123)	(0.0150)	(0.0150)	(0.0150)
Divorced	0.194***	0.195***	0.195***	0.130***	0.127***	0.127***
	(0.0165)	(0.0165)	(0.0165)	(0.0183)	(0.0183)	(0.0183)
Constant	8.104***	8.912***	8.878***	7.748***	8.592***	8.561***
	(0.0460)	(0.0153)	(0.0159)	(0.0552)	(0.0189)	(0.0196)
Observations	38583	38583	38583	37396	37396	37396
R-squared	0.252	0.251	0.252	0.149	0.147	0.148

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the log of annual earnings. All earnings have been converted to 2007 dollars using the CPI-U.