The Returns to the Federal Tax Credits for Higher Education*

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ABSTRACT

Three tax credits benefit households who pay tuition and fees for higher education. The credits have been justified as an investment: generating more educated people and thus more earnings and externalities associated with education. The credits have also been justified purely as tax cuts to benefit the middle class. In 2009, the generosity of and eligibility for the tax credits expanded enormously so that their 2011 cost was $25 billion. Using selected, de-identified data from the population of potential filers, we show how the credits are distributed across households with different incomes. We estimate the causal effects of the federal tax credits using two empirical strategies (regression kink and simulated instruments) which we show to be strong and very credibly valid for this application. The latter strategy exploits the massive expansion of the credits in 2009. We present causal estimates of the credits' effects on postsecondary attendance, the type of college attended, the resources experienced in college, tuition paid, and financial aid received. We discuss the implications of our findings for society's return on investment and for the tax credits' budget neutrality over the long term (whether higher lifetime earnings generate sufficient taxes to recoup the tax expenditures). We assess several explanations why the credits appear to have negligible causal effects.

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1 Introduction to the Tax Credits for Higher Education

Since 1997 the U.S. federal government has offered tax credits--the Hope Tax Credit (HTC) and Tax Credit for Lifelong Learning (TCLL)--to households who pay tuition and fees for higher education. In 2009, the enactment of the American Opportunity Tax Credit (AOTC) made the postsecondary tax credits much more generous. It also expanded eligibility for the credits to a large number of low-income and higher-income households that had previously been ineligible. The estimated fiscal cost of the tax credits is $23 billion for 2014. For comparison, the much better-known Pell Grant program, which provides grants to low-income students, cost approximately $33 billion in the same year. All other federal programs that support higher education are smaller.

From 1997 to today, proponents have offered two main justifications for the tax credits. The first is that tax credits will induce individuals to invest more in their own education, causing them to have improved earnings and other improved outcomes (some of which may occur through social mechanisms such as educational spillovers or reduced dependency). The improvements will be such that the tax credits ultimately pay for themselves--for the federal government in particular or for society in general. Hereafter, we classify arguments under this general heading as "return on investment" (ROI) arguments.

Some proponents of the tax credits have suggested, as a second justification, that they are simply a tax cut--more especially a "middle class tax cut." Although this justification has always been more controversial than the ROI argument, it is safe to say that at least some proponents would judge the credits to be successful if they could be shown to be an efficient means of reducing taxes relative to other tax cuts with similar incidence.

In this paper, we show how the tax expenditures associated with the tax credits are distributed among households. This evidence should help readers assess the credits' distributional consequences purely as tax cuts. Most of the study is, however, dedicated to assessing the ROI argument. It is logically necessary for this argument that the tax credits have a causal effect on some educational outcome such as college attendance, the educational resources students experience, or the type of college students attend. Once one has obtained causal effects on such outcomes, one can project their long-term consequences by, for instance, by associating changes in college attendance with changes in lifetime earnings.

The main challenge in this study is to identifying causal effects of the tax credits. Our first approach relies on the phase-out of each tax credit. Each phase-out creates two kinks in an otherwise linear relationship between household income and the tax credit obtainable. These kinks allow us to use regression kink methods to estimate effects of the tax credits. These methods are suitable not only because they can produce highly credibly causal estimates but also because we estimate the kinks precisely using dense data from the population of potential tax returns. The limitation of the regression kink estimates is that they inform us only about causal effects for households in the

vicinity of the phase-out range of income. If the effects on these households is dissimilar from the effects on, say, low-income households, we have learned only part of the story.

Therefore, we also use the method of simulated instruments to analyze the effects of the tax credits. In particular, we look before and after the enactment of the AOTC in 2009. This enactment greatly increased the generosity of the tax credits and also extended credits to households that had previously been ineligible. Thus, we have "before" and "after" periods and we have households whose eligibility was changed ("treated") and whose eligibility was unchanged ("controls"): the ingredients of a classic difference-in-differences analysis. Because the changes in the tax credits are complicated, we form simulated instruments that embody the policy-driven (and only the policy-driven) changes in the credits available to a household. Nevertheless, one should think of the simulated instruments analysis as logically analogous to a differences-in-differences analysis.

The advantage of the simulated instruments analysis is that we can assess the effects of the tax credits on households of all income levels, not just households in the phase-out ranges. However, a disadvantage is that the 2008 to 2009 period is hard to analyze because the financial crisis and recession might also have affected higher education. For instance, the method could be undermined by effects of the business cycle that differ for students with different family incomes. Nevertheless, we are confident that our simulated instruments findings can dependably be interpreted as causal. Our confidence is based on three facts. First, changes in the generosity of the tax credits were spread throughout the income distribution. There were low-income, middle-income, and high-income individuals who were "treated." Similarly, there were low-, middle-, and high-income "controls" who experienced little or no change in the tax credits. Second, we can show that individuals who would be more or less affected by the enactment of the AOTC were on parallel trends, in terms of college outcomes, prior to the AOTC. Third, when applied to the relatively high income individuals for whom we have regression kink results, the simulated instruments method produces results that are essentially the same.

Having produced credible estimates of the causal effects of the tax credits on outcomes such as college attendance, we consider the implications for the ROI argument. We conclude the paper by discussing explanations for the apparently negligible causal effects of the tax credits. We also discuss the tax credits purely as tax cuts.

We benefit from several excellent, previous studies of the tax credits for higher education. Crandall-Hollick (2012a, 2012b) concisely summarizes the provisions of the higher education tax credits and the legislative debate surrounding them. Lederman's (1997) narrative about the lobbying for and passage of the tax credits is highly informative about the announced intentions of their proponents. Several previous studies have predicted the impact of the credits or highlighted their peculiar features: Hoxby (1998), Davis (2002), Dynarski and Scott-Clayton (2006), Kane (1997), and Maag and Rohlay (2007).

Long (2004b) assesses the impact of the initial introduction of the credits. She uses the data from the National Postsecondary Student Aid Survey to show their distributional consequences. She then uses differences-in-differences methods on the 1990 through 2000 October Enrollment Supplements to the Current Population Survey to show that the introduction of the tax credits appears to have generated little or no increase in postsecondary enrollment. Long classifies students based on their actual eligibility for the credit.

Like Long (2004b), Turner (2011) analyzes the initial enactment of the tax credits. He relies on data from the 1996 and 2001 waves of the Survey of Income and Program Participation, and uses an approach that is essentially differences-in-differences. However, he classifies students by their potential eligibility for the credits. In other work, Turner (2012a, 2012b) investigates whether the tax credits are offset by tuition increases and why many filers fail to take the tax credit that would apparently benefit them most.

Relative to Long (2004b) and Turner (2011), we make several improvements. First, we use data from the population of potential tax return filers. These allow us to be fairly definitive about the distributional consequences of the credits. They also allow us to use the regression kink method--a method that is not reliable with data that is less than very dense. (Certain key variables are not available before 1999 so we do not study the initial enactment of the credits.) Second, although we cannot study the initial introduction of the tax credits, the enactment of the AOTC provides us with a much larger shock to tax expenditures than the initial introduction provided. The fiscal cost of the credits rose by $12 billion between 2008 and 2009 ($2014 dollars). The fiscal cost rose by only $4.9 billion when the credits were initially introduced ($2014 dollars). The AOTC also affected households over a much wider range of incomes than the HTC and TCLL Third, our use of simulated instruments is a major improvement over both the Long and Turner methods. This point is subtle but boils down to the fact that we observe both the exact use of the tax credits and exact eligibility for the credits. This allows us to instrument for the actual credits with the credits for which the filer is eligible. This is superior to using just the actual credits (Long) because the actual credits are potentially endogenous. It is also superior to using only an inexact measure of eligibility in a reduced-form analysis (Turner). Instrumental variables analysis is strictly superior to the reduced-form analysis because we obtain the correct magnitudes of the effects.[1] Fourth, since the data are longitudinal, we know the filer on whom an individual would be a dependent if she were a student. This allows us to construct tax credit eligibility even for those who are not students. Finally, because we have very dense data, we can

[1] Turner estimates a reduced-form whereas we estimate by instrumental variables. While time-series and cross-sectional variation in eligibility drives the estimates in both cases, only the instrumental variables results will deliver coefficients of the correct magnitudes.

construct simulated instruments based on behavior that is typical for households in precise income ranges. This is also a subtle point but it greatly increases our statistical power to discern effects relative to what Turner has to do.[2]

We are able to make these improvements over prior studies mainly because we have better data. They allow the estimates to be fully representative (an obvious point) but also allow us to use empirical methods that are otherwise infeasible. Had we only the limited survey data that Long and Turner had, we would have had been hard-pressed to improve upon their studies.

2 The Tax Credits

2.1 The Mechanics of the Tax Credits

In the Taxpayer Relief Act of 1997, two important and "permanent" tax credits were enacted: the HTC and the TCLL. Both credits reduce the amount that a household owes in taxes, dollar for dollar, when the household spends a sufficient amount on qualifying postsecondary tuition and fees. A household does not need to itemize deductions to take these credits, but the HTC and TCLL are non-refundable so that these credits can only reduce a household's tax liability to zero. Thus, a household with no tax liability cannot benefit from the credits and a household with little tax liability may benefit only to a limited extent.

The HTC gives a household a credit equal to 100 percent of its first $1200 and 50 percent of its second $1200 of expenditure on each student's qualifying tuition and fees.[3] Thus, the maximum amount of the credit is $1800 per student, and this maximum can reached only by households that spend at least $2400 per student. For his tuition and fees to qualify, a student must be enrolled at least half time in the first two years of a postsecondary education that could lead to some degree or certificate. In 2008, the HTC phased-out between $48,000 and $58,000 of modified adjusted gross income for single tax filers. The phase-out range was $96,000 to $116,000 for married joint filers. (Hereafter, we use "income" to denote modified adjusted gross income.)

Independent students (mainly students age 24 and over) receive the credit

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[2] Turner assigns each student to the maximum tax credit for which she would be eligible if she enrolled in college and had tuition spending equal to or greater than the relevant credit's spending limit. This is the best available procedure given his data.

[3] The HTC and TCLL have had their parameters adjusted multiple times to account for inflation. In 1997, the HTC was 100 percent of the first $1000 and 50 percent of the second $1000. Because the HTC has been effectively suspended since the 2009 introduction of the AOTC, the tuition and fee numbers in this paragraph reflect the HTC parameters in 2008. However, the phase-out range for the HTC is the same as that for the TCLL so we know where the HTC would phase out--were it in effect--in 2009 and after. If the AOTC expires in 2017, as planned under current legislation, the HTC will resume with tuition and fee parameters that take account of inflation between 2008 and 2017.

themselves. However, if a student is a dependent of another tax filer, as most full-time students under age 24 are, then the HTC goes to the filer--typically a parent. In theory, there is no limit on the number of dependent students a family could have who qualify for the HTC. In practice, it is most common for there to be only one credit per filer and it is rare for there to be more than two because each child is eligible only during her first two years of college.

It is important to note that the credit is for expenses paid in the relevant tax year. For instance, if a student entered college in the 2007-08 school year, his family would typically pay for the fall term in the summer of 2007 and pay for the spring term in December of 2007 or January of 2008. If the family paid for both fall and spring in calendar year 2007, their expenditures on the 2007-08 school year would generate a credit on the taxes due on April 15, 2008. However, if the family paid for spring in January 2008, they would only receive the credit with their 2008 tax filing, due in April 2009.

The household itself must spend the money for tuition and fees. If some or all of a student's college expenses are paid by a tax-free scholarship, fellowship, grant, employer assistance, or veterans' assistance, the qualifying tuition and fees are reduced commensurately.

The TCLL is a non-refundable credit equal to 20 percent of a tax payer's first $10,000 of expenditure on tuition and fees.[4] Thus, the maximum credit is $2,000. Unlike the HTC, the credit is per tax payer, not per student. The TCLL can be generated by the tax payer's expenditure on virtually any postsecondary coursework: undergraduate, graduate, or courses that improve job skills (even if they are not part of a degree or certificate program). The other major features of the TCLL--timing, the phase-out ranges, are the same as for the HTC.

Although both the HTC and TCLL are "permanent" tax credits, the HTC has been in abeyance since the enactment of AOTC in 2009 because the AOTC is more generous than the HTC on all dimensions and expenses cannot qualify for both. Thus, so long as the AOTC is in effect, the HTC is effectively suspended. The AOTC was passed as a temporary measure as part of the American Recovery and Reinvestment Act.[5] Due to expire in 2012, it was extended for an additional five years by the American Taxpayer Relief Act and will expire at the end of 2017 under current law.

The AOTC is equal to 100 percent of the first $2,000 plus 25 percent of the next $2,000 of a student's qualifying tuition and fee expenditures. Thus, the maximum credit is $2,500 per student, but $4,000 per student must be spent to reach that maximum. Unlike the HTC, the AOTC can be claimed for all four of a student's first four years of postsecondary education.

It is important for its distributional consequences that, unlike the HTC and

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[4] Between 1998 and 2002, the TCLL was equal to 20 percent of the first $5,000 of expenditures on qualifying tuition and fees.

[5] It was extended to 2012 by the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010.

TCLL, the AOTC is partially refundable. Specifically, a tax payer receives a minimum of 40 percent of what he would receive, per student, had his taxes owed not been taken into account. Thus, a tax payer who owes zero taxes receives a check for $1,000 per student if each student spends at least $4,000 on qualifying tuition and fees. Also important for its distributional consequences are the substantially higher income thresholds before the AOTC begins to phase out: the range is $80,000 to $90,000 for single filers and $160,000 to $180,000 for married joint filers. In other words, the AOTC makes eligible many taxpayers who were previously ineligible for higher education tax credits because their incomes were either too low or too high. Table 1 summarizes key parameters of the HTC, TCLL, and AOTC from 1999 through 2012.

Figures 1 through 6 show the tax credits available to a student by income and spending on qualified tuition and fees. In order to emphasize the change in the law between 2008 and 2009, these figures are for an individual who, if he were to attend college, would be a dependent of a married couple filing jointly. Figure 1 and 2 show the tax credits available to him if he were to spend $10,000, the tuition at which the TCLL is maximized. Figures 3 and 4 show the credits if he were to spend $4,000, the tuition at which the AOTC is maximized. Figures 5 and 6 show the credits if he were to spend $2,400, the tuition at which the HTC is maximized.

There are a few things to take away from these figures. First, for students with less than $9,000 in qualified tuition, the HTC is always preferable to the TCLL. Above $9,000, the TCLL is always preferable to the HTC. Thus, up through 2008, many students would take the HTC in their first two years and only take the TCLL in the third and high years. Second, the AOTC is more generous at every income and tuition level than the HTC or TCLL. Thus, from 2009 to today, all students in their first four years of postsecondary school should take the AOTC in preference to the TCLL. Third, each figure shows that the tax credits phase out rather sharply. The HTC and TCLL always phase out in the same income range, which is much lower than the AOTC's phase-out range.

Fourth, on the left hand side of each figure, there is what appears to be a phase-in range for the HTC and TCLL. This is not a true phase-in but, rather, the empirical evolution of federal tax liability which limits the HTC and TCLL because they are nonrefundable. That is, owing to exemptions, deductions, brackets, and certain non-education credits (the credits for child care expenses and foreign taxes), households with fairly low incomes have negative, no, or small positive tax liability before the education tax credits are considered. Thus, the tax credits grow with income in the lower ranges but not because of income per se. Rather, a whole host of tax provisions affect a household's tax liability in the lower range and it is the combination of all these provisions that makes the education credits tend to grow with income as an empirical matter. Put another way, the apparent phase-in would look different if we made different assumptions about households' children under 17, deductions,

allocation of earnings, childcare expenses, and so on.

We make further use of Figures 1 through 6 below when we exploit the changes in the tax law between 2008 and 2009 to analyze the causal effects of the tax credits.

2.2 The Fiscal Cost of the Tax Credits

Even prior to the enaction of the AOTC, the higher education tax credits were the single largest educated-related tax expenditure. They represent a very important component of federal support for students' higher education expenses. Total tax expenditures on the tax credits were $25.1 billion in 2011.

Table 2 and Figure 7 show how the fiscal cost of the tax credits grew from their inception. Actual credits claimed are shown for 1998 through 2012. Estimated tax expenditures are shown for 2013 through 2015. The data show the fiscal cost of the higher education tax credits grew gradually in real dollars until 2008 when they totaled $8.3 billion in 2014 dollars. With the advent of the AOTC, the tax expenditures on the credits more than doubled in a single year: the 2009 total was $20.3 billion. Much of the growth in expenditures was due to the introduction of the refundable component of the credit which cost $8.4 billion in 2009 and grew to $12.1 billion in 2011, the last year for which we have non-preliminary actual numbers available. However, the cost of the nonrefundable component of the tax credits also grew dramatically--by 42 percent between 2008 and 2009.

2.3 The Manner in which the AOTC is Computed

Here, it is useful to note a curious feature of how the refundable credits are computed because it affects interpretation of Table 2, Figure 7, and all of our distributional calculations. One might think that the legislation would have individuals calculate the AOTC they could take as a nonrefundable credit and then take the partially refundable credit only if the latter were greater than the nonrefundable credit. This is not, however, what is done. Instead, everyone eligible for the AOTC takes the partially refundable credit first (40 percent of qualified tuition and fees after imposing the phase-out). Only then is the remaining 60 percent of tuition and fees considered for the nonrefundable credit.[6]

The result is that many filers who do not need the AOTC to be refundable--that is, they have more than enough taxes owed--are reported as taking a refundable credit. To see why this matters, consider a filer with a single child

[6] The legislation (Public Law 111–5, section 1004) states: "(6) Portion of Credit Made Refundable.—40 percent of so much of the credit allowed under subsection (a) as is attributable to the Hope Scholarship Credit (determined after application of paragraph (4) and without regard to this paragraph and section 26(a)(2) or paragraph (5), as the case maybe) shall be treated as a credit allowable under subpart C (and not allowed under subsection (a)). The phrase we have italicized is the crucial part.

for whom she spends $10,000 on tuition in 2008. If she has tax liability of at least $2,000, the filer can get a $2,000 TCLL. With the same circumstances in 2009, the filer can get a refundable credit of $1,000 and a nonrefundable credit of $1,500. Although her total tax credits have risen by $500 and the refundability of the AOTC is irrelevant to her, her nonrefundable credit will be reported as falling by $500.

In short, the enormous rise in refundable credits from 2009 onwards and the smaller rise in nonrefundable credits does not mean that most of the tax expenditure on the AOTC has gone to low-income households. Most of the increased tax expenditure on the AOTC has gone to households that were already eligible for the HTC and TCLL or to households with incomes above the HTC/TCLL phase-out range. Later, we show the distributional consequences of the AOTC's refundability where we define it as refundable only for those filers who would get a different credit were it nonrefundable.

2.4 The Intended Effects of the Tax Credits

It is always difficult to say what legislators intended a policy to do, but there is good documentation of the origins and debate surrounding the enactment of the HTC, TCLL, and AOTC. In particular, see Lederman (1997). The majority of the justifications for the tax credits suggest that they were intended to cause an increase in students' investments in higher education.

For instance, in the Princeton University commencement address in which he initially proposed tax credits that would become the HTC and TCLL, President Clinton said:

> America knows that higher education is the key to the growth we need to lift our country....Today, the college-educated worker makes 74 percent more than the high school worker. Higher education is the key to a successful future in the 21century. We must say to all Americans: Go to college....That is why, today, I am announcing a new plan to complete our college strategy, and make two years of college as universal as four years of high school. And the right way to do it is to give families a tax cut, targeted to achieve our national goal....[N]o tax cut will do more to raise incomes and spur economic growth over the long haul than one designed to help people to college.

Similarly, President Obama proposed a fully refundable higher education tax credit when campaigning late in 2007:

> It ... means putting a college education within reach of every American. That's the best investment we can make in our future. I'll create a new and fully refundable tax credit worth $4,000 for tuition and fees every year, which will cover two-thirds of the tuition at the average public

college or university.[7]

While the tax credits enacted do not precisely match the policies initially envisioned by Presidents Clinton or Obama, both speeches emphasize the ROI argument. That is, the presidents suggest that the tax credits will cause students to invest more in higher education which will generate higher future earnings, greater economic growth, and other benefits over the long term. Notably, both speeches suggest that the tax credits will have a causal effect on college education and that they represent an investment (not a simple transfer of income).

In contrast, Lederman (1997) indicates that, when pushing their passage, various policy makers argued that the higher education tax credits were simply a well-targeted middle class tax cut. For instance, he quotes the then head of the National Economic Council, Gene Sperling, as saying, "This is a middle-class tax break, first and foremost."

It would be hard to justify the higher education tax credits purely as a method of cutting the taxes of middle-income households because they require substantially more paperwork than would a reduction in the tax rates applied to middle incomes. However, we may speculate that the tax credits were intended to direct tax relief to middle-income households who invest in higher education rather than, say, spend money on consumption. Such intentions would be consistent with optimal tax logic which, as rule, suggests that income that is invested should be treated differently than income that is consumed. For instance, fundamental tax reform proposals often provide for income that is invested being pre-tax (not subject to tax) while income that is consumed is post-tax.[8] Like the simpler ROI arguments, optimal tax-based arguments require that (i) the credits have causal effects on families' spending on higher education, (ii) families' college spending is actually an investment with positive expected returns. The latter requirement is something we evaluate in other studies but that is beyond the scope of this study.

Alternatively, policy makers may have preferred the higher education tax credits to a simpler rate cut for middle-income households because the credits were less transparent. That is, policy makers may have been willing to accept more paperwork and a lack of causal effects in return for a tax cut that was politically more feasible because it appeared to be an education program, not tax relief program.

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[7] Barack Obama, "Remarks in Bettendorf, Iowa: 'Reclaiming the American Dream'", November 7, 2007. Posted online by Gerhard Peters and John T. Woolley, The American Presidency Project. http://www.presidency.ucsb.edu/ws/?pid=77019

[8] The proceeds of the investments are eventually consumed so all income is eventually taxed. A practical classic on fundamental tax reform is Bradford (1984). See Stantcheva (2014) for an optimal tax analysis using the most modern methods.

3 Data

We rely on selected, de-identified data from an IRS database. We use variables derived from Form 8863: qualified spending on tuition and fees, the refundable credit (from 2009 onwards), and the nonrefundable credit before it is limited by taxes owed. We also use tax credit-related variables from returns: modified adjusted gross income, taxes owed before credits, and credits that are considered before the education credit. For non-filers, we use wages from Form W-2 in place of adjusted gross income. Finally, we use variables derived from Form 1098t (the form on which institutions report payments of tuition and fees): tuition and fee payments, whether the student is enrolled at least half-time, whether the student is enrolled in graduate studies, and scholarships and grants received by the student.

It is not always possible to use 1098t-derived variables to compute the credit for which the filer is eligible. First, scholarships are reported in such a way that they cannot be used for precise tax credit calculations. If a scholarship can pay for qualified tuition and fees and can also pay for other expenses such as room and board, only the part of scholarship that pays for tuition and fees should be subtracted from the payment made by the student's family. However, all of the scholarship is typically reported on the 1098t. Below, we show lower bounds that assume that all of the scholarships reported pay for tuition and fees. We show upper bounds that assume that none of the scholarships pay for tuition and fee. Second, tax years are not aligned with school years, and the restrictions on the HTC and AOTC are a function of how many years of school the student has enrolled in. It is possible that a student who has been reported as enrolled at least half-time in two previous tax years is, in fact, only beginning her second year of enrollment. Thus, the lower bound we show below assumes that the a student is ineligible for the HTC (AOTC) once she has been reported as enrolled half-time in two (four) previous years. Our upper bound allows her three (five) previous years before she is ineligible for the HTC (AOTC). Summing up, when we use 1098t-derived variables to compute the credit for which the filer is eligible, our upper bound overstates the truth probably much more than our lower bound understates the truth.

We use information on each postsecondary school's characteristics from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS). We employ College Board and ACT data in a limited capacity.

4 The Distribution of the Tax Credits

In this section, we examine how the higher education tax credits are distributed among households. This is not merely a matter of who is potentially eligible based on income. It is also a matter of how much each student and tax filer spends on tuition and fees and what the student's college attendance patterns are. Thus, a household with a college-aged individual who is academically ready for college may get a credit when a household with a similarly college-aged but not college-ready individual could not get a credit.

Even within households with the same income and same college readiness, one household may get the credit and another may not owing to differences in local schools' tuition and fees, the availability of full-time degree programs, and so on. Even within households who have the same income, same college experience, and same expenditures on tuition and fees, some may take up a credit when others fail to do so owing to, for instance, their knowledge of the tax law. See Davis (2002) and Turner (2011a).

Table 3 shows potential and actual higher education tax credits for 19 and 20 year olds in 2008. This and the subsequent tables, which present different age ranges and tax years, are structured similarly. Thus, it is worthwhile reviewing the table structure here. Each row of the table shows an income group: 0 to $10000, $10001 to $20000, and so on up to $190,000 to $200,000.

The left-hand column shows the number of 19 and 20 year olds who would belong to each income group were they to be students who would (therefore) typically qualify as dependents. That is, the column shows the approximate number of 19 and 20 year olds who could be affected by the tax credits. For the "potential" calculations, we assign 19 and 20 year olds an income group based on the 2008 income of the person of whom they were a dependent at age 17. This is regardless of whether they are still a dependent since their 2008 dependency is a function of whether they actually choose to be a student, which is possibly a function of the tax credits.

The next column shows the percentage of the 19 and 20 year olds in the left-hand column who appear to qualify for a tax credit based on 1098t information returns. That is, the column shows the share of 19 and 20 year olds who are reported to pay qualified tuition and fees and who are eligible for a credit based on the filer's income and tax due before credits. Observe that low income individuals tend not to qualify because they do not owe positive tax before credits. No individual above the phase-out range qualifies.

The next column shows the total tax expenditure associated with the tax credits that could be received by the 19 and 20 year olds. To make these calculations, we need to determine whether an individual is in her first two years of postsecondary school and whether she attends at least half-time. This allows us to determine whether she qualifies for the HTC or only for the TCLL.

The two aforementioned columns show minimum and maximums for the 19 and 20 year olds who qualify for a tax credit. These are the lower and upper bounds mentioned in the previous section. Keep in mind that the upper bound is probably farther from the truth than the lower bound.

So far, we have only considered the potential higher education tax credits. That is, we have shown how they would be distributed if they were to be based purely on administrative reports. We have not accounted for take-up.

The remaining three columns address this gap by showing how the tax credits are actually distributed based on variables derived from returns and Form 8863. The potential (1098t based) and actual (8863 based) distribution of the tax credits can differ for at least four reasons. First, some postsecondary institutions might not file accurate 1098t returns. Second, some families might

(deliberately or mistakenly) overstate or understate their true qualified spending on tuition and fees. Third, some families who qualify for a tax credit and who would report their qualified tuition and fees accurately if they knew to do it might be unaware of the tax credits and fail to take them up. Fourth, some families who take up a tax credit might fail to take the one that benefits them most.

The next column presents the percentage of 19 and 20-year-olds who are actually associated with a nonrefundable credit--the only type of credit available in 2008. The subsequent column presents their average nonrefundable credit.[9] The final column presents the tax expenditure associated with the students in each income group.

The corresponding tables for 2009 have additional columns that show the refundable part of the AOTC.

Having reviewed the structure of the table, now consider what Table 3 shows. The table demonstrates that, in 2008, the credit was very much a middle-class affair. For instance, there were 902,946 19 and 20 year olds who, had they been dependent students, would have been in households with $20,001 to $30,000 of income. Only 16 to 23 percent of them appear to have qualified for a credit based on 1098t information, and only 7 percent of them actually got a tax credit. The potential tax expenditure on them was $79 to 134 million, and the actual tax expenditure on them was $37 million. This modest tax expenditure is partly because many were not students and partly because many owed insufficient taxes to benefit from a nonrefundable credit. Furthermore, their average tax credit when they did take one was a modest $631. Compare this record to that of households with $70,001 to $80,000 of income. They were associated with a smaller number of 19 to 20 year olds who could have been students: 438,416. However, 45 to 49 percent of them appear to have qualified for a tax credit based on 1098t information. 30 percent of them (in other words, about 2/3rds of those who qualified) actually got a tax credit, and their average tax credit was a much larger $1,394. Thus, the potential tax expenditure on them was $244 to 323 million, and the actual tax expenditure was $183 million.

So far, we have contrasted low-income households, who often spent too little on tuition or owe insufficient taxes to get tax credits, to middle-income

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[9] We can show the average nonrefundable credit per student in all households that contain a 19 or 20 year old claimant. We can alternatively show the average nonrefundable credit for 19 and 20 year olds who are the only students in their households for whom a credit is claimed. The first calculation matches aggregate data. but includes credits not just for 19 and 20 year olds but for students who are 21 to 23 years old. The older students tend to be eligible only for the TCLL but the breakdown between the HTC and TCLL by student is not reported. Therefore, there is some advantage to the second calculation which, though not fully representative, excludes older dependent students. We did the calculation both ways and found that they were so similar that we show only the first version.

households. But, Table 3 also shows that high-income households got no tax credits in 2008 because they were above the phase out. For instance, households with $120,001 to $130,000 in income (just above the phase out) got no tax credits although they were associated with 167,373 19 and 20 year olds.

If we divide the actual tax expenditures by the potential tax expenditures in Table 3, we see that the take-up rate of the tax credits rises almost monotonically with income until we reach the bottom edge of the phase-out range. The increasing take-up rate may be due to higher income households being (or using) better tax preparers. It may also be due to their having more to gain from filing the tax credit paperwork: their average tax credit is much larger.

At least some of the low credit take-up of low-income households was probably due to their students being poorly prepared for college, especially for the sort of colleges that would charge sufficient tuition and fees that they would not have been entirely covered by a Pell Grant. (For students of most achievement levels, colleges that have more resources are more selective and charge higher tuition and fees.[10]) For instance, Appendix Table 1 shows that only 39.5 percent of 19 and 20 year olds associated with a 2008 household with $20,001 to $30,000 of income took a college assessment, a prerequisite for admission to most selective colleges.[11] (By including the PSAT©, we are being very generous in recording someone as having taken a college assessment.) Among the minority who took an exam, their mean math score was 444 in SAT© scale points (approximately the 26th percentile among test-takers in that year).

In contrast, 59.2 percent of potential students from households with $70,001 to $80,000 of income took a college assessment. Among those who took an exam, their mean math score was 496 (the 43rd percentile among test-takers). More generally, the (admittedly partial) exam-based measure of college preparedness is monotonically increasing in household income. For instance, the top income group shown on the table (which is, of course, not the

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[10] This pattern is reversed for very high-achieving students. For them, the most resource-rich institutions charge them the lowest tuition and fees. See Hoxby and Avery (2013). However, the patterns for these very high-achieving students are largely irrelevant to the distribution of tax credits: the very high achieving make up only a small share of total potential students.

[11] We record a student as having taken a college assessment if he or she took the SAT©, ACT©, or PSAT©. In some states and some school districts, nearly all students take one of these of tests owing to universal test-taking policies. In other states, students elect to take one of these tests. It is rare, however, for a student to enter any selective college in the U.S. without taking a college assessment. Students with no assessment scores are typically restricted to enrolling in two-year institutions and "open enrollment" or nonselective four-year institutions. Of course, some students who take no assessment exam would have proved to be college ready had they been forced to take one. However, almost no students who would score very well on a college assessment fail to take one. For evidence on these points, see Bulman (2012) and Klasik (2013).

top income group in the U.S.) has an average math score of 556, the 62nd percentile. In short, not all of the differences in tax credit receipt are due to eligibility criteria that are potentially controlled by the federal government. Some of the differences are probably due to differences in preparation for college.

Table 4 is like Table 3 except that it shows numbers for 2009, after the enactment of the AOTC. In this table,we classify the tax credits as nonrefundable and refundable according to the IRS definition. We hereafter refer to this as the "legislative" definition. However, we also present Table 5 which treats as nonrefundable all those credits that would be approximately the same if the AOTC were purely nonrefundable. We hereafter refer to this as the "economic" definition of refundability. It is what we need to answer questions about how refundability changes the distributional consequences of the credits.

Because the individuals themselves are very much the same in 2008 and 2009[12], nearly all of the changes between Table 4 and Table 3 are due to changes in the tax credit formulae. Most obviously, there is massive increase in the share of potential and actual tax expenditure for students with incomes above $120,000. For instance, 71 to 75 percent of 19 or 20 year olds associated with households with $150,001 to $160,000 of income appear to qualify for a credit. The potential tax expenditure on them (nonrefundable plus refundable) is $162 to $178 million, and the actual tax expenditure on them is $135 million. Their average tax credit (nonrefundable plus refundable) is $2261--close to the maximum. Notice that the households who are newly eligible due to the raised phase-out (those with $116,000 to $180,000 in income) disproportionately contain students who not only have qualifying tuition but enough of it to generate a substantial credit. Thus, raising the phase-out range to cover them greatly increased the share of credits taken by relatively high income households.

To understand the importance of refundability, it is necessary to examine Table 5 in which credits are classified according to the economic definition. Comparing Table 5 to Table 3, we see an enormous increase in the potential tax expenditure on individuals from low-income households. This is entirely due to the refundable nature of the AOTC. For instance, among the 962,065 students associated with households with 2009 income of $20,001 to $30,000, the potential tax expenditure on nonrefundable credits is $81 to $130 million--almost unchanged from 2008. However, the potential tax expenditure on economic refundable credits was $0 in 2008 but $128 to $235 million in 2009. Actual economic refundable tax expenditures on these individuals was a smaller but still very substantial $94 million. Note also that low-income students' average refundable credit hovers around $800--that is, 80 percent of

[12] We have verified this statement but do not show the data for reasons of conciseness. The results are available from the authors.

the maximum of $1000 potentially available as a refund.

In contrast, refundability is unimportant for higher income households. For households with incomes of $60,001 and up, nearly all of the tax expenditure comes from credits that would be received regardless of whether the AOTC was refundable.

So far we have emphasized the differences caused by income eligibility changes between the HTC and the AOTC. However, the increased generosity of the AOTC (four years rather than two years, a $2,500 maximum rather than an $1,800 maximum) affected middle-income households who were never limited either by the phase-out or by taxes due. For instance, for households with $70,001 to $80,000 of income, tax expenditure rose by 92 percent between 2008 and 2009: from $183 to $352 million!

Tables 6 through 8 replicate Tables 3 through 5 except that they are for individuals aged 22 to 23. These students would still typically be dependents if they were enrolled at least half-time. Therefore, for the "potential" calculations, they are associated with the incomes of the filer on whom they were dependent at age 17. For these 22 to 23 year olds, we find patterns very similar to those for 19 to 20 year olds. Many more higher income students take the credit because they are newly eligible; there is a dramatic increase in credits for low-income students, entirely because they receive refunds; middle-income students receive very substantial increases in credits owing to the increased generosity of the AOTC; the take-up rate rises monotonically with income.

To see some of the interesting effects of the AOTC, one must examine students who are too old to be dependent students. They were unlikely to be eligible for the HTC in 2008 owing to its being available only for the first two years of college. However, many are eligible for the AOTC's third and fourth year. Moreover, the 25- to 26-year-olds are younger than the parents of dependent students and they are therefore much more bunched at the low end of the income distribution where refundability matters. Thus, for instance, the potential tax expenditures on 25- to 26-year olds with $10,000 to $20,000 rises from $100-128 million in 2008 to $160-226 million in 2009. Actual tax expenditures on them rose from only $73 million in 2008 to $205 million in 2009. See Tables 9 and 10.[13]

Finally, Tables 11 and 12 show potential and actual higher education tax credits for 29- to 30-year-olds. Again, there are dramatic changes in potential and actual credits for low income individuals. There is little action in the middle or higher income ranges, however. This is because most 29- to 30-year-olds who earn middle and higher incomes have completed their education (at least their full-time education) and are eligible only for the TCLL whose

[13] For older students, we do not show a version of Tables 5 and 8 --that is, a table in which we use the economic definition of refundability. This is because young, independent filers owe so few taxes that the legislative and economic versions of the refundable credit are very similar.

formula does not change from 2008 to 2009.

We do not show statistics for individuals older than 30 because our analysis suggests that they were largely unaffected by the introduction of the AOTC. As a rule, they are ineligible for the AOTC because they have too many years of prior education and/or are too unlikely to enroll at least half-time.

Summing up, the AOTC dramatically changed the nature of the federal higher education tax credits. It made them available to low-income and higher income households who were previously ineligible. It also greatly increased the generosity of the credits for middle-income households who were never affected by the phase-out and who were never limited by taxes due.

5 Take-Up of the Tax Credits and their Coincidence with Calculations based on Third Party Reports

So far, we have presented calculations that could be used to compute very rough take-up rates: one can divide actual tax expenditures by potential tax expenditures. However, these numbers are somewhat deceptive because the actual tax credit may be smaller or larger than what one would predict based on third party reports (crucially, 1098t information). If some households take a smaller and others take a larger tax credit than third party reports suggest, the households will tend to cancel one another out. As a result, the crude take-up rate that one could compute using the above tables is hard to interpret.

In Appendix Table 2, we present more revealing measures of the coincidence between actual credits and what one would predict based on third party reports. As in the foregoing tables, we show a lower bound on the tax credit computed from 1098t information by applying relative stringent criteria. We also show an upper bound computed by applying generous criteria. Appendix Table 2 is based on tax filers of all ages in 2011.

For students who have simple attendance patterns and simple payments, Form 1098t tends to generate information that entirely coincides with the true information needed to calculate a tax credit. For instance, if a student attends college full-time for four years in a row between the ages of 18 and 23 and his family pays all the tuition itself, Form 1098t can be interpreted in a completely straightforward way. However, intermittent attendance and scholarships and grants may make the family better informed about the true information for tax credit calculations than anyone relying of Form 1098t could be. In short, the calculations based on the third party reports should not be regarded as the "truth," but as what they are: the best available calculations given the information readily available to the IRS.

Using the stringent criteria, we find that 26 percent of actual and potential tax credits in 2011 are within $500 of what one would calculate based on third party reports. (Potential tax credits are those we compute based on third party reports but that are not taken at all--not even in an amount smaller than the calculation.) Another 24 percent are at least $500 greater than what one would calculate based on third party reports. The remaining 50 percent are at least $500 smaller than what one would calculate based on third party reports.

Using the generous criteria, we find that 24 percent of actual and potential tax credits in 2011 are within $500 of what one would calculate based on third party reports. 15 percent are at least $500 greater than what one would calculate based on third party reports. The remaining 61 percent are at least $500 smaller than what one would calculate based on third party reports.

Regardless of whether we use the stringent or generous criteria, another pattern emerges. Higher income people are more likely to have actual tax credits that are aligned with third party reports. They are less likely to take credits greater or smaller than the calculation based on third party reports. There a few possible explanations. They may be more accurate tax preparers. They may have more consistent attendance patterns which make the third party reports more reliable. They may attend postsecondary schools that make more accurate reports to the IRS.

6 The Causal Effects of the Tax Credits

6.1 Using Regression Kink Analysis at the Boundaries of the Phrase Ranges to Identify the Causal Effects of the Tax Credits

In this section, we identify the causal effects of the tax credits by exploiting the fact that the relationship between the credits and income changes at each "edge" of the phase-out range. The estimates contained in this sub-section are highly credible because it is very unlikely that any other factors that affect college-going also just happen to change at exactly the same income numbers. We are aware that the regression kink method has limitations. These are discussed below.

The logic of regression kink analysis is easy to see in figures. Suppose that there is an underlying relationship between a household's income and its members' propensity to attend college. This relationship could be the result of many factors: richer parents might find it easier to pay for tuition but it might also be that they are more educated themselves and therefore make more effort to ensure that their children get a postsecondary education. The numerous factors that combine to generate the relationship do not matter since all that the regression kink method requires is that the combination of the other factors generate a relationship with income that changes smoothly, not sharply, at the exact incomes that form the edges of the phase-out range.

Figure 8 shows a stylized example. Panel (a) shows what the college attendance-income relationship might look like in the absence of the tax credits. That is, panel (a) shows the effects of many factors--parents' ability to pay for tuition, parents' education, secondary school quality--that affect college attendance and that are correlated with parents' income. Panel (b) shows the statutory relationship between the maximum value of the tax credits and income. This statutory relationship is flat until income reaches the first edge of the phase-out range. At that first kink, the slope of the credit-income relationship becomes negative. At the end of the phase-out range, the relationship abruptly levels out, producing a second kink.

If the tax credits have a causal effect on college attendance then we will see kinks in the attendance-income relationship at exactly the income levels at which the phase out begins and ends. Moreover, the changes in the slope of the attendance-income relationship will mimic the changes in the slope of the tax credit-income relationship at those two points. This is shown in panel (c), which shows how the attendance-income relationship will appear if the credits have positive causal effects on attendance. If, instead, the credits have no causal effect, the attendance-income relationship will exhibit no change in slope at the edges of the phase out range.

Of course, many students do not qualify for the maximum tax credit because they spend an insufficient amount on qualifying tuition and fees. We might expect (and, in fact, we will see) that throughout much of the eligibility range, higher income students tend to qualify for higher credits because they spend more on tuition. If so, the credit-income relationship will look like that in Figure 9 panel (a). It is upward sloping until it hits the first edge of the phase-out range. It is then downward sloping until it hits the second edge of the phase-out range. After that, the credit-income relationship is flat at zero credit. Once again, we have a first kink at which the slope changes abruptly in a negative direction and a second kink at which the slope changes abruptly in a positive direction. Once again, if tax credits have a causal effect, the attendance-income relationship will exhibit a negative change in slope at the first edge of the phase-out range and a positive change in slope at the second edge. See panel (b) of Figure 9.

The regression kink method requires that we estimate two equations. In a first stage, we estimate

$$(1) \qquad CreditTaken_i = \alpha_0 + \sum_{k=1}^{K} \alpha_k (Income_i - L)^k + \beta_k (Income_i - L)^k \cdot 1^{Income_i > L} + \varepsilon_i$$

and in a second stage we estimate a parallel equation which we illustrate with attendance although we estimate it for other outcomes as well.

$$(2) \qquad Attendance_i = \delta_0 + \sum_{k=1}^{K} \delta_k (Income_i - L)^k + \gamma_k (Income_i - L)^k \cdot 1^{Income_i > L} + \upsilon_i$$

In the above equations, L is the lower limit of a phase-out range. The summation term is a k^{th} order polynomial in income.

From the above equations, the regression kink estimate of the causal effect of tax credits on attendance is:

$$(3) \qquad \frac{\beta_1}{\gamma_1}$$

We employ similar equations to estimate causal effects at U, the upper limit of each phase-out range:

$$(4) \qquad CreditTaken_i = \alpha_0 + \sum_{k=1}^{K} \alpha_k (Income_i - U)^k + \beta_k (Income_i - U)^k \cdot 1^{Income_i > U} + \varepsilon_i$$

$$(5) \qquad Attendance_i = \delta_0 + \sum_{k=1}^{K} \delta_k (Income_i - U)^k + \gamma_k (Income_i - U)^k \cdot 1^{Income_i > U} + \upsilon_i$$

So far, we have used stylized figures to illustrate how the regression kink method works. Now consider how data actually appear. Figure 10 shows the empirical credit-income relationship in 2007 and in 2011 for students who are dependents in households that file jointly. In both years, credits rise smoothly with income until the first edge of the phase-out range. This sweeping curve reflects higher income students' tendency to pay more tuition. At the first edge, the relationship abruptly becomes very negative and nearly linear, indicating that the phase-out formula is dictating the relationship. At the second edge, the slope of the credit-income relationship abruptly changes again from negative to flat. Thus, Figure 10 looks very much like the stylized example in panel (a) of Figure 9.

Although we have not shown it for reasons of conciseness, the credit-income relationship looks very similar for every year from the introduction of the credits though 2012. The relationship also looks similar for single filers, as opposed to married couples filing jointly. There is always a sharp negative change in the slope of the credit-income relationship at the lower edge and a sharp positive change in the slope at the upper edge. Only the height of the credit and location of the phase-out range changes.

Figure 10 shows close-ups of the kinks in the empirical credit-income relationship. These close-ups may seem unnecessary for displaying the kinks because they are very obvious. However, the regression kink method can depend on small changes in slopes at the edges of the phase-out range. Therefore, close-ups are useful for examining the empirical relationships between outcomes, like attendance, and income.

We have seen that the credit-income relationship exhibits sharp kinks just as in the stylized example. Do outcome-income relationships similarly match what we would expect if the credits have causal effects? Figures 11 through 13 show that the answer is no. The students in Figure 11 correspond to those on whom Figure 10 is based yet we see no change whatsoever in the slope of their college attendance-income relationship at the edges of the phase-out range. (The close-ups are helpful here.) Perhaps, however, students are not changing whether they attend college but are changing where they attend college. The tax credit might, for instance, allow them to attend a four-year college rather than a two-year college. It might allow them to attend a college with higher instructional resources. We look for evidence of such "upgrading" in Figures 12 through 14 but we see none. At the edges of the 2011 phase-out range, we do not perceive changes in the slope of the four-year college attendance-income relationship, the two-year college attendance-income relationship, or the instructional resources-income relationship. Perhaps the tax credit changes

the grants and scholarships a student receives rather than his attendance? Figure 15 suggests not. It shows no perceptible changes in the slope of the grants-income relationship at the edges of the phase-out range.[14]

Of course, we should not rely exclusively on our visual ability to discern changes in slopes at the edges of the phase-out range. Therefore, we show the results of formal regression kink analysis in Tables 13 and 14.

Table 13 shows estimates of the first stage equations--that is, estimates of β_1 from equations (1) and (4) above. Each equation is estimated for 19 and 20 year olds in the year mentioned using a bandwidth of plus or minus $3,000 around the location of the kink mentioned. The results shown are for a cubic polynomial following the guidance given by Ganong and Jäger (2014). Although we do not show alternative specifications, the first stage estimates are, in fact, highly robust to our (i) changing the degree of the polynomial, (ii) expanding the bandwidth around each kink as far as plus or minus $10,000, (iii) focusing on older students, (iv) estimating the equations on years other than 2007 and 2011.[15]

Each estimated coefficient in Table 13 should be interpreted as the change in the slope of the credit-income relationship that occurs at the kink mentioned. Thus, for instance, -0.107 in the first row tells us that the slope of the credit-income relationship decreases by about 11 cents per dollar at the lower edge of the phase-out range for joint filers in 2011. This makes a great deal of sense and corresponds closely to what we saw in the Figure 10 close-up. The credit-income relationship is almost flat at a credit of about $2,200 as it approaches the lower edge. The relationship then falls fairly linearly so that the entire $2,200 goes to zero smoothly over a $20,000 income interval. This means that, just from the figure, we expect the slope to fall from approximately zero to approximately -0.11. This is exactly what it does. All of the estimated coefficients in Table 13 can be similarly interpreted and line up similarly with what we expect based on the credit formula.[16] For context, we have included a column showing the coefficient we would expect if credit-income relationship were flat at the maximum possible credit when approaching the lower edge of the phase-out range. Of course, students are not generally at the maximum credit and the relationship need not be flat approaching the phase-out range. Nevertheless, these expected coefficients are a reminder of the sign we expect and the maximum magnitude consistent with the formula.

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[14] For conciseness, we show certain outcome-income relationships for 2011 only. However, they are available from the authors for all outcomes in all years.

[15] We do not mean that the estimated coefficients do not change. We expect them to change with the year and the individuals' age because the credit formula that applies changes with year and age. Rather, we mean that the estimated coefficients are always close to what we expect based on the formula that applies.

[16] We do not show estimates for kinks at which there is insufficiently dense data. For instance, there are insufficient independent, young filers at the upper edge of the single and joint phase-out ranges.

We use selected data from the population of individuals to produce the estimates in Table 13. Therefore, standard errors and p-values should not be interpreted using a conventional sampling framework. Moreover, the regression kink method employs a specification that imposes very little economic modeling so it is not easy to interpret the standard errors as misspecification of the model as proposed by Abadie, Athey, Imbens, and Wooldridge (2013).

Robust-to-heteroskedasticity standard errors, which have been employed in numerous studies with regression kink analysis have been shown to be far too small. This is because regression kink estimates can be highly sensitive to curvature in the underlying relationship between the outcome and the assignment variable--income, in our case. Therefore, Ganong and Jäger (2014) propose a permutation test based on estimating the regression kink equations at placebo kinks where no kink in the relationship should exist.[17] We do this using as placebos 100 randomly selected incomes that are 3,000 to 7,000 dollars plus or minus each actual kink.[18] Armed with 100 placebo estimates for each kink, we examine whether our estimate based on the actual kink falls outside the 95% confidence interval generated by the estimates from the placebos. If the estimate based on the actual kink passes this test, we show a check mark below it in Table 13.

All of the first stage estimates very easily pass the Ganong and Jäger test. Thus, we are confident that the phase-out range gives us a strong environment for testing the causal effects of the tax credits.

Table 14 shows estimates of the second stage equations--that is, estimates of γ_1 from equations (2) and (5) above. Again each equation is estimated for 19 and 20 year olds in the year mentioned using a bandwidth of plus or minus $3,000 and a cubic polynomial. Each estimated coefficient in Table 14 should be interpreted as the change in the slope of the outcome-income relationship that occurs at the kink mentioned. Thus, for instance, -0.000007 in the upper left-hand cell should be interpreted as saying that the slope of the attending-income relationship decreases by about 0.0007 percent per dollar at the lower edge of the phase-out range for joint filers in 2011.

However, there is little point in interpreting the estimated coefficients in Table 14 because none of them passes the Ganong and Jäger permutation test. That is, there are no discernable causal effects of the tax credits on any of the following outcomes: attending postsecondary school at all, attending at least half-time, attending a four-year college, attending a two-year college, instructional resources, core educational resources, the "list" tuition and fees

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[17] Interestingly, we independently devised essentially the same permutation test after examining our initial regression kink results. However, Ganong and Jäger (2014) wrote up the permutation test first and their paper contains numerous useful results on issues we did not explore.

[18] Notice that the bandwidth of 3,000 around each of these placebos never overlaps an actual kink.

of the student's college, the grant and scholarships the student receives, and the tuition the student pays. (The last eight outcomes are all conditional on attending at all.)

We cannot rule out effects of the tax credits that are too small to be discernable. For instance, if a $1,000 tax credit were to increase attending by 0.1 percent, we would be unable to distinguish this effect from random noise. Generally, though, we interpret the estimates in Table 14 as strong confirmation of what the figures suggest: the tax credits have no or at most extremely small causal effects on college-related outcomes in the vicinity of the phase-out ranges.

The advantage of regression kink analysis is that, so long as the assumptions of the method are met, it produces estimates that are very credibly causal. The disadvantage is that the estimates are relevant only for households with incomes near the phase-out regions. Owing to the changes in the phase-out ranges, especially the major rise in the ranges that accompanied the AOTC, we have estimates for married joint filers that cover a rather wide array of incomes: from about $107,000 to $180,000 in 2013 dollars. For single filers, we have regression kink estimates than span incomes from about $53,000 to about $90,000 in 2013 dollars. We find no causal effects of the tax credits over these fairly wide regions.

However, the phase-out range never occurs in the lower to middling percentiles of the income distribution and, therefore, we cannot extrapolate from the regression kink estimates to say that removing or reducing the tax credits would have no or only a slight effect on college attendance by students whose families have earnings at, say, the 50th percentile for their filing status. There is no reason to think that the effects on them will be as modest as they are around the phase-out range. Indeed, a policy maker who is trying to minimize the causal effects of withdrawing a tax credit might choose to phase it out among precisely those households who are likely to be unaffected. This does not imply that all households would be similarly unaffected.

6.2 Using the Introduction of the AOTC to Identify the Causal Effects of Tax Credits Across All Eligible Incomes

Because we cannot extrapolate our regression kink estimates to low and middle income households, we turn to the introduction of the AOTC which, as we have seen, sharply increased the generosity of the education tax credits for some households. In this section, we employ the classic method of analyzing how the change in college-going behavior, from cohort to cohort, is related to the change in the tax credits they experience. Because the introduction of the AOTC affected students across a very wide range of incomes, including poor students, the estimates from this method have broad application.

This method can be embodied in the simple equation:

$$(6) \qquad Attendance_{it} = \lambda_0 + \lambda_1 CreditTaken_{it} + \sum_{j=1}^{J} \mu_j Income_{it} + \mathbf{1}_t^{year}\nu + \xi_i$$

where λ_1 is the coefficient of interest, there is a polynomial in income, and there is a full set of year effects. Because we estimate this equation for individuals of certain ages (such as 19), we do not include cohort effects which would be redundant.

Because the tax credits that the household actually takes may reflect its response to the tax credits (for instance, receiving a larger credit because the credit causes one to attend a more expensive school) and not just the policy-driven change in the credits, we construct a simulated instrument for each tax credit. A properly constructed simulated instrument embodies the policy-driven change in the credit, holding the household's behavior constant. Thus, our simulated instrument is the credit the household would receive if its college-going choices were typical for a household of its income in a base year (which we set to be 2008). These typical choices are run through the laws of the actual year so that the instrument reflects the changes in the tax credit parameters and only the tax credit parameters. An especially simple example would be the following. Suppose that households with $50,000 of income and one child aged 18 have a 50 percent probability of sending a child to college in such a way as to fulfill the requirements of the HTC (and therefore the AOTC): at least half-time enrollment, enrollment in a degree or certificate program, and so on. Suppose that, conditional on its child enrolling, such a household typically spends $4,000 on qualifying tuition and fees. Then, the simulated instrument for the 2008 credit would be 50% × $1,800, and the simulated instrument for the 2009 credit would be 50% × $2,500 in 2009.

Of course, computing the simulated instruments is more complicated but the essential elements are clear. For each level of income, we need the tax credit qualifying variables: spending on tuition and fees, half-time enrollment, taxes owed before the education credits, and so on.[19]

With the simulated instruments, we have a simple first stage equation:

$$(7) \qquad CreditTaken_{it} = \varphi_0 + \varphi_1 SimulatedCredit_{it} + \sum_{j=1}^{J} \rho_j Income_{it} + 1_t^{year}\omega + \iota_i$$

When estimating equations (6) and (7), it is important to cluster the standard errors to account for the fact that the tax credit policy is not

[19] For each potential student cohort (those who are 19 in 2008, say), we divide their filers' income in each year into 300 quantiles for married filers and 300 quantiles for single filers. We then find the mean of each qualifying variable for each quantile. We use these means to construct the simulated instrument for the tax credits by running them through the credit formulae that apply in each year. A student is assigned to a quantile based on his filer's income when he is 17. After that, the filer's qualifying variables are made to evolve with those of his quantile. This excludes all possibility of endogeneity. We choose 300 quantiles because it puts about 5,000 households in each quantile--enough households to generate precise measures of their average behavior. Additional details are available from the authors.

individual-specific. For instance, consider two households each of which spends $4,000 on tuition in 2008. If both households have incomes below $96,000 and owe at least $2,500 in taxes before credits, these households will experience the same change in credits due to the introduction of the AOTC even if they have quite different incomes--$60,000 and $95,000, say. To generate the clusters, we run each household through the tax credit formulae in 2008 and 2009. We put households in the same cluster if they receive identical tax credits when they make the same college attendance and payment choices.

The weakness of the simulated instrumental variables method, which is often used to assess tax reforms, is that its estimates may reflect other events that occur at the same time as the change in the tax credits and that affect the same people who experience a change in tax credits. Given that the AOTC was introduced as part of the stimulus package, one might worry that certain households were either affected by the events that triggered the stimulus (the financial crisis, the rise in unemployment) or by other components of the stimulus bill. For instance, college enrollment has often been found to be anti-cyclical owing to the decrease in opportunity costs (that is, labor earnings) during downturns. So, we might expect enrollment to rise in 2009 regardless of the credits. Or families who lost home equity in 2008 may have found it harder to finance college.

Despite these circumstances, we are fairly confident that our estimates based on the introduction of the AOTC bear a causal interpretation. Our confidence is based on three things. First, the AOTC increased tax credits not just for low-income or high-income households but for both types of households. Indeed, as we show below, the changes in the tax credits are not a simple function of household income. Some "control" (unaffected or hardly affected) households have high incomes; some have relatively low incomes. Some of the most affected households have fairly high incomes; some have low incomes. Our second reason for confidence is that trends in college-going behavior were parallel before and after the law change, not just for students as a whole but when we define groups who were more and less affected by the change in tax credits. Our third reason for confidence is that this method produces results that closely match the regression kink results for households in the income ranges covered by those results.

Figures 16 through 18 demonstrate our point that the changes induced by the AOTC were not a simple function of income. To construct these figures, we subtract each of the 2008 figures from section 2 from its 2009 counterpart. This shows us the change in the tax credit available to a household with a given amount of spending on tuition, for each level of income. For instance, Figure 17 shows the change in the tax credit available to a household that files jointly, that has no dependent other than the prospective student, and that would spend $4,000 on qualified tuition and fees if its child were to attend college. In zone (a) of the figure, we see that households with incomes up to about $35,000 ($30,000 for third and fourth year students) experience a large increase of about $1,000 in tax credits owing to the AOTC's refundability. In

zone (b), households with incomes from about $40,000 to $96,000 experience a modest increase of $500 if their student is in his first or second year. They experience a very large increase of $1,700 if their student is in his third or fourth year. In zone (c), households with incomes from $116,000 to about $160,000 experience a tremendous increase of $2,500 in their tax credit regardless of the year of their student. This is because they are above the phase-out range for the TCLL and HTC but not for the AOTC. Finally, households in zone (d) with incomes of $180,000 and above experience zero change in the tax credits they could take.

Figures 16 and 18 show similar change in tax credit graphs for households who spend, respectively, $10,000 and $2,400 on tuition on fees. One can see that the most and least affected households are somewhat different than in Figure 17. Indeed, there is variation in treatment not only as we scan the figures horizontally (across incomes) but also as we scan them vertically--across the second versus third year of college. Below, we refer to zones a through d in Figures 16 through 18 so we encourage readers to fix them in their minds.

In econometric terms, it is helpful to have all this variation in the location of the most affected and least affected households because it means that the treatment and control groups have fairly common support, in terms of the income distribution. Put another way, we can compare high income households who are greatly treated because they are just inside the top end of the new phase out range with other high income households who experience no treatment because they are just outside the top end of the phase out range. We need not compare high-income households only to low-income households. Similarly, we can compare upper-middle income households who are greatly treated because they are just outside of the upper limit of the old phase out range with households who are only modestly treated because they are just inside the upper limit of the old phase out range. And so on.

In addition, we gain a great deal of econometric common support from the "vertical" differences due to the AOTC (but not the HTC) being available to third and fourth year students.

Although the variation in tax credits between 2008 and 2009 is too complex to be reasonably described as differences-in-differences, the logic of our empirical strategy is essentially that of differences-in-differences. That is, we are simultaneously exploiting differences across cohorts and differences within cohorts in the tax credits that apply to them. An important test of such a identification strategy is whether the groups who are differentially treated by the law change are on parallel trends prior to the law change. If they are on trends that are fairly parallel, the method is usually reliable. If they are on diverging trends, the estimates may spuriously reflect the divergence in their preexisting trends.

In Figures 19 through 23, we show trends in college attendance and other outcomes by income group, where each group is set up to be as close as possible to the edge of one of the zones mentioned above. Thus, in each figure, the panel

for 19-year-olds has a group from the top of zone a ($25,000-35,000, experienced a moderate increase in credits) whom one would naturally compare to the bottom of zone b ($40,000-50,000, experienced only a slight increase in credits). It also has a group from the top of zone b ($86,000-96,000, experienced only a slight change) whom one would naturally compare to the bottom of zone c ($116,000-126,000, experienced an extremely large increase). It finally contains a group from the top of zone c ($150,000-160,000, experienced an extremely large increase) whom one would naturally compare to the bottom of zone d ($180,000-190,000, entirely unaffected by the introduction of the AOTC).

In all of Figures 19 through 23, the pairs whom we need to be on parallel trends are on parallel trends as we approach 2008, both for 19-year-olds and 23-year-olds. All income groups are slightly affected by the business cycle, but the effects tend to be parallel. Another way to see the parallel trends is to group people by the change in tax credits that they experience if they behave as they do in the base year. That is, the next figure is set up to show the variation that will, through the simulated instruments, drive the estimates. For instance, for 19-year-olds, the groups are 0 change, a $1 to $500 increase in the simulated tax credit, a $501 to $750 increase, a $751 to $900 increase, and a $901 and greater increase. Figure 24 shows the trends for attendance and other outcomes for 19 year olds when individuals are grouped that way. The figure demonstrates that people who were more and less affected by the tax credit changes were not previously on divergent attendance trends prior to the introduction of the AOTC. (We can show similar figures for other outcomes and people of other ages.)

Indeed, Figures 19 through 24 not only show parallel trends prior to the AOTC. They show parallel trends right through the introduction of the AOTC. That is, the figures provide little evidence that people who experienced much larger increases in tax credit generosity had college outcomes that were any different as a result.

In Tables 15 and 16 we formalize this finding by showing estimates of equations (6) and (7). Each regression contains a quintic polynomial in adjusted gross income as well as a full set of year effects.[20] To maximize statistical power, we use the three years before and three years after the introduction of the AOTC: 2006 through 2011. However, the results are very similar if we use only 2008 and 2009. We show results for 19-year-olds and 23-year-olds. The results for individuals of ages 20 through 22 and ages 24 through 26 are similar. As we have seen, older people are much less affected by the AOTC so it is not worthwhile analyzing them.

Table 15 shows the first stage regressions in which the actual tax credits a person takes are regressed on her simulated instrument. There are multiple columns only because the individuals over whom the first stage is estimated varies slightly with the outcomes under study. Most of the coefficients for 19-

[20] The results are very similar if we use polynomials from a cubic upwards.

year-olds are around 0.38. This suggests that, for every extra dollar that a student would receive as a result of the AOTC's enactment if he were entirely typical of his income group, a student actually receives about 38 cents. This makes sense because the simulated instrument deliberately excludes variation in actual tax credits that is potentially endogenous. (That is, the coefficient on the simulated instrument is expected to be between 0 and 1 but well below 1 unless all individuals act in the same way as others with the same income.) The crucial thing for the method is not, however, the coefficient but the statistical power of the instrument. This it has in abundance. The t-statistic for the coefficient on the simulated instrument is 1,190 to 1,512 for regressions based on 19-year-olds. It is 533 to 669 for 23-year-olds. In other words, the simulated instrument is such a strong predictor of actual tax credits that we can estimate the effect of the tax credits with precision.

Table 16 demonstrates that enacting the AOTC did not affect any college-related outcome we study to a degree that is statistically significantly different from zero. All of the t-statistics are far from conventional levels of statistical significance such as 1.96. Moreover, about half of the coefficient estimates that are not statistically significantly different from zero have an unexpected sign. (For instance, the point estimates suggest that the tax credits make a student less likely to attend a 4-year college or a college with generous instructional resources.) Thus, there is no pattern that might tempt us to interpret the statistically insignificant point estimates.

We interpret the evidence in Table 16 as confirmation of Figures 19 through 23. They all suggest that the introduction of the AOTC generated very little change in college attendance or other college-related outcomes.

Using the same simulated instruments method, we have generated separate estimates for relatively low income households (from $10,000 below the upper edge of zone a to $10,000 above the lower edge of zone b), upper-middle income households (from $10,000 below the upper edge of zone b to $10,000 above the lower edge of zone c), and upper-income households (from $10,000 below the upper edge of zone c to $10,000 above the lower edge of zone d). Purely for reference (since we include all households in the analysis), these income ranges are, for 19-year-olds in joint filing households, $25,000 to $50,000, $86,000 to $126,000, and $150,000 to $190,000.

In these regressions that allow effects to vary with income, we find results that are fully consistent with those reported in Tables 15 and 16. That is, the first stage of the method is very strong: the introduction of the AOTC greatly increased tax credits taken. The second stage estimates consistently suggest that the tax credits have no causal effect on college-related outcomes. Part of the reason we do not present these results in tables is that they are already fairly obvious from Figures 19 through 22. The reader will observe that the two lowest income groups in those figures tend to track one another through the enactment of the AOTC. Similarly, the two middle groups track one another and the two highest groups track one another.

Finally, it is noteworthy that the regression kink method and simulated

instruments method confirm one another's results for households in the vicinity of the phase-out ranges. That is, both methods suggest no or very small causal effects of the tax credits on college outcomes.

7 Federal and Social Returns to the Investment in the Tax Credits

We would like to compute various rate of return on investment calculations for the tax credits. However, given that they appear to have little or no causal effect on college-going, the exercise would be nugatory. Regardless of how we make the calculation, we will find that the U.S. Treasury will recoup none of the spending on the higher education tax credits through higher future tax payments.

Since the tax credits cannot generate effects on other outcomes interesting to the federal government (such as crime) if they do not first affect educational outcomes, we will also necessarily find that the federal government as a whole will recoup none of the spending on the higher education tax credits.

Finally, education can have social returns as well as private returns. For instance, one person's education may improve that of her children or neighbors. A more educated person may be a better civic participant. Nevertheless, the mechanisms for social returns all rely on a policy actually affecting education attainment in some way. Thus, regardless of how education generates social returns, we will necessarily find that society will earn a zero return on the tax credits.

In 2014, the federal government and society spent $23 billion on tax credits, an increase of about $15 billion or 177 percent since 2008 (in real dollars). Since we closely study the period from 2006 onwards, our findings can fairly confidently be interpreted as evidence that this increase in tax credits is unlikely to be recouped.

Because we do not have data to study the initial enactment of the tax credits, we can be less confident about the $8.3 billion that the federal government was already spending in 2008. That is, it is possible that this $8.3 billion has causal effects on collegiate attainment and will be recouped with interest. However, there is at best weak evidence in favor of this possibility. Neither the regression kink estimates from 2007 nor Long's estimates support this interpretation. Moreover, such an argument would have to rely on the idea that the $8.3 billion was targeted at precisely those households most likely to be affected--that is, those with incomes of $40,000 to about $93,000 in 2008. If this targeting story were correct, however, it would be surprising that we find no evidence of effects either at the lower end of this range (upper zone a to lower zone b) or the higher end of this range (upper zone b to lower zone c where simulated instrument as well as regression kink estimates are available). Nevertheless, we cannot rule out the possibility that the pre-AOTC tax credits had substantial effects on collegiate attainment right in the middle of this income range--$60,000 to $80,000, say. If this were to be the case, which seems unlikely, it would suggest that the highest return on investment would

be attained if the federal government were to focus higher education tax credits on this specific income range, giving credits not much more generous than the 2008 HTC and TCLL.

Overall, we conclude that there are shaky evidential foundations for arguments based on the idea that the Treasury, federal government, or society will recoup the tax credits with interest through higher education investments.

Of course, none of this means that the tax credits are wasted. They are simply a transfer from some individuals to others. If there is some way other than higher education in which the people who receive the transfers employ money in a way that is especially helpful to society or to the federal budget, the tax credits may be somewhat recouped through this other channel. However, we are not aware of clear hypotheses about channels other than higher education.

8 Discussion and Conclusions

There are at least four possible explanations for the tax credits' meager effects on college-going: the credits are offset by decreased financial aid; the credits are offset by increased tuition and fees; eligible individuals are not liquidity constrained with regard to college-going; the credits are structured in a way that minimizes their causal impact. Consider these explanations in turn.

If every increase in the generosity of the higher education tax credits is offset by a corresponding decrease in financial aid, we would expect the credits to have few or no effects on college. The tax credits would serve merely as a transfer to state governments and private philanthropies that would have provided the aid and can now use the funds for other purposes. However, we find no evidence that grants received by students fall when the credits rise. Thus, financial aid offset is very unlikely to be the reason why the tax credits have few effects on college-going.

There is a long-standing hypothesis (the "Bennett Hypothesis") that increased federal support for higher education (in all forms) causes tuition to rise, thereby limiting the effect on college-going. That is, the supply of higher education might be inelastic so that the increased federal support would trigger a price, not a quantity, response. The price response need not occur through individual institutions raising their tuition. Students could be unable to find seats at inexpensive public or non-profit colleges that are supply constrained. They might enroll instead at for-profit schools that charge higher tuition. However, we do not find any evidence that the tax credits induce students to attend schools with higher list tuition or to pay higher tuition conditional on attending. Thus, our results provide no support for the Bennett Hypothesis as an explanation of the tax credits' inefficacy.

If individuals are not liquidity constrained when making college choices, they will exhibit approximately the same college-going behavior with or without the tax credits. The credits will simply reduce their borrowing or increase their saving. It may well be that households with incomes at or above

the HTC/TCLL phase-out range are unconstrained. If they are, the regression kink analysis will indicate no effects and the AOTC's great rise in the location of the phase-out (from $96,000-116,000 to $160,000-180,000) will have produced no effects in the simulated instrument analysis. A lack of liquidity constraints is a less obvious explanation for the refundable AOTC's lack of effect on low-income households. However, even they may be unconstrained owing to their being eligible for grants (most obviously the Pell Grant), work-study, and loans at interest rates well below what a truly private lender would charge.[21] While the Pell Grant and federal loans cannot cover the cost of America's most selective non-profit colleges for a low-income student, such colleges offer generous financial aid to low-income students who meet their stringent academic criteria. Thus, all in all, we consider a lack of liquidity constraints to be plausible explanation for the tax credits' inefficacy.

The structure of the tax credits may also contribute to their inefficacy. This possibility has been discussed since the debates that preceded the enactment of the HTC and TCLL.[22] First, a household receives a credit only after spending money on tuition and fees. This timing guarantees that credit takers are those who do not have liquidity constraints. Second, the tax filer gets the credit, and the filer is very often not the student. This would not matter if the filer and student shared unified liquidity constraints, but they might not. For instance, a student might be liquidity constrained from attending the college of his choice and his parents might leave him in this position although they themselves are not liquidity constrained. If they get a tax credit, his parents might buy a more expensive car or take out a smaller mortgage. They are not obliged to use the money to relax the liquidity constraints affecting their child. Third, the tax credits may not be terribly salient at the times when families are making college-going decisions. Although IRS materials on the credits are readily available, a family planning its finances might overlook the credits because calculating them requires a number of steps (see Davis 2002). Or, a family may discount the credits because they are uncertain--they can depend on income that has not yet been realized at the time when enrollment decisions are made.

Because the tax credits have always had the same basic structure (timing, recipient, information required for their calculation), we cannot readily assess whether changing the credits' structure would change their efficacy. Experiments in informing people about them are ongoing,[23] but the structural issues may go beyond a mere lack of information. The issues may be inherently difficult to address through the tax system unless filers are given some means

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[21] We mean a private lender who accounted for borrowing risk and had no government guarantee to help enforce repayment.

[22] See, for instance, Lederman (1997), Hoxby (1998), Davis (2002), Long (2004), Dynarski and Scott-Clayton (2006), Kane (1997), Maag and Rohlay (2007), and Turner (2011).

[23] The source is authors' personal communication with the researchers.

to anticipate the credits and to pre-designate them for college expenses. Devising such means is within the scope of what is practical--a sort of "Advance" HTC, TCLL, or AOTC analogous to the Advance Earned Income Tax Credit. However, only a small share of people who were eligible for the Earned Income Tax Credit took it in the form of an advance, and the Advance Earned Income Tax Credit was eliminated in 2010 because its disadvantages were seen to outweigh its advantages.[24]

Recall that at least some proponents of the higher education tax credits suggested that they were simply intended as a middle-class tax cut. To this point, we saw in Tables 3 through 12 that most of the tax expenditures associated with the credits do go to middle-income households. This is less true now, with the AOTC, than it was in 1999 through 2008. Nevertheless, middle-income households remain the key recipients of the tax expenditures.

It is far beyond the scope of this paper to evaluate the incidence or efficiency of the higher education tax credits if we view them purely as middle-class tax cuts, setting aside their links to education investments. However, it is useful to make two points on the tax credits purely as tax cuts.

First, the tax credits raise marginal tax rates by as much as 12.5 to 25 percentage points in the phase-out ranges. These are potentially important marginal rate increases. On the other hand, the credits lower marginal tax rates for households whose credits are limited by their taxes due. We can see from Figures 1 through 6 that these households tend to be in the 15 percent tax bracket. Nevertheless, over quite a wide region of the income distribution (especially under the AOTC), the credits do not affect marginal tax rates but only average tax rates. Thus, anyone investigating whether the credits change taxable income (labor supply) of middle-income households should focus on the minority of households whose marginal tax rates are affected.

Second, the tax credits interact with state and local support for higher education in a manner that generates horizontal differences in the tax cuts for middle-income households who exhibit essentially the same behavior. For instance, consider a state or locality that collects considerable sales tax revenue and uses it to subsidize tuition at its public postsecondary institutions. Its families would not pay much tuition because they have already paid "up front" through sales taxes. They would receive smaller federal tax credits than families with identical incomes who live in areas where public institutions have the same total resources but where state and local governments choose to subsidize tuition less by taxes collected "up front." This may seem like a contrived example but it is not. State and local policies dominate tuition setting in the U.S., and states differ greatly in the extent to which they subsidize tuition through state and local taxes (Long 2004a). Since the federal government is inevitably a minor player in higher education relative to the states, it may not be possible to design horizontally equitable tax cuts through

[24] See General Accounting Office (2007).

the means of higher education tax credits.

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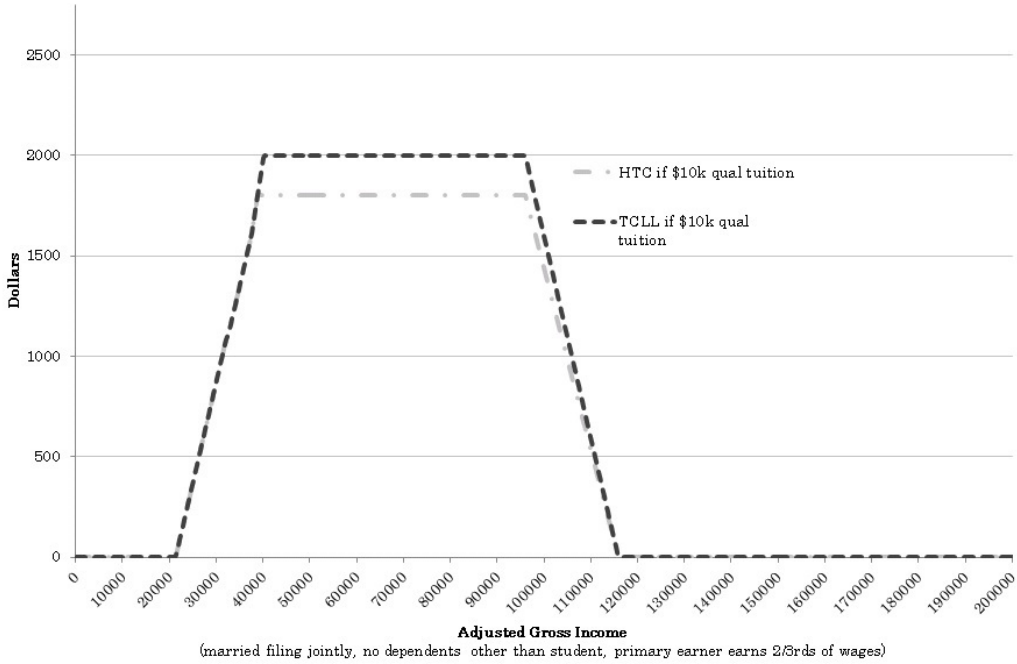
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Figure 1

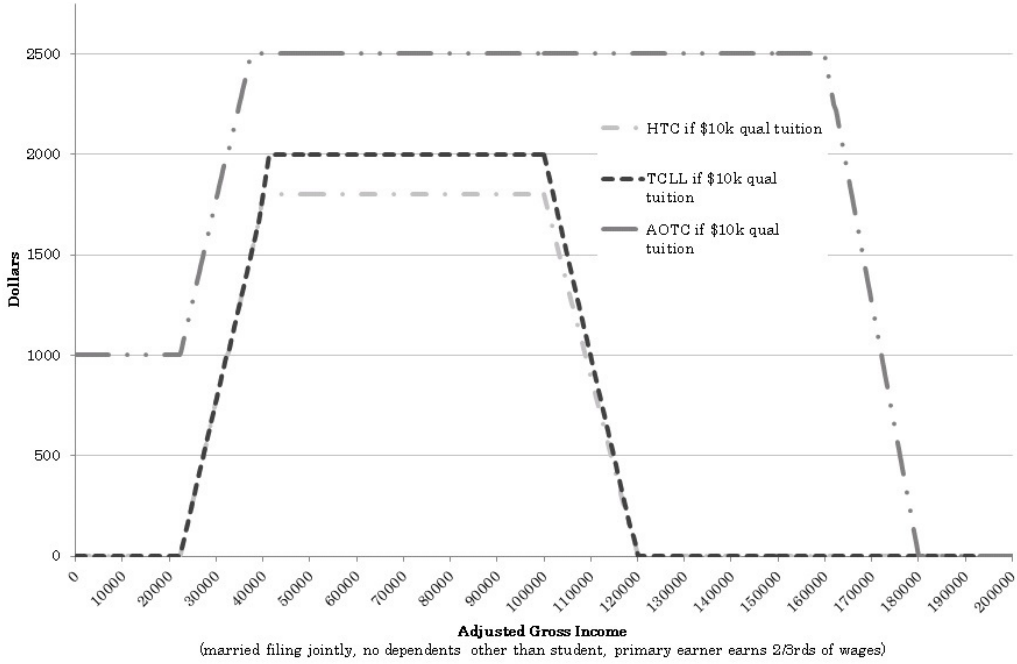
Higher education tax credits in 2008 for a student with $10,000 of qualifying tuition and fees



(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 2

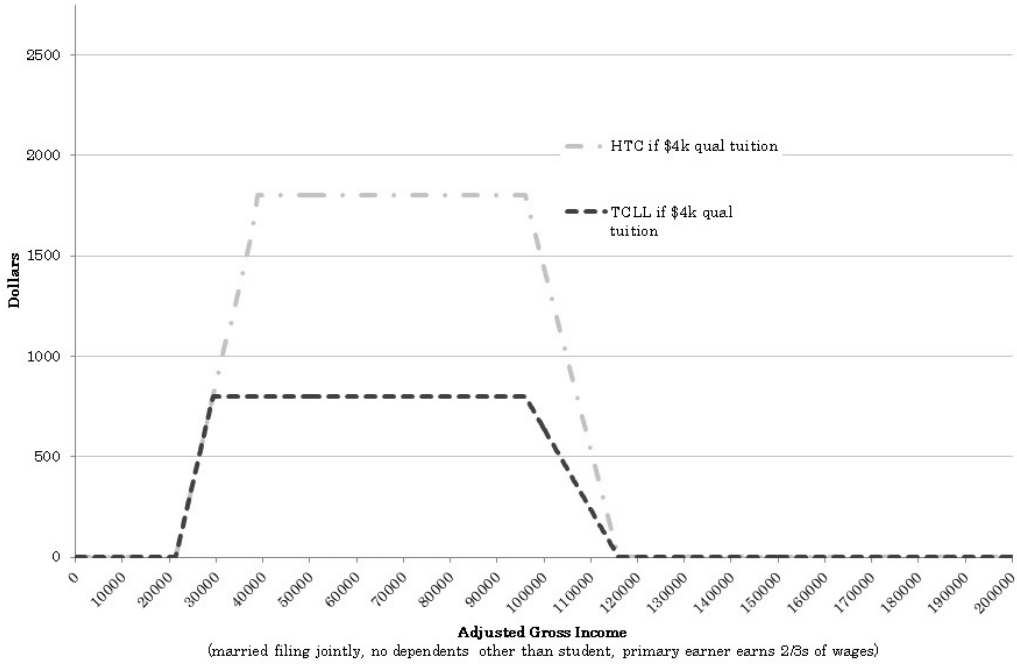
Higher education tax credits in 2009 for a student with $10,000 in qualifying tuition and fees



(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 3

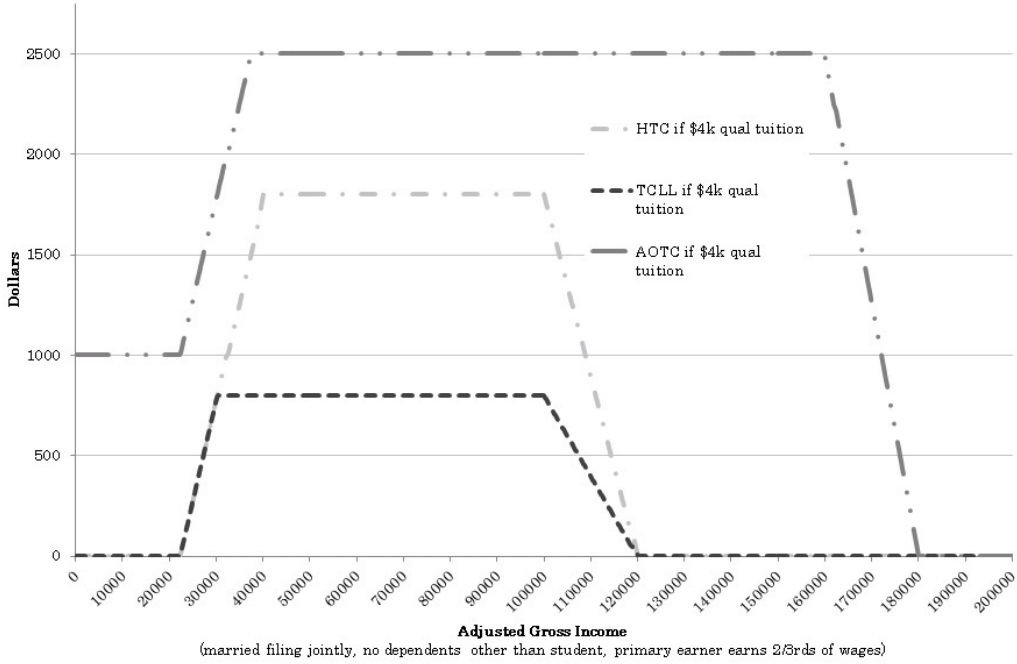
Higher education tax credits in 2008 for a student with $4,000 of qualifying tuition and fees



(married filing jointly, no dependents other than student, primary earner earns 2/3s of wages)

Figure 4

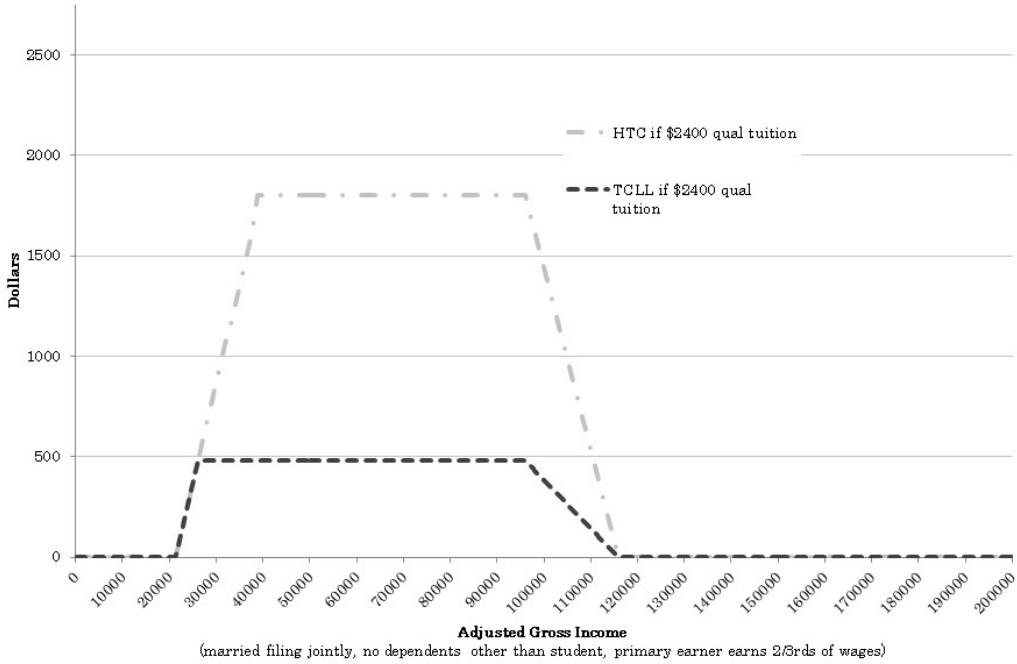
Higher education tax credits in 2009 for a student with $4,000 in qualifying tuition and fees



(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 5

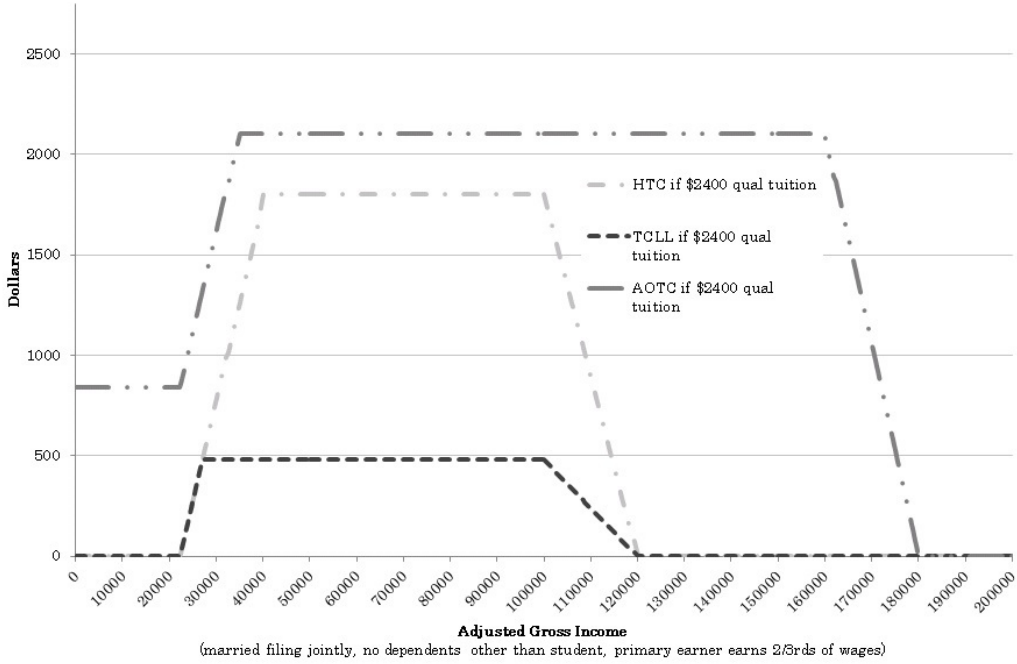
Higher education tax credits in 2008 for a student with qualifying tuition and fees of $2,400



(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 6

Higher education tax credits in 2009 for a student with $2,400 in qualifying tuition and fees



(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 7

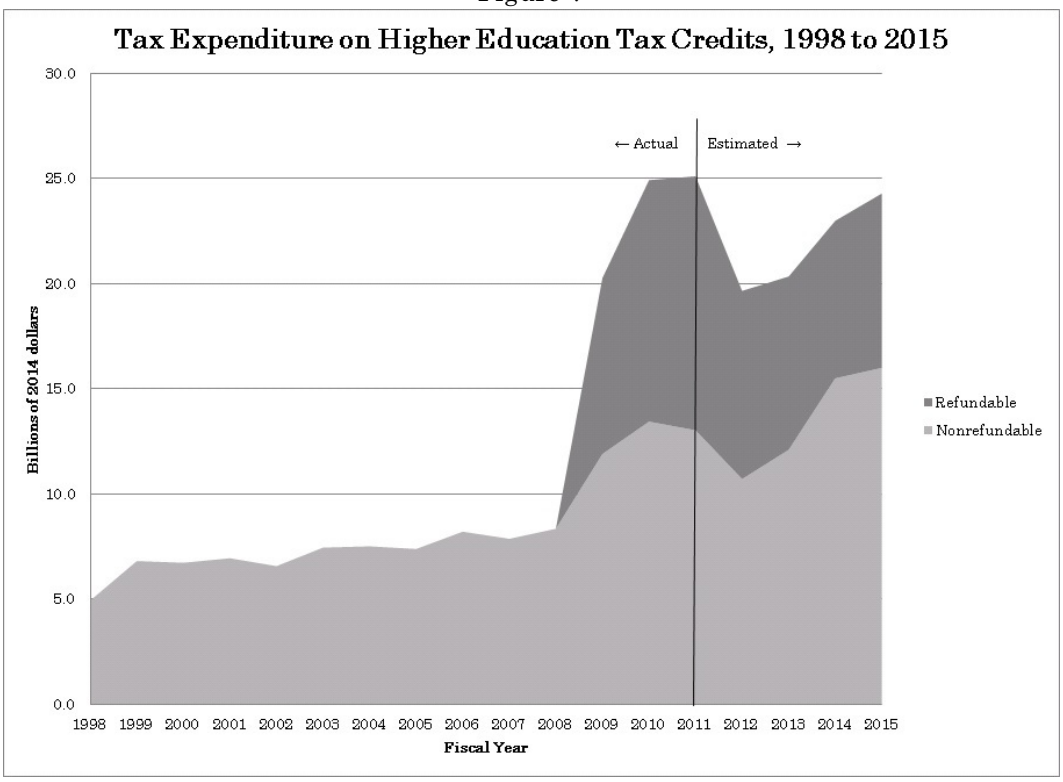

Tax Expenditure on Higher Education Tax Credits, 1998 to 2015
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Billions of 2014 dollars
← Actual
Estimated →
Refundable
Nonrefundable
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Fiscal Year

Figure 8

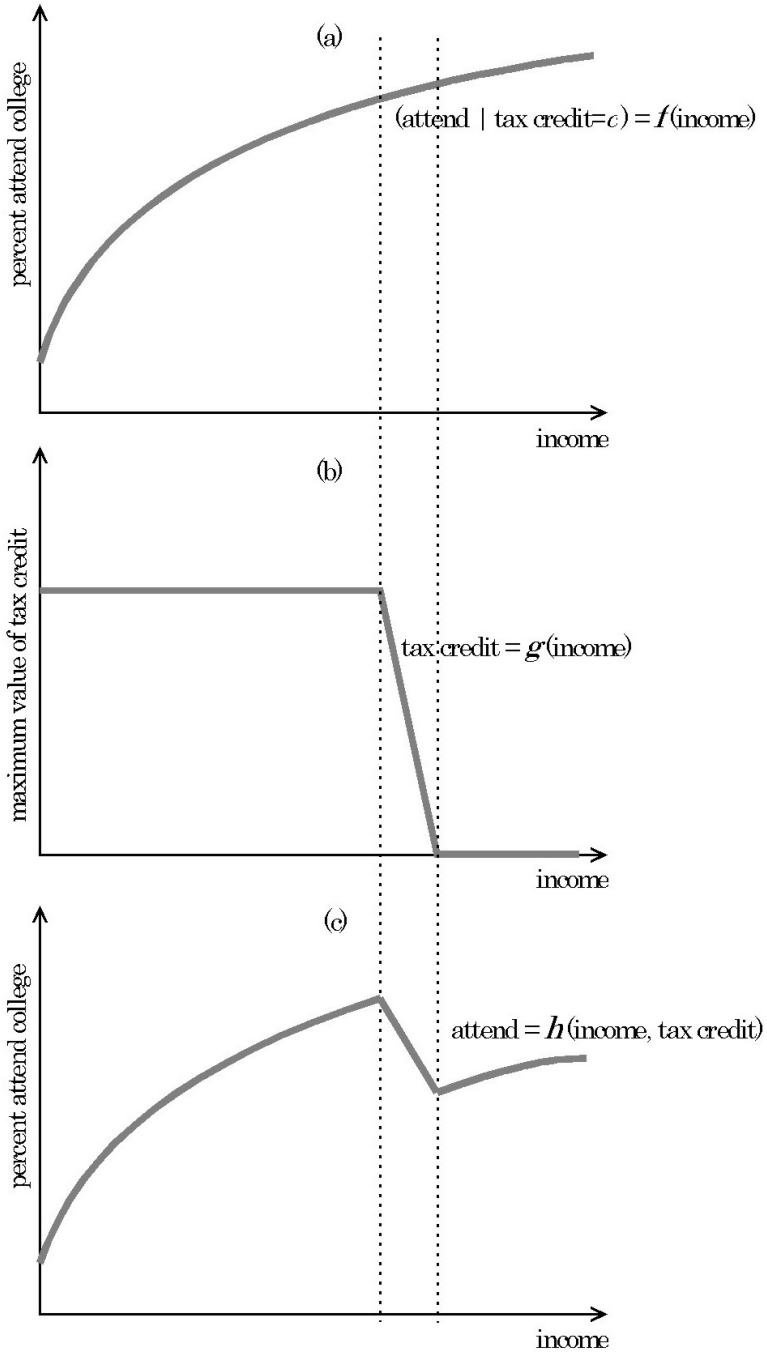

(a)
percent attend college
(attend | tax credit=c) = f (income)
income
(b)
maximum value of tax credit
tax credit = g (income)
income
(c)
percent attend college
attend = h (income, tax credit)
income

Figure 9

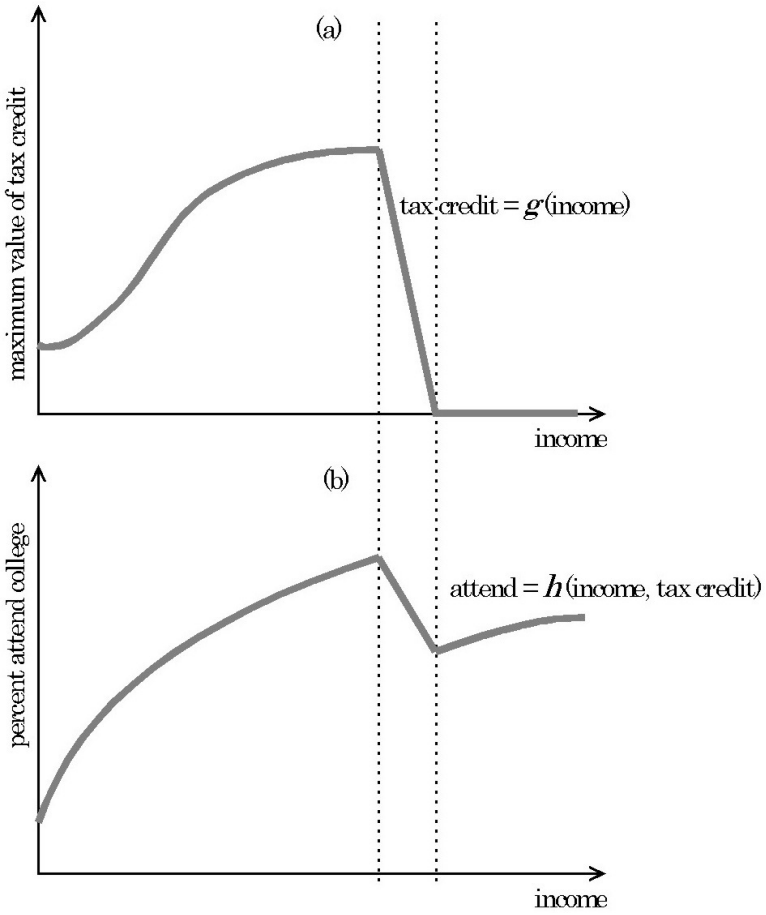

(a)
maximum value of tax credit
tax credit = g(income)
income
(b)
percent attend college
attend = h(income, tax credit)
income

Figure 10

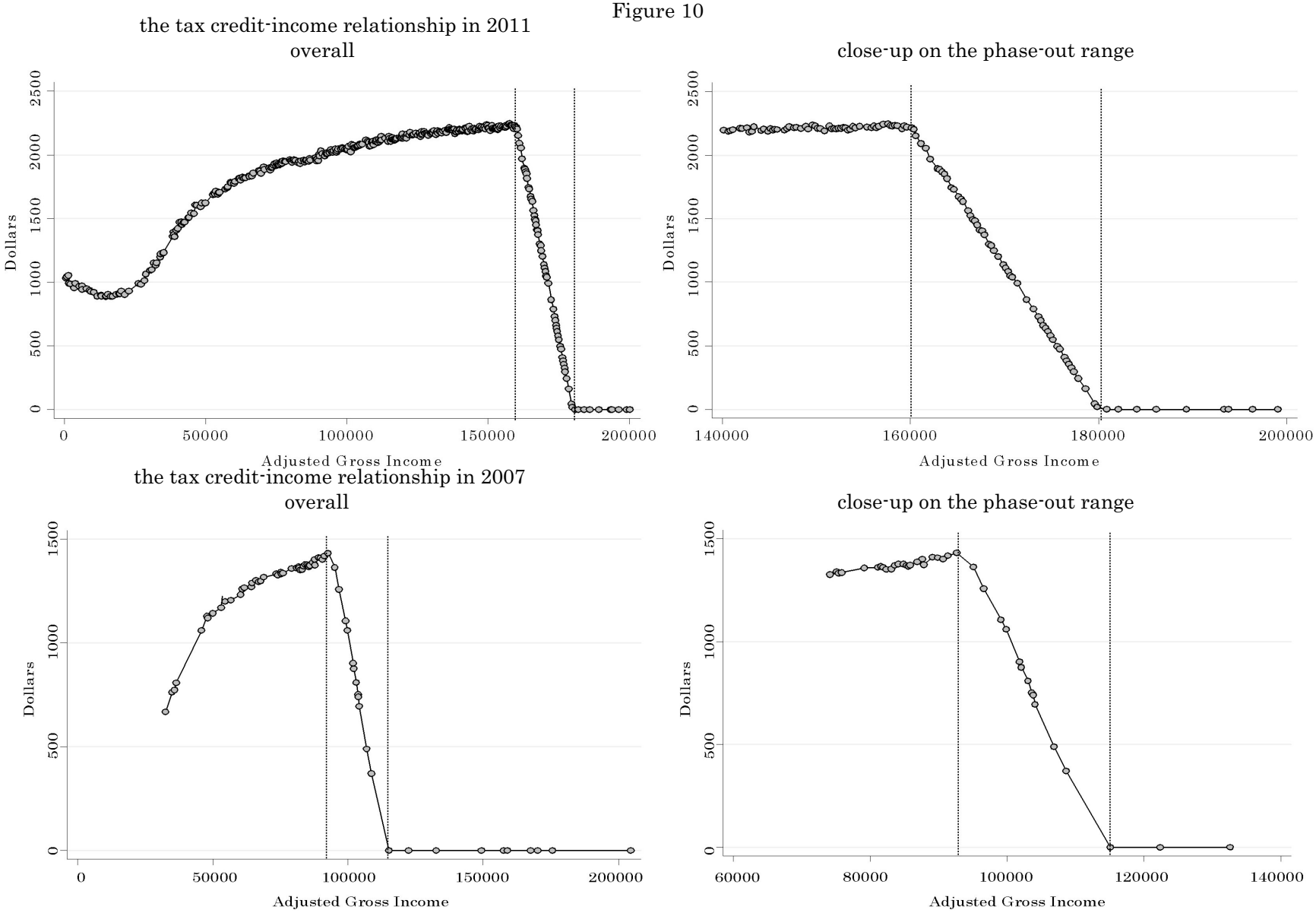
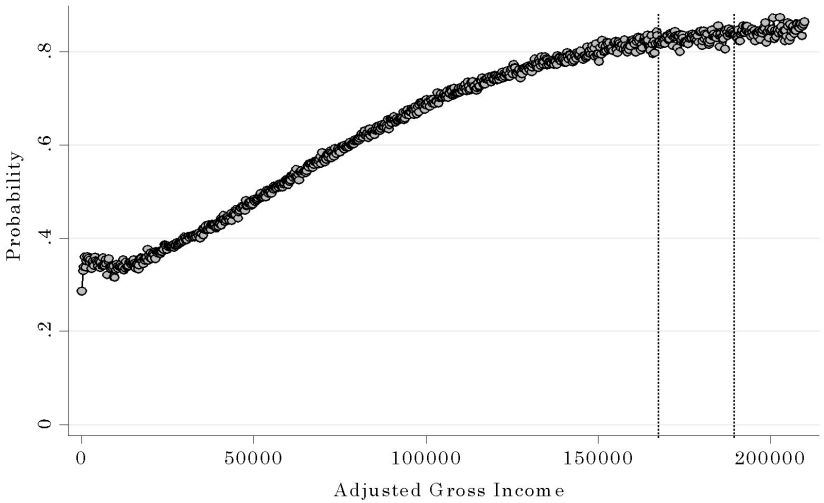
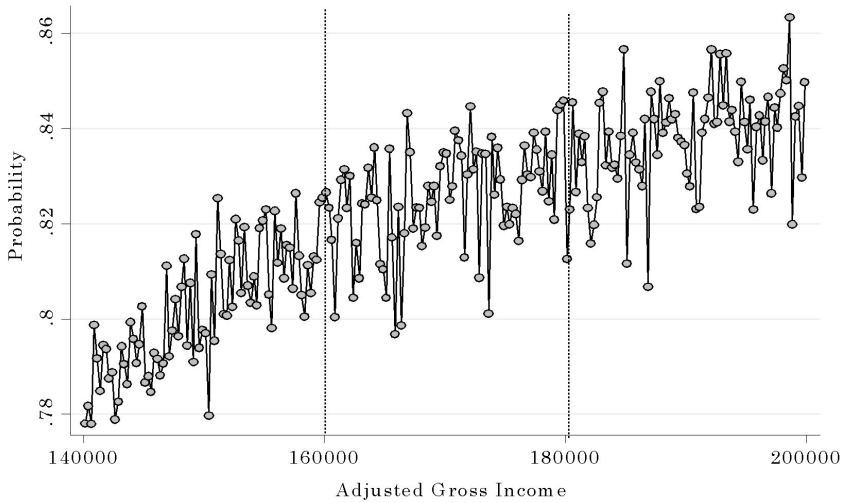

the tax credit-income relationship in 2011
overall
close-up on the phase-out range
the tax credit-income relationship in 2007
overall
close-up on the phase-out range
Dollars
Adjusted Gross Income
0
500
1000
1500
2000
2500
0
50000
100000
150000
200000
140000
160000
180000
200000
60000
80000
100000
120000
140000

Figure 11

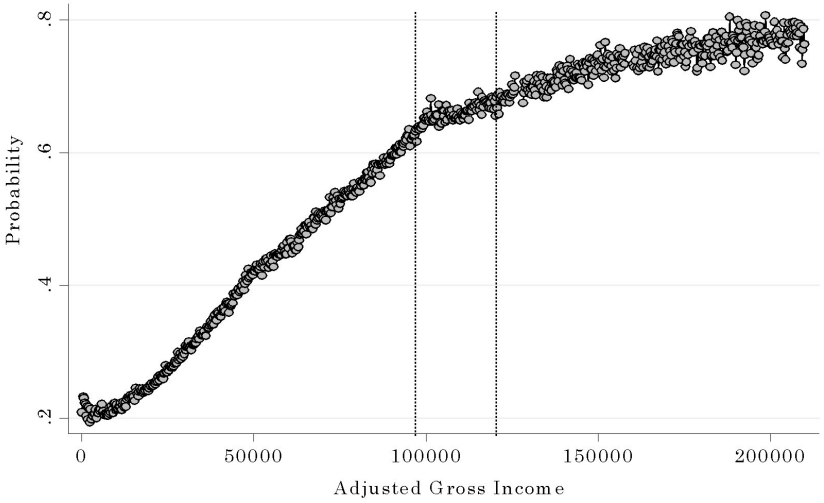
the attendance-income relationship in 2011
(attending at least half-time)



close-up on the phase-out range



the attendance-income relationship in 2007
(attending at least half-time)



close-up on the phase-out range

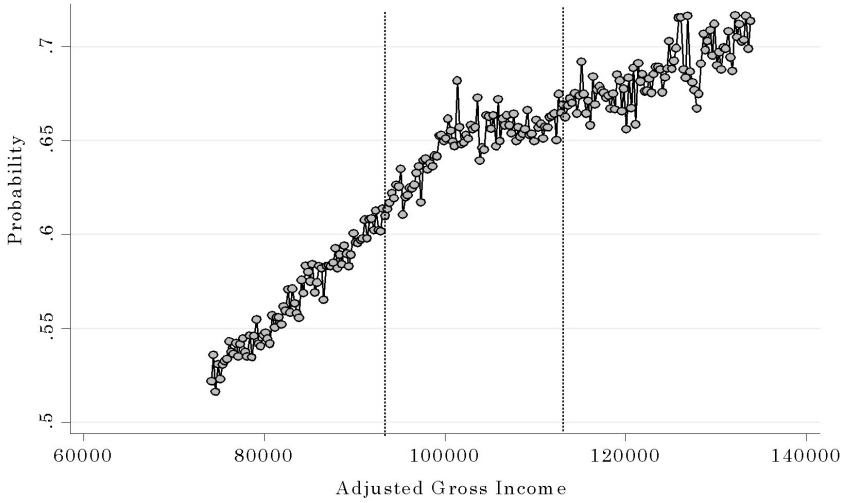


Figure 12

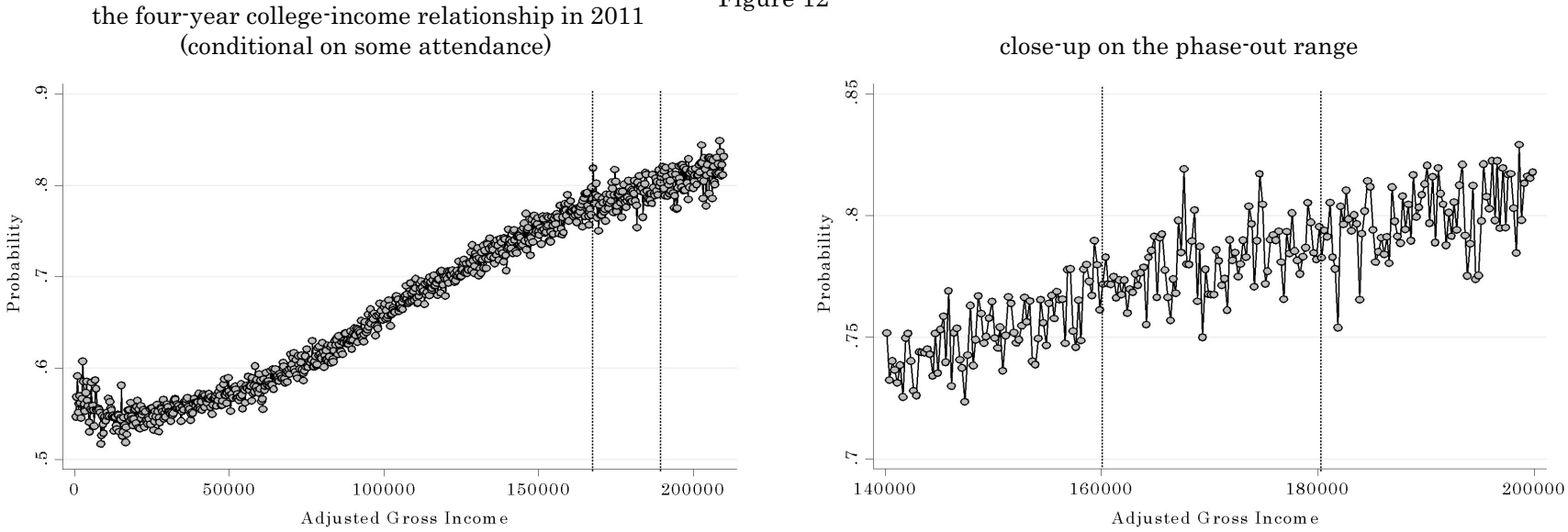


Figure 13

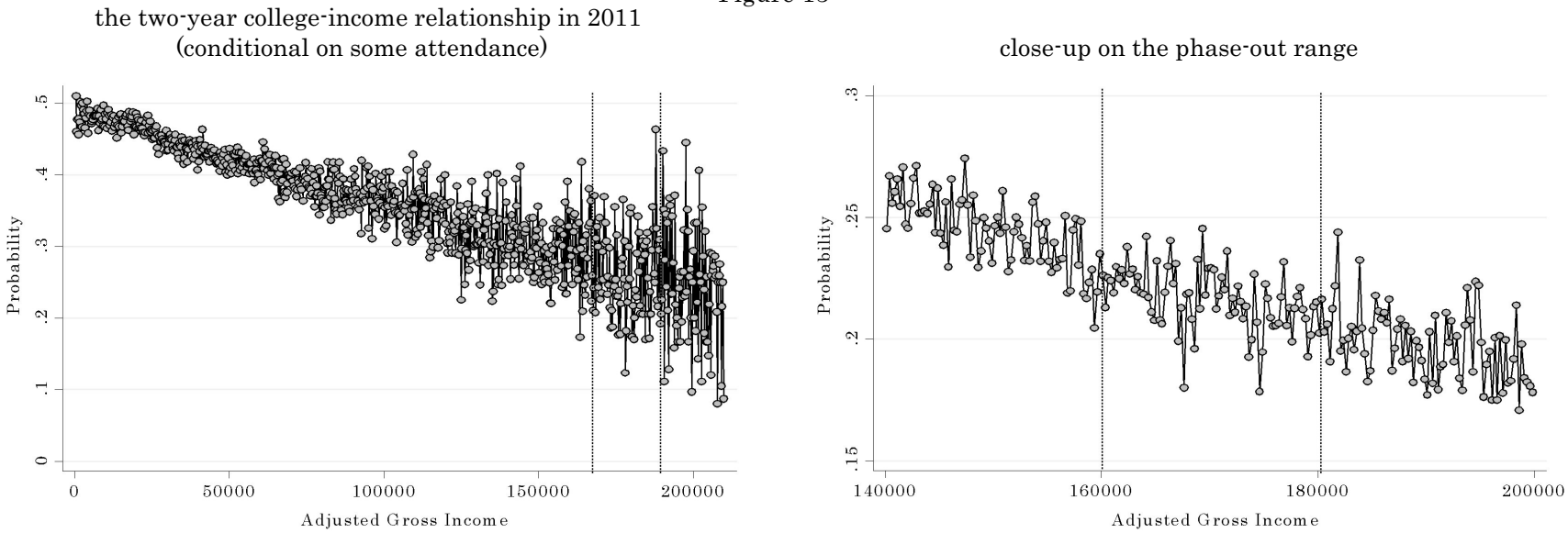
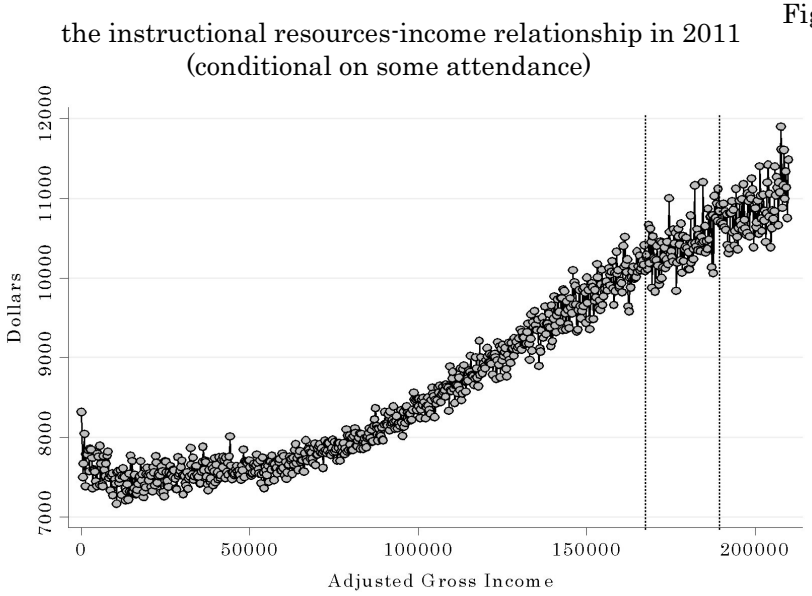


Figure 14



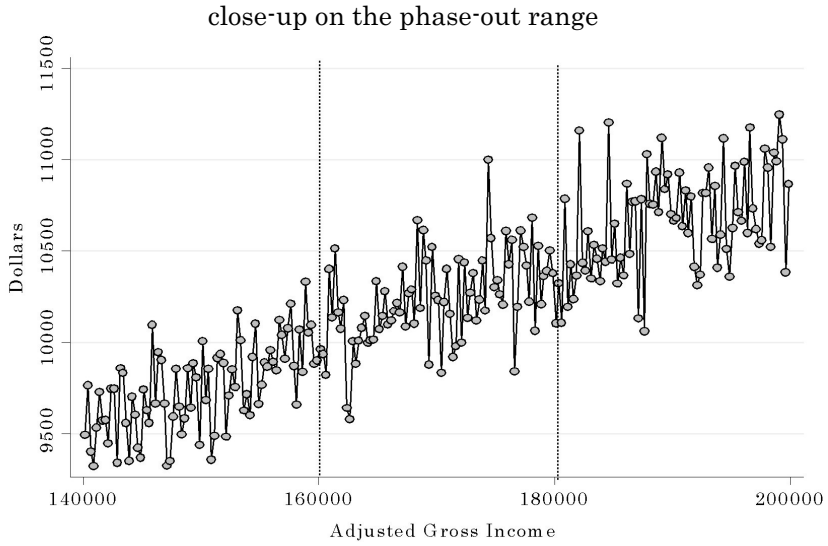
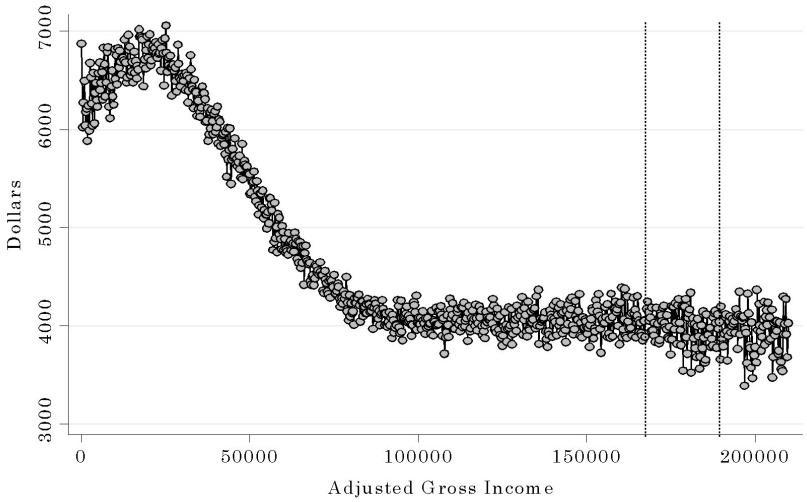


Figure 15



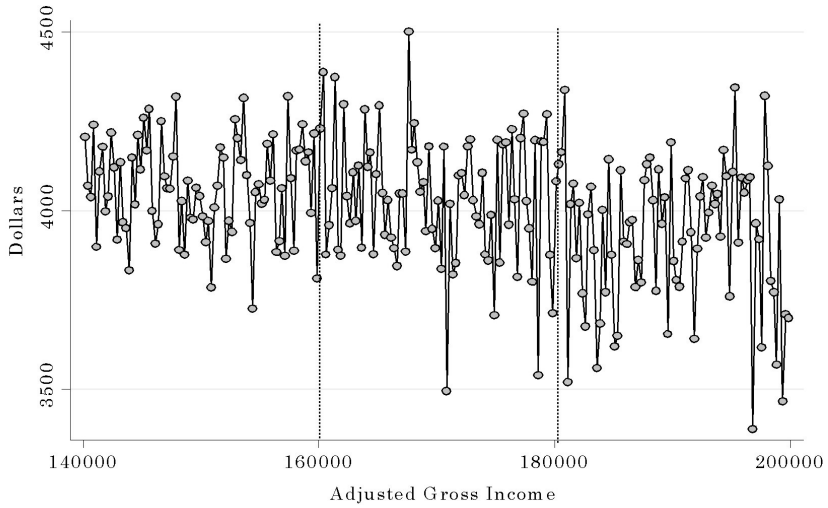


Figure 16

Change in higher education tax credits that could be taken, 2008 to 2009, for a student with $10,000 in qualifying tuition and fees

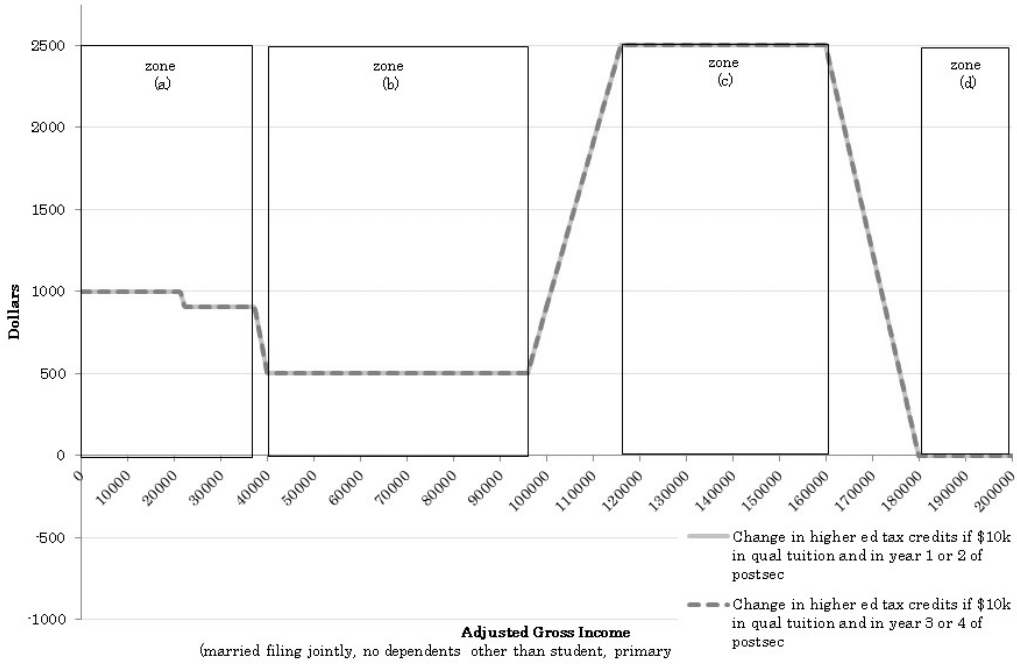


Figure 17

Change in higher education tax credits that could be taken, 2008 to 2009, for a student with $4,000 in qualifying tuition and fees

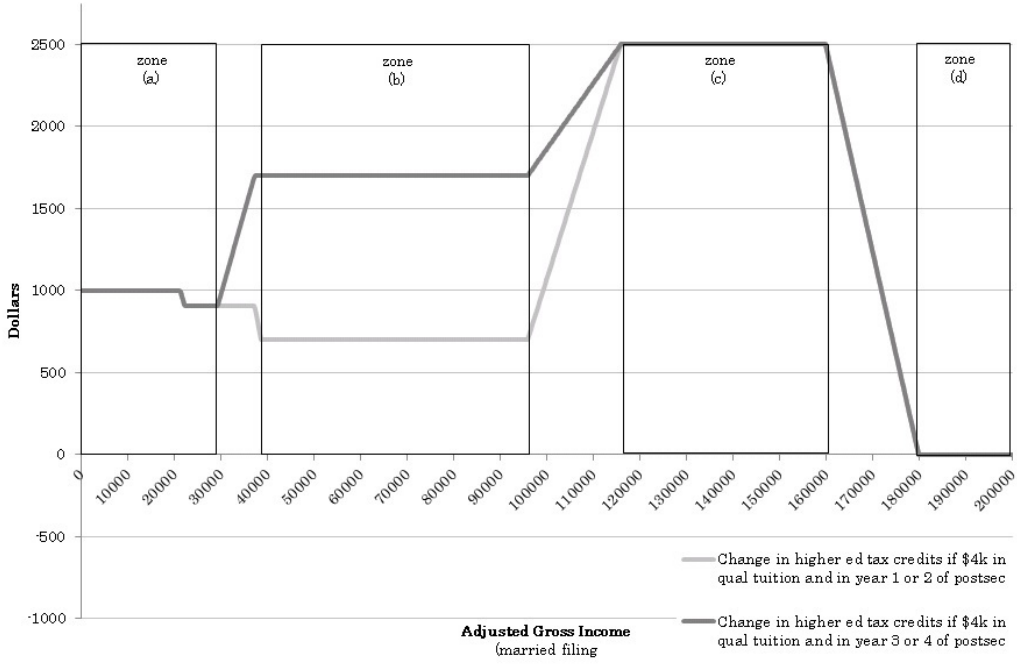


Figure 18

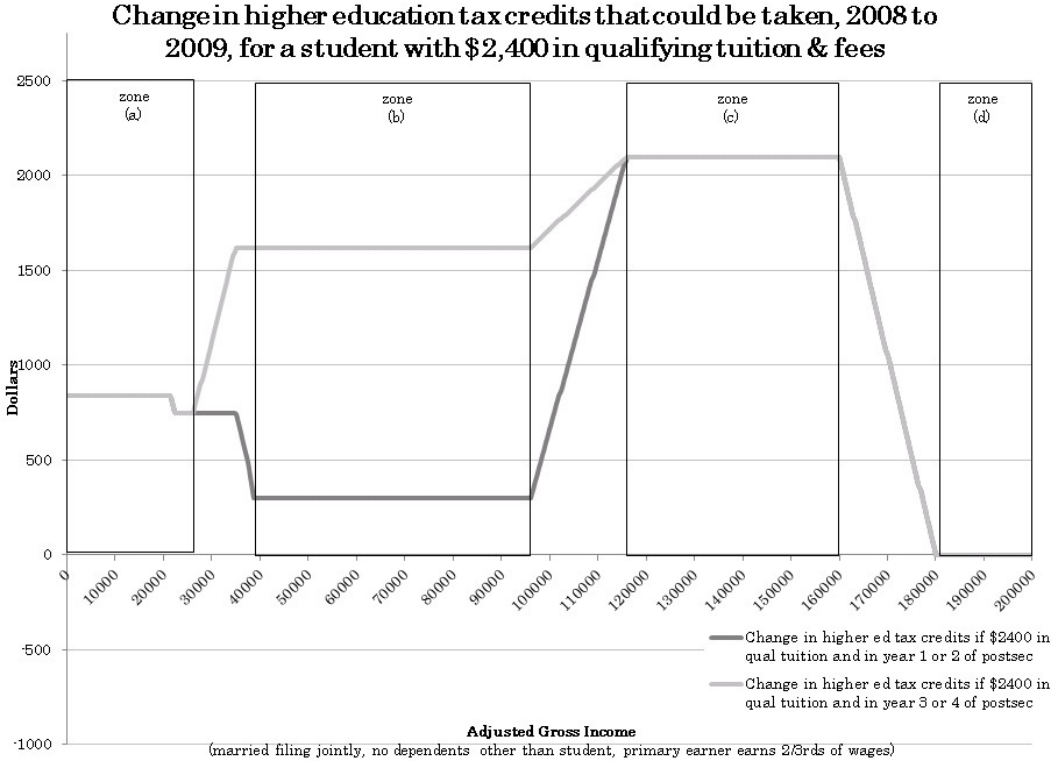
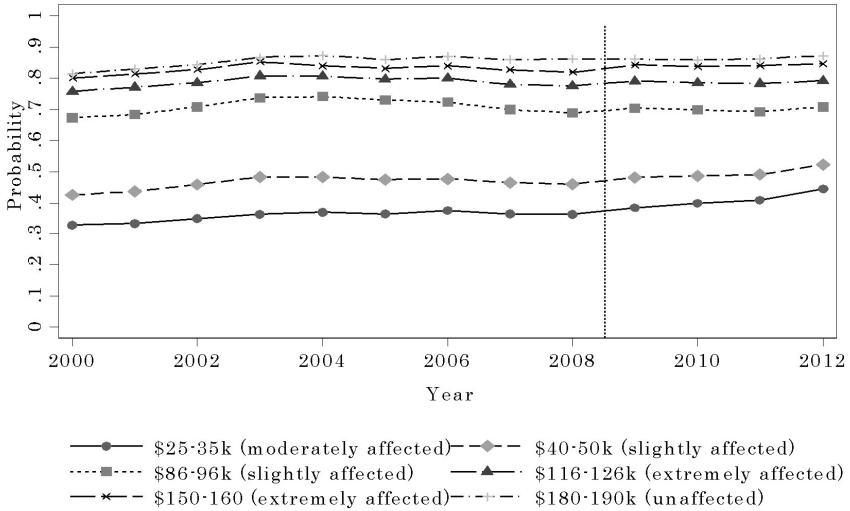

Change in higher education tax credits that could be taken, 2008 to 2009, for a student with $2,400 in qualifying tuition & fees
zone (a)
zone (b)
zone (c)
zone (d)
Dollars
2500
2000
1500
1000
500
0
-500
-1000
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
110000
120000
130000
140000
150000
160000
170000
180000
190000
200000
Change in higher ed tax credits if $2400 in qual tuition and in year 1 or 2 of postsec
Change in higher ed tax credits if $2400 in qual tuition and in year 3 or 4 of postsec
Adjusted Gross Income
(married filing jointly, no dependents other than student, primary earner earns 2/3rds of wages)

Figure 19

attending college at all by income group and year

age 19



age 23

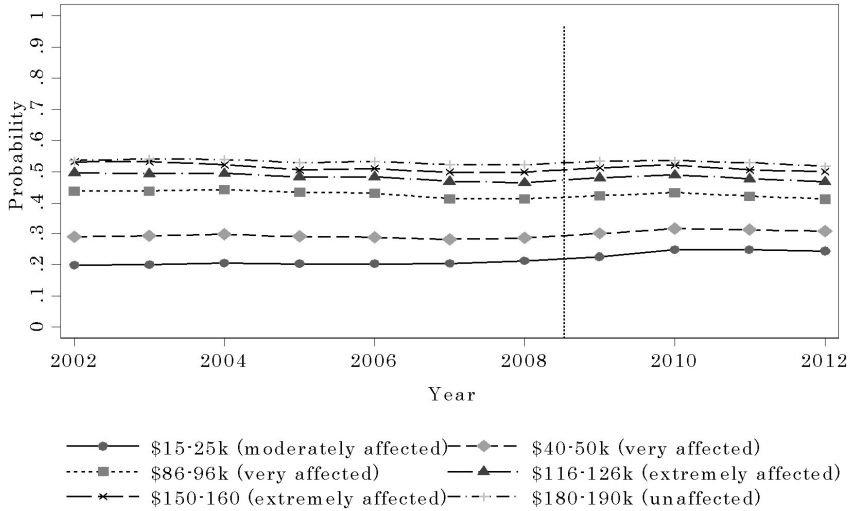
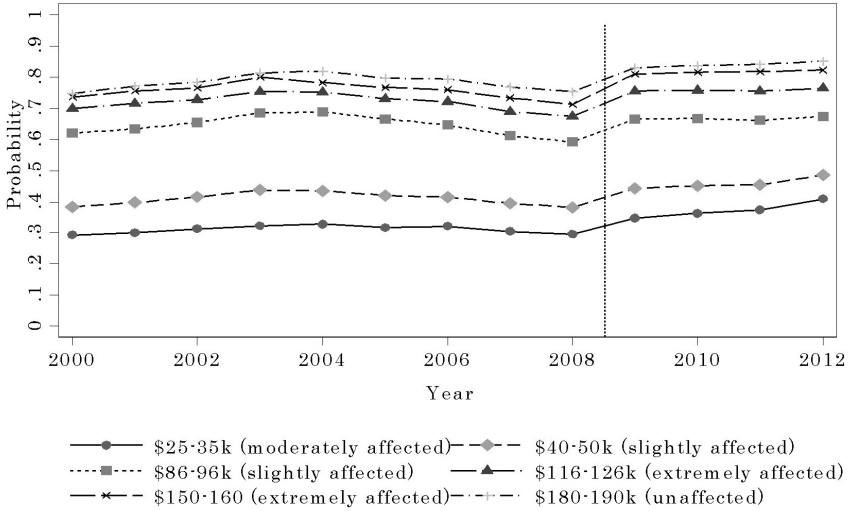


Figure 20

attending college at least half time by income group and year

age 19



age 23

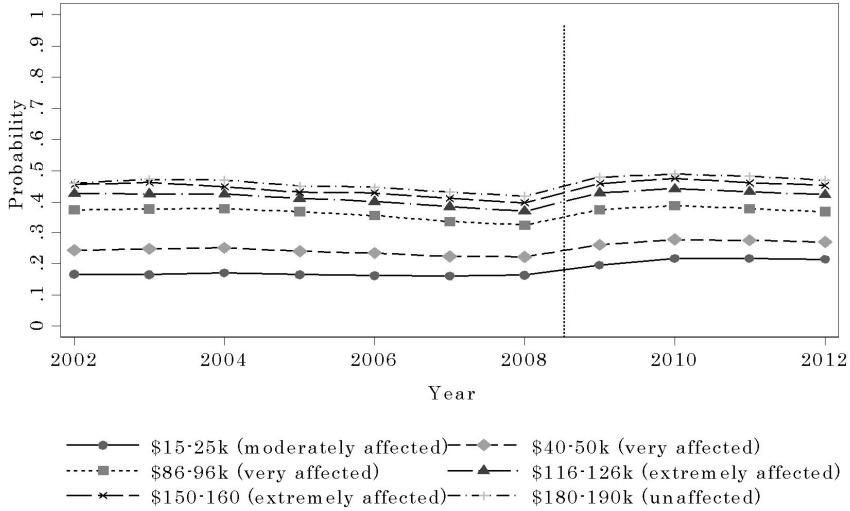


Figure 21
attending four-year college (conditional on attending)

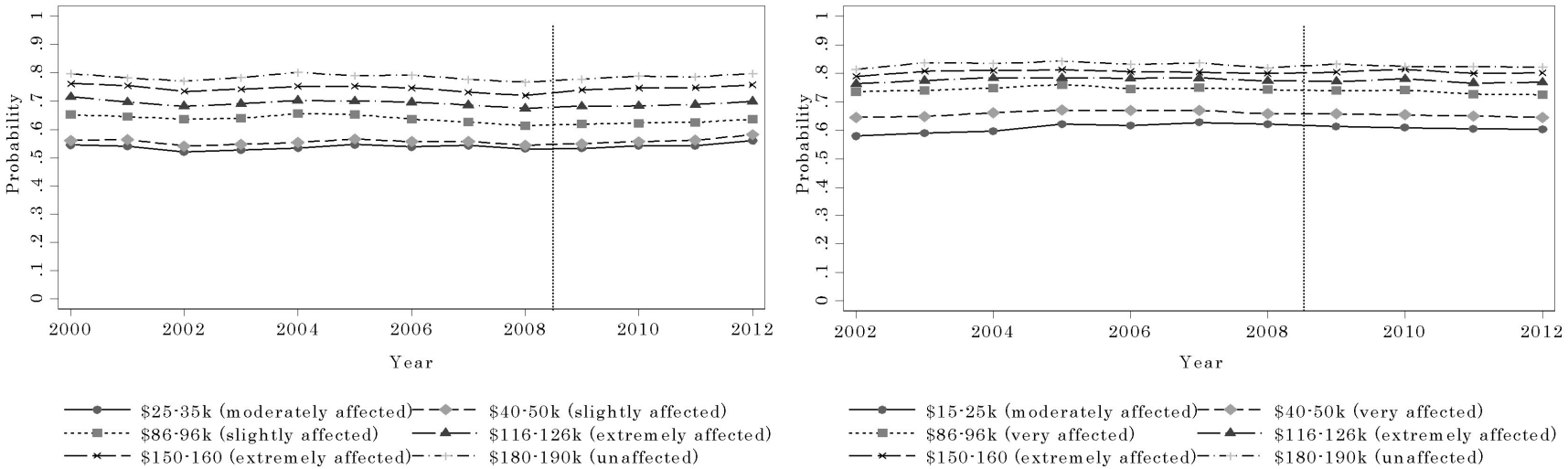


Figure 22
attending two-year college (conditional on attending)

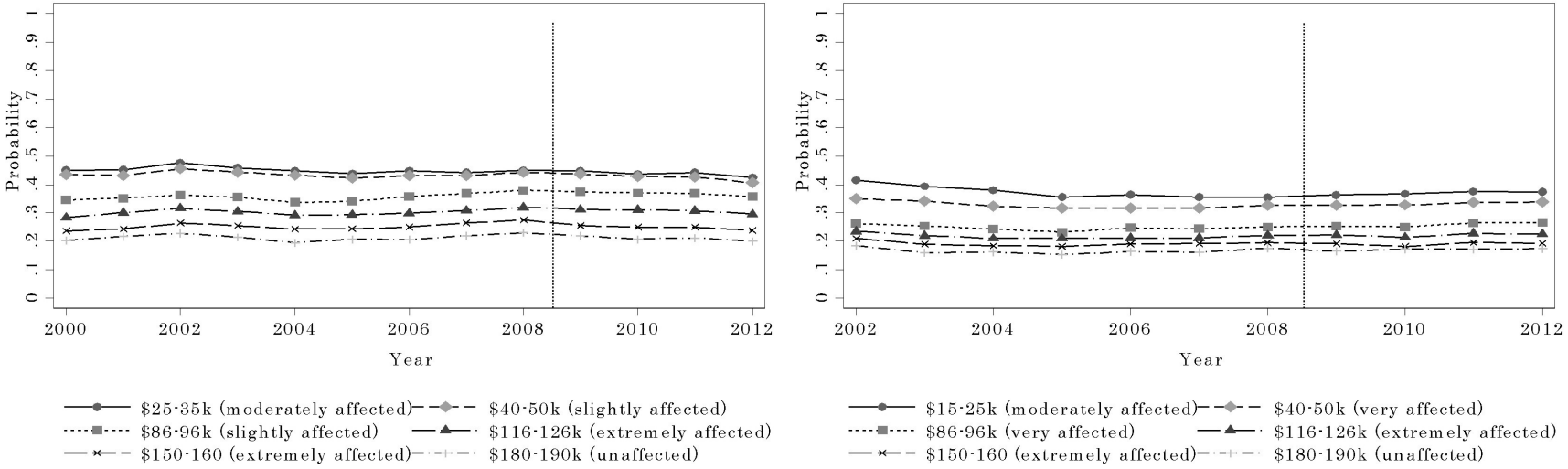


Figure 23
instructional resources (conditional on attending)

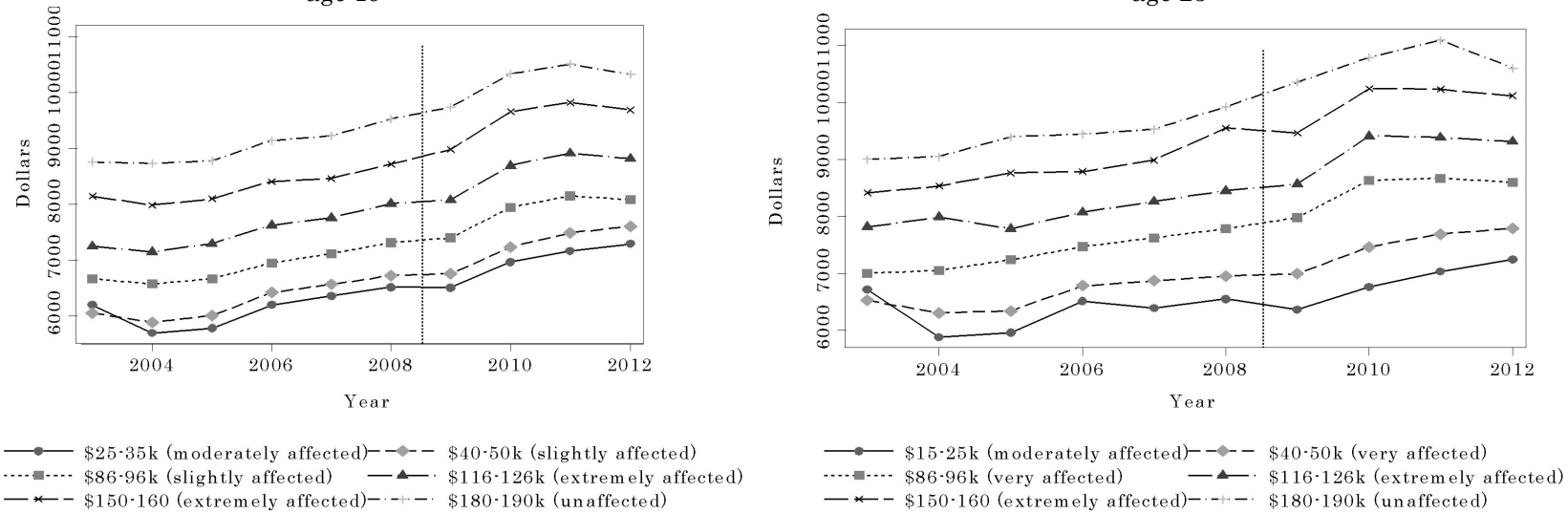
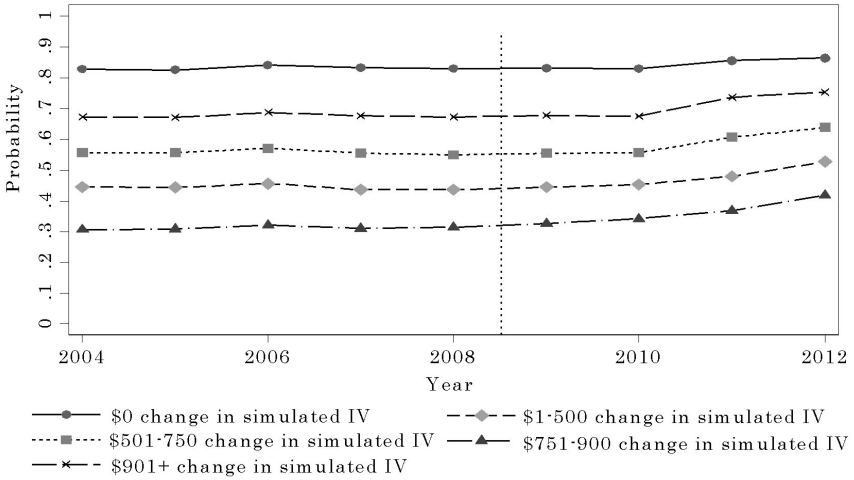


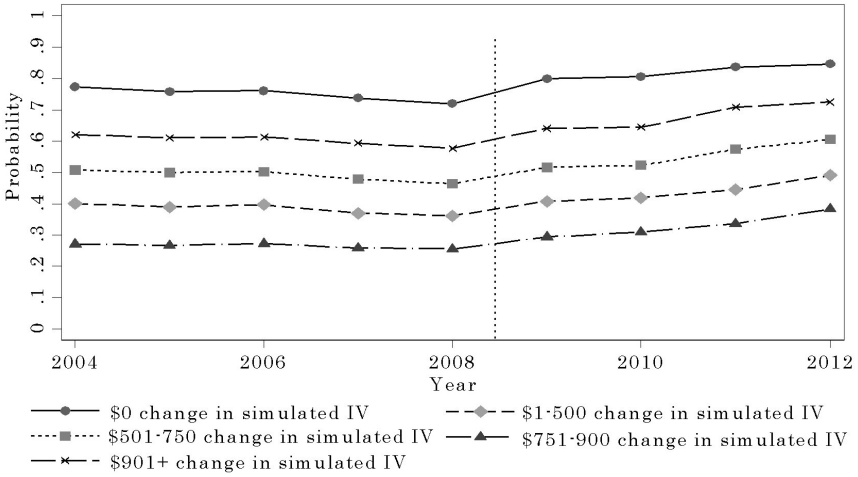
Figure 24

Outcomes of 19-year-olds by year and the degree to which they were potentially affected by the introduction of the AOTC

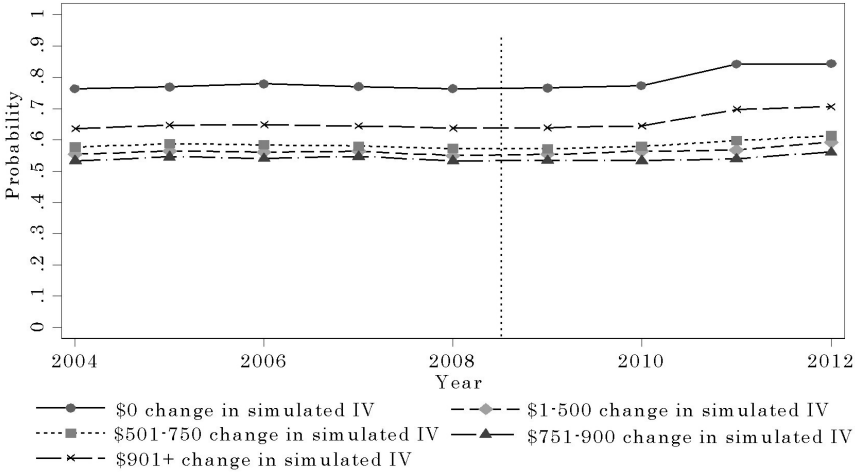
attending college at all



attending at least half-time



attending four-year college (conditional on attending)



instructional resources (conditional on attending)

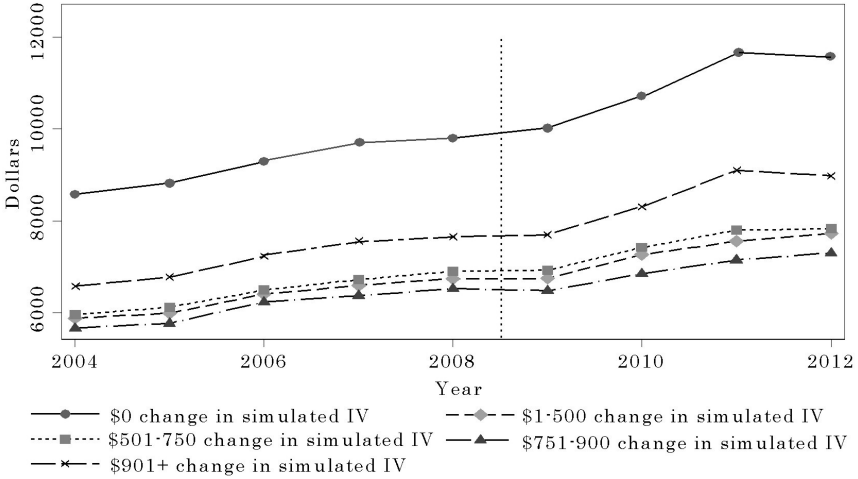


Table 1
Parameters of the Higher Education Tax Credits

year	HTC is equal to 100% of first $x + 50% of second $x of tuition and fees where x is:	TCLL is equal to 20% of first $x of tuition and fees where x is:	HTC and TCLL phase out range for single filers	HTC and TCLL phase out range for married joint filers	AOTC is equal to 100% of first $x + 25% of second $x of tuition and fees where x is:	AOTC phase out range for single filers	AOTC phase out range for married joint filers
1999	1,000	5,000	40,000-50,000	80,000-100,000			
2000	1,000	5,000	40,000-50,000	80,000-100,000			
2001	1,000	5,000	40,000-50,000	80,000-100,000			
2002	1,000	5,000	41,000-51,000	82,000-102,000			
2003	1,000	10,000	41,000-51,000	83,000-103,000			
2004	1,000	10,000	42,000-52,000	85,000-105,000			
2005	1,000	10,000	43,000-53,000	87,000-107,000			
2006	1,100	10,000	45,000-55,000	90,000-110,000			
2007	1,100	10,000	47,000-57,000	94,000-114,000			
2008	1,200	10,000	48,000-58,000	96,000-116,000			
2009	1,200	10,000	50,000-60,000	100,000-120,000	2,000	80,000-90,000	160,000-180,000
2010	1,200	10,000	50,000-60,000	100,000-120,000	2,000	80,000-90,000	160,000-180,000
2011	1,200	10,000	51,000-61,000	102,000-122,000	2,000	80,000-90,000	160,000-180,000
2012	1,200	10,000	52,000-62,000	104,000-124,000	2,000	80,000-90,000	160,000-180,000
2013	1,200	10,000	53,000-63,000	107,000-127,000	2,000	80,000-90,000	160,000-180,000

Source: Internal Revenue Service, Form 8863 and Instructions for Form 8863,1999 to 2013.

Table 2
Tax Expenditure Consequences of the Higher Education Tax Credits

	Billions of Dollars of the Day				Billions of 2014 Dollars (CPI-U adjusted)			
	Actual			Estimated	Actual			Estimated
Year	Nonrefundable Component of Education Tax Credits	Refundable Component of Education Tax Credits	Total (Nonrefundable plus Refundable)	Total	Nonrefundable Component of Education Tax Credits	Refundable Component of Education Tax Credits	Total (Nonrefundable plus Refundable)	Total
1998	3.4		3.4		4.9		4.9	
1999	4.8		4.8		6.8		6.8	
2000	4.9		4.9		6.7		6.7	
2001	5.2		5.2		6.9		6.9	
2002	5.0		5.0		6.6		6.6	
2003	5.8		5.8		7.5		7.5	
2004	6.0		6.0		7.5		7.5	
2005	6.1		6.1		7.4		7.4	
2006	7.0		7.0		8.2		8.2	
2007	6.9		6.9		7.9		7.9	
2008	7.6		7.6		8.3		8.3	
2009	10.8	7.6	18.4		11.9	8.4	20.3	
2010	12.4	10.6	23.0		13.4	11.5	24.9	
2011	12.4	11.5	23.9		13.0	12.1	25.1	
2012	10.4	8.7	19.1	20.3	10.7	9.0	19.7	20.9
2013				20.1				20.4
2014				23.0				23.0
2015				24.3				24.3

Sources: The source for 1998 to 2011 in the "actual" columns is Table A in U.S. Department of the Treasury (2013). The source for 2012 in the "actual" column is authors' calculations based de-identified IRS data. The source for 2012 and 2013 in the "estimated" column is Joint Committee on Taxation (2013). The source for 2014 and 2015 in the estimated column is Joint Committee on Taxation (2014).

Table 3
Potential and Actual Higher Education Tax Credits among 19- to 20-year-olds, 2008 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, half-time enrollment (HTC), AGI and tax liability min-max	potential tax expend on non-refundable credits based on criteria in prior column and year in college (millions of dollars) min-max	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)
0-10k	604,667	0-1%	1	0%		0
10-20k	886,106	5-7%	12-19	1%	245	2
20-30k	902,946	16-23%	79-134	7%	631	37
30-40k	754,038	26-34%	163-270	14%	1,031	105
40-50k	624,855	34-42%	219-339	20%	1,220	152
50-60k	555,990	40-46%	202-293	21%	1,177	138
60-70k	487,247	37-41%	214-294	24%	1,360	157
70-80k	438,416	45-49%	244-323	30%	1,394	183
80-90k	390,349	51-55%	257-331	35%	1,419	195
90-100k	346,472	58-61%	253-320	38%	1,433	190
100-110k	307,661	64-67%	152-186	29%	944	84
110-120k	229,681	40-43%	20-24	7%	268	4
120-130k	167,373	0%	0	0%		0
130-140k	148,353	0%	0	0%		0
140-150k	122,893	0%	0	0%		0
150-160k	92,244	0%	0	0%		0
160-170k	83,036	0%	0	0%		0
170-180k	70,097	0%	0	0%		0
180-190k	58,702	0%	0	0%		0
190-200k	49,268	0%	0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 4
Potential and Actual Higher Education Tax Credits among 19- to 20-year-olds, 2009 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, AGI and tax liability	potential tax expend on non-refundable credits based on criteria in prior column, half-time, and year in college (millions of dollars)	percent who appear to qualify for a refundable credit based on tuition, AGI and tax liability	potential tax expend on refundable tax credits based on criteria in prior column half-time and year in college (millions of dollars)	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
		min-max	min-max	min-max	min-max						
0-10k	656,553	0%	0	20-29%	96-158	0%		0	8%	812	43
10-20k	974,541	4-7%	12-18	16-26%	112-210	1%	191	3	9%	771	64
20-30k	962,065	15-23%	75-123	20-30%	134-242	9%	518	44	12%	767	86
30-40k	794,527	26-35%	155-242	26-36%	147-238	17%	856	115	17%	784	104
40-50k	642,415	35-44%	207-294	34-42%	157-227	24%	1,053	161	22%	804	113
50-60k	559,497	43-50%	244-320	41-48%	171-226	29%	1,149	188	27%	824	123
60-70k	490,602	49-55%	262-324	47-53%	178-221	35%	1,213	206	32%	838	130
70-80k	437,815	55-60%	272-324	52-58%	182-217	40%	1,242	217	36%	850	135
80-90k	383,149	60-65%	249-290	57-62%	165-192	44%	1,194	202	40%	811	124
90-100k	331,337	58-62%	227-260	55-59%	149-171	44%	1,277	187	40%	866	114
100-110k	280,080	62-66%	210-238	60-64%	139-157	48%	1,293	173	44%	874	108
110-120k	230,018	66-70%	182-205	63-67%	121-136	50%	1,293	148	48%	883	98
120-130k	183,832	65-69%	152-170	65-69%	102-114	52%	1,332	127	52%	889	84
130-140k	152,113	68-72%	132-147	68-72%	88-98	54%	1,340	110	54%	894	73
140-150k	125,506	70-74%	114-126	70-74%	76-84	55%	1,349	94	55%	900	62
150-160k	104,543	71-75%	97-107	71-75%	65-71	57%	1,356	81	57%	905	54
160-170k	85,901	73-77%	62-68	73-77%	42-46	57%	1,035	50	56%	691	33
170-180k	71,190	74-77%	18-19	74-77%	12-13	53%	358	14	53%	239	9
180-190k	58,655	0%	0	0%	0	0%		0	0%		0
190-200k	49,260	0%	0	0%	0	0%		0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 5
Defining as Refundable Only Those Tax Credits That Filer Would Not Obtain If the Credit Were Nonrefundable
Potential and Actual Higher Education Tax Credits among 19- to 20-year-olds, 2009 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	potential tax expend on non-refundable credits (millions of dollars) min-max	potential tax expend on refundable tax credits based on criteria in prior column and year in college (millions of dollars) min-max	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
0-10k	656,553	1	96-157	0%		0	8%	807	42
10-20k	974,541	12-19	111-210	1%	248	3	8%	769	63
20-30k	962,065	81-130	128-235	9%	428	36	13%	775	94
30-40k	794,527	188-282	114-198	17%	1,024	138	13%	803	81
40-50k	642,415	283-392	80-129	24%	1,563	240	7%	827	35
50-60k	559,497	367-471	48-75	29%	1,808	296	3%	838	15
60-70k	490,602	411-501	29-44	35%	1,926	326	2%	846	9
70-80k	437,815	439-519	15-22	40%	1,983	346	2%	836	6
80-90k	383,149	406-471	8-11	44%	1,908	324	1%	828	3
90-100k	331,337	372-425	4-6	44%	2,036	298	1%	835	3
100-110k	280,080	347-392	2-3	48%	2,091	280	0%	833	1
110-120k	230,018	302-339	1-2	50%	2,139	245	0%	850	1
120-130k	183,832	253-283	1	52%	2,209	210	0%	836	1
130-140k	152,113	220-245	1	54%	2,225	182	0%		0
140-150k	125,506	189-209	0	55%	2,239	156	0%		0
150-160k	104,543	162-178	0	57%	2,250	134	0%		0
160-170k	85,901	103-114	0	57%	1,721	84	0%		0
170-180k	71,190	30-32	0	53%	594	22	0%		0
180-190k	58,655	0	0	0%		0	0%		0
190-200k	49,260	0	0	0%		0	0%		0

Source: Authors' calculations based on de-identified IRS data. The definitions of nonrefundable and refundable used in this table are discussed in the text as the "economic" definitions, useful for answering questions about the distribution consequences of the AOTC's refundability.

Table 6
Potential and Actual Higher Education Tax Credits among 22- to 23-year-olds, 2008 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, half-time enrollment (HTC), AGI and tax liability min-max	potential tax expend on non-refundable credits based on criteria in prior column and year in college (millions of dollars) min-max	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)
0-10k	513,558	1-1%	1	0%		0
10-20k	612,923	6-7%	11-16	1%	218	1
20-30k	680,673	14-18%	50-76	5%	553	18
30-40k	615,158	20-24%	88-134	9%	905	50
40-50k	535,309	25-29%	108-160	12%	1,052	69
50-60k	481,878	28-31%	94-133	12%	1,041	60
60-70k	429,382	26-28%	98-132	13%	1,156	63
70-80k	386,721	30-33%	108-142	15%	1,208	70
80-90k	344,359	35-38%	114-146	17%	1,249	73
90-100k	303,075	40-42%	112-141	17%	1,317	67
100-110k	259,567	43-46%	64-79	11%	941	26
110-120k	200,386	27-29%	9-11	3%	230	1
120-130k	149,979	0%	0	0%		0
130-140k	130,937	0%	0	0%		0
140-150k	108,252	0%	0	0%		0
150-160k	83,317	0%	0	0%		0
160-170k	72,956	0%	0	0%		0
170-180k	61,909	0%	0	0%		0
180-190k	51,640	0%	0	0%		0
190-200k	43,236	0%	0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 7
Potential and Actual Higher Education Tax Credits among 22- to 23-year-olds, 2009 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, AGI and tax liability	potential tax expend on non-refundable credits based on criteria in prior column, half-time, and year in college (millions of dollars)	percent who appear to qualify for a refundable credit based on tuition, AGI and tax liability	potential tax expend on refundable tax credits based on criteria in prior column half-time and year in college (millions of dollars)	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
		min-max	min-max	min-max	min-max						
0-10k	517,376	0-1%	1	11-20%	41-85	0%		0	4%	826	18
10-20k	631,684	6-7%	11-15	10-18%	45-93	1%	182	1	6%	792	31
20-30k	680,586	14-18%	51-74	11-20%	54-110	7%	504	24	8%	788	42
30-40k	611,254	22-26%	96-135	13-22%	56-112	12%	885	64	10%	805	49
40-50k	522,568	27-31%	120-163	14-25%	54-108	15%	1,078	85	12%	822	51
50-60k	467,110	31-35%	133-179	15-27%	54-108	17%	1,161	92	14%	843	54
60-70k	415,083	32-37%	132-177	16-30%	52-104	19%	1,232	95	15%	861	54
70-80k	371,824	36-41%	139-180	17-32%	51-101	21%	1,270	99	17%	874	55
80-90k	325,842	40-44%	134-168	18-34%	45-91	23%	1,228	92	19%	830	50
90-100k	281,723	42-45%	126-153	17-33%	39-82	23%	1,316	86	19%	887	47
100-110k	239,392	45-48%	103-134	18-36%	36-74	24%	1,312	77	21%	893	44
110-120k	196,744	47-50%	60-102	19-37%	30-64	24%	1,290	61	22%	899	40
120-130k	155,762	19-38%	36-77	19-38%	24-52	24%	1,351	51	24%	902	34
130-140k	130,193	19-39%	32-68	19-39%	21-45	26%	1,359	45	25%	908	30
140-150k	107,384	20-40%	27-58	20-40%	18-39	27%	1,364	39	26%	910	26
150-160k	89,442	20-41%	23-49	20-41%	15-33	28%	1,369	34	27%	913	22
160-170k	73,893	20-41%	14-31	20-42%	10-21	27%	1,044	21	27%	698	14
170-180k	61,234	20-42%	4-9	20-42%	3-6	24%	364	5	24%	244	4
180-190k	51,035	0%	0	0%	0	0%		0	0%		0
190-200k	42,677	0%	0	0%	0	0%		0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 8
Defining as Refundable Only Those Tax Credits That Filer Would Not Obtain If the Credit Were Nonrefundable
Potential and Actual Higher Education Tax Credits among 22- to 23-year-olds, 2009 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	potential tax expend on non-refundable credits (millions of dollars) min-max	potential tax expend on refundable tax credits based on criteria in prior column and year in college (millions of dollars) min-max	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
0-10k	517,376	1	41-85	0%		0	4%	817	18
10-20k	631,684	13-17	44-92	1%	232	2	6%	785	30
20-30k	680,586	59-84	47-104	7%	388	18	9%	791	47
30-40k	611,254	117-168	38-84	12%	876	63	10%	817	50
40-50k	522,568	153-220	23-54	15%	1,478	117	5%	824	20
50-60k	467,110	169-252	13-33	17%	1,699	135	3%	832	11
60-70k	415,083	173-260	7-20	19%	1,835	141	2%	808	8
70-80k	371,824	182-270	4-10	21%	1,917	150	2%	796	5
80-90k	325,842	171-245	2-6	23%	1,861	140	1%	759	3
90-100k	281,723	159-224	1-3	23%	2,010	132	1%	763	1
100-110k	239,392	134-202	1-2	24%	2,068	121	0%		0
110-120k	196,744	88-161	0-1	24%	2,128	100	0%		0
120-130k	155,762	60-127	0	24%	2,242	85	0%		0
130-140k	130,193	53-111	0	26%	2,257	75	0%		0
140-150k	107,384	45-95	0	27%	2,266	65	0%		0
150-160k	89,442	38-80	0	28%	2,275	56	0%		0
160-170k	73,893	24-51	0	27%	1,735	35	0%		0
170-180k	61,234	7-14	0	24%	615	9	0%		0
180-190k	51,035	0	0	0%		0	0%		0
190-200k	42,677	0	0	0%		0	0%		0

Source: Authors' calculations based on de-identified IRS data. The definitions of nonrefundable and refundable used in this table are discussed in the text as the "economic" definitions, useful for answering questions about the distribution consequences of the AOTC's refundability.

Table 9
Potential and Actual Higher Education Tax Credits among 25- to 26-year-olds, 2008 Tax Year

household income of filer (independent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, half-time enrollment (HTC), AGI and tax liability	potential tax expend on non-refundable credits based on criteria in prior column and year in college (millions of dollars)	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)
		min-max	min-max			
0-10k	1,749,780	11-12%	115-145	0%		0
10-20k	1,676,196	12-13%	100-128	9%	493	73
20-30k	1,546,261	12-13%	115-148	12%	882	158
30-40k	1,075,742	13-14%	90-110	12%	942	126
40-50k	622,725	14-15%	57-68	10%	1,060	69
50-60k	358,434	13-14%	18-22	7%	857	21
60-70k	212,399	6-7%	10-13	7%	871	12
70-80k	127,190	8-9%	8-9	8%	870	9
80-90k	76,182	10-11%	6-7	8%	921	6
90-100k	45,302	14-15%	4-6	6%	1,047	3
100-110k	27,652	17-19%	2-3	3%	760	1
110-120k	17,023	20-22%	0-1	1%	176	0
120-130k	10,838	0%	0	0%		0
130-140k	7,200	0%	0	0%		0
140-150k	5,089	0%	0	0%		0
150-160k	3,786	0%	0	0%		0
160-170k	2,768	0%	0	0%		0
170-180k	2,028	0%	0	0%		0
180-190k	1,504	0%	0	0%		0
190-200k	1,197	0%	0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 10
Potential and Actual Higher Education Tax Credits among 25- to 26-year-olds, 2009 Tax Year

household income of filer (independent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, AGI and tax liability	potential tax expend on non-refundable credits based on criteria in prior column, half-time, and year in college (millions of dollars)	percent who appear to qualify for a refundable credit based on tuition, AGI and tax liability	potential tax expend on refundable tax credits based on criteria in prior column half-time and year in college (millions of dollars)	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
		min-max	min-max	min-max	min-max						
0-10k	1,783,401	11-12%	116-144	6-10%	81-140	0%		0	7%	806	97
10-20k	1,737,221	12-13%	108-136	4-7%	52-90	11%	464	90	9%	767	115
20-30k	1,487,233	12-13%	122-155	4-6%	40-67	14%	874	179	8%	753	89
30-40k	992,906	13-14%	94-112	4-6%	27-44	14%	931	131	7%	755	53
40-50k	567,754	15-16%	60-71	4-7%	17-29	13%	1,009	74	6%	763	27
50-60k	328,623	16-18%	32-34	5-8%	12-20	10%	986	33	6%	761	15
60-70k	190,235	9-11%	13-17	6-10%	9-15	10%	987	18	6%	766	9
70-80k	111,311	12-14%	10-13	9-13%	7-12	11%	946	11	6%	758	5
80-90k	66,044	15-19%	6-8	12-18%	4-7	11%	879	6	6%	691	3
90-100k	39,555	16-18%	5-6	6-9%	2-3	8%	997	3	4%	762	1
100-110k	24,230	20-23%	3-4	8-12%	1-2	7%	1,008	2	4%	752	1
110-120k	15,245	25-28%	2	10-15%	1-2	5%	902	1	4%	761	0
120-130k	9,532	9-13%	1	12-19%	1	3%	1,136	0	3%	770	0
130-140k	6,014	11-17%	1	16-23%	1	3%	1,098	0	3%	747	0
140-150k	4,236	13-20%	0-1	17-27%	1	3%	1,126	0	3%	774	0
150-160k	3,233	15-21%	0-1	20-30%	0-1	2%	1,111	0	2%	733	0
160-170k	2,253	16-25%	0	21-32%	0	3%	891	0	2%	629	0
170-180k	1,577	19-29%	0	25-38%	0	2%	336	0	3%	225	0
180-190k	1,098	0%	0	0%	0	0%		0	0%		0
190-200k	854	0%	0	0%	0	0%		0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 11
Potential and Actual Higher Education Tax Credits among 29- to 30-year-olds, 2008 Tax Year

household income of filer (assuming dependent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, half-time enrollment (HTC), AGI and tax liability min-max	potential tax expend on non-refundable credits based on criteria in prior column and year in college (millions of dollars) min-max	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)
0-10k	1,266,193	10-11%	13-16	0%		0
10-20k	1,231,808	8-9%	6-8	4%	485	23
20-30k	1,218,769	9%	7-9	6%	846	67
30-40k	1,015,033	9-10%	6-8	8%	919	73
40-50k	719,290	10%	5-6	7%	1,006	54
50-60k	480,766	8-9%	2	5%	824	21
60-70k	339,227	5%	1-2	5%	850	15
70-80k	251,042	5%	1	6%	838	13
80-90k	182,012	5%	1	6%	872	10
90-100k	129,186	5-6%	1	5%	985	6
100-110k	91,350	6%	0	3%	772	2
110-120k	62,409	5%	0	1%	175	0
120-130k	44,319	0%	0	0%		0
130-140k	32,369	0%	0	0%		0
140-150k	24,390	0%	0	0%		0
150-160k	18,573	0%	0	0%		0
160-170k	14,311	0%	0	0%		0
170-180k	11,190	0%	0	0%		0
180-190k	8,729	0%	0	0%		0
190-200k	6,854	0%	0	0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 12
Potential and Actual Higher Education Tax Credits among 29- to 30-year-olds, 2009 Tax Year

household income of filer (independent student)	number of persons (potential students)	percent who appear to qualify for a non-refundable credit based on tuition, AGI and tax liability	potential tax expend on non-refundable credits based on criteria in prior column, half-time, and year in college (millions of dollars)	percent who appear to qualify for a refundable credit based on tuition, AGI and tax liability	potential tax expend on refundable tax credits based on criteria in prior column half-time and year in college (millions of dollars)	percent actually assoc with a non-refundable credit	their average non-refundable credit (dollars)	tax expend on their non-refundable credits for (millions of dollars)	percent actually assoc with a refundable credit	their average refundable credit (dollars)	tax expend on their refundable credits for (millions of dollars)
		min-max	min-max	min-max	min-max						
0-10k	1,306,053	10-11%	87-106	5-8%	51-83	0%	52		4%	809	45
10-20k	1,324,729	8-9%	67-83	4-5%	33-53	5%	456	33	6%	778	57
20-30k	1,241,641	9-10%	74-93	3-4%	27-43	8%	816	83	5%	766	52
30-40k	1,012,705	9-10%	69-83	3-4%	20-33	9%	893	86	5%	765	41
40-50k	712,363	10-11%	52-60	3-4%	14-22	9%	966	63	5%	769	26
50-60k	476,820	10-11%	28-33	3-4%	10-15	8%	960	35	4%	768	16
60-70k	332,638	6-7%	16-20	3-4%	7-11	7%	957	23	4%	767	11
70-80k	243,360	6-7%	12-14	3-4%	5-8	8%	934	18	4%	769	8
80-90k	176,261	6-7%	8-9	3-5%	3-5	8%	864	13	4%	697	5
90-100k	123,810	6%	6-7	2-3%	2	7%	957	8	3%	758	3
100-110k	87,667	6-7%	4-5	2-3%	1-2	5%	998	5	3%	769	2
110-120k	60,790	7%	2	2-3%	1	3%	884	2	2%	754	1
120-130k	42,072	2-3%	1	3-4%	1	2%	1,129	1	2%	759	1
130-140k	30,512	2-3%	1	3-4%	1	2%	1,155	1	2%	782	1
140-150k	22,745	2-4%	1	3-5%	1	2%	1,169	0	2%	782	0
150-160k	17,612	2-3%	0-1	3-5%	0-1	2%	1,182	0	2%	793	0
160-170k	13,391	3-4%	0	3-5%	0	2%	898	0	2%	604	0
170-180k	10,095	3-4%	0	3-5%	0	1%	338	0	1%	230	0
180-190k	7,951	0%	0	0%	0	0%	0		0%		0
190-200k	6,112	0%	0	0%	0	0%	0		0%		0

Source: Authors' calculations based on de-identified IRS data.

Table 13
First Stage of Regression Kink Estimation
Changes in the Slope of the Credit-Income Relationship at the Edges of the Phase-Out Range

		coefficient we expect if all students at lower edge of phase-out qualified for maximum AOTC (2011) or HTC (2007)	estimated coefficient
dependents of 2011 joint filers	lower kink	-0.125	-0.1074026*** ✓
dependents of 2011 joint filers	upper kink	0.125	0.1146557*** ✓
dependents of 2011 single filers	lower kink	-0.250	-0.2019312*** ✓
dependents of 2011 single filers	upper kink	0.250	0.2164388*** ✓
independent 2011 single filers	lower kink	-0.250	-0.2268326*** ✓
dependents of 2007 joint filers	lower kink	-0.090	-0.0731243*** ✓
dependents of 2007 joint filers	upper kink	0.090	0.0638205*** ✓
dependents of 2007 single filers	lower kink	-0.180	-0.1386706*** ✓
dependents of 2007 single filers	upper kink	0.180	0.1441341*** ✓
independent 2007 single filers	lower kink	-0.180	-0.1156229*** ✓

Source: Authors' estimates based on de-identified IRS data. ✓ indicates that the estimate passes the Ganong and Jäger (2014) permutation test at the 5% level. *** indicates a Ganong and Jäger (2014) p-value of no more than 0.001. The estimates shown are for equations (1) and (4) in the text using cubics for the polynomials. Households with incomes plus or minus $3,000 around each kink are included.

Table 14
Second Stage of Regression Kink Estimation
Changes in the Slope of Outcome-Income Relationships at the Edges of the Phase-Out Range

		attending at all (any 1098t)	attending at least half time	attending a 4-year college (cond'n on attendance)	attending a 2-year college (cond'n on attendance)	attending a 1-year college (cond'n on attendance)	instructional resources of student's college	core educational resources of student's college	"list" tuition and fees of student's college	tuition and fees student paid	grants student received
dependents of	lower	-0.000007	-0.000018	-0.000006	0.000003	0.000004	0.071056	0.144720	0.143040	0.006100	0.016414
2011 joint filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	upper	-0.000007	-0.000008	-0.000024	0.000021	0.000003	-0.054728	0.201426	-0.054842	-0.055844	-0.027458
2011 joint filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	lower	-0.000043	-0.000045	-0.000080	0.000067	0.000013	-0.017826	-0.076237	-0.186003	-0.158227	-0.039391
2011 single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	upper	-0.000002	0.000017	0.000068	-0.000078	0.000010	0.086454	0.127346	0.052391	0.124465	0.021564
2011 single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
independent 2011	lower	-0.000001	-0.000005	-0.000048	0.000047	0.000000	0.034621	-0.059597	-0.058494	-0.139827	-0.044528
single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	lower	-0.000012	-0.000016	0.000001	-0.000002	0.000001	0.023902	0.407249	-0.034750	0.241871	0.018055
2007 joint filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	upper	0.000004	-0.000005	-0.000016	0.000018	-0.000002	-0.071761	0.007405	-0.147745	-0.201568	-0.031292
2007 joint filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	lower	0.000005	0.000001	0.000010	-0.000017	0.000007	0.041122	0.050035	-0.206478	0.038334	0.028287
2007 single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
dependents of	upper	0.000006	0.000012	0.000025	-0.000027	0.000002	0.058673	-0.017263	0.048465	0.021211	-0.065977
2007 single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
independent 2007	lower	-0.000003	0.000002	0.000050	-0.000045	-0.000005	0.056424	0.056902	0.080008	0.073536	0.019659
single filers	kink	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Source: Authors' estimates based on de-identified IRS data. ✗ indicates that the estimate fails the Ganong and Jäger (2014) permutation test at the 5% level. In fact, none of the Ganong and Jäger (2014) p-values suggest that any of the estimates is at all close to being statistically significant different from zero. The estimates shown are for equations (2) and (5) in the text using cubics for the polynomials. Households with incomes plus or minus $3,000 around each kink are included.

Table 15
First Stage of Simulated Instrumental Variable Estimation
Effect of Policy-Based Tax Credit on Actual Tax Credit Taken

	first stage regression for...									
	age 19					age 22				
	attend college at all (any 1098t) and attend college at least half-time	attend 4-year, 2-year, 1-year college (conditional on attending)	instructional resources and core educational resources of student's college	"list" tuition and fees of student's college	tuition paid and grants received	attend college at all (any 1098t) and attend college at least half-time	attend 4-year, 2-year, 1-year college (conditional on attending)	instructional resources and core educational resources of student's college	"list" tuition and fees of student's college	tuition paid and grants received
coefficient on pure policy-based tax credit (simulated instrument)	0.300***	0.373***	0.380***	0.375***	0.380***	0.257***	0.361***	0.367***	0.363***	0.368***
robust clustered std error	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001
t-statistic	1,512	1,202	1,190	1,214	1,386	669	533	533	539	619
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
quintic polynomial in income	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
full set of year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
number of observations	33,198,780	13,444,991	12,792,374	13,639,755	17,847,816	23,783,288	7,915,372	7,670,236	8,016,694	10,600,587

Source: Authors' estimates based on de-identified IRS data. We show robust clustered standard errors and t-statistics associated with the estimated coefficients shown in the first row. *** indicates a p-value of no more than 0.001. Each cluster is a group of tax filers who receive identical higher education tax credits if they make the same college attendance and payment choices. The estimates are based on equation (7) in the text. They are for 19- and 22-year-olds in the 3 years before and after the introduction of the AOTC (2006 through 2011).

Table 16
Second Stage of Simulated Instrumental Variable Estimation
Effect of Tax Credits on Collegiate Outcomes, 19 and 22-Year-Olds, 3 Years Before and After the Introduction of the AOTC

	attending college at all (any 1098t)	attending college at least half-time	attending 4-year college (conditional on attending)	attending 2-year college (conditional on attending)	instructional resources of student's college	core educational resources of student's college	"list" tuition and fees of student's college	tuition and fees paid by student	grants received by student
	second stage regression for 19-year-olds...								
estimated coefficient on tax credit	0.000014	0.000014	-0.000009	0.000010	-0.017421	-0.031501	-0.023057	-0.030099	0.025649
robust clustered standard error	0.000137	0.000136	0.000068	0.000064	0.020863	0.033153	0.030556	0.031756	0.051689
t-statistic	0.10	0.10	-0.14	0.15	-0.84	-0.95	-0.75	-0.95	0.50
number of observations	33,198,780	33,198,780	13,444,991	13,444,991	12,792,374	12,792,374	13,639,755	17,847,816	17,847,816
	second stage regression for 22-year-olds...								
estimated coefficient on tax credit	-0.000016	0.000097	-0.000065	0.000067	-0.026581	-0.044069	-0.032052	-0.033826	-0.001832
robust clustered standard error	0.000020	0.000255	0.000096	0.000090	0.035438	0.053032	0.045294	0.046040	0.016842
t-statistic	-0.79	0.38	-0.68	0.75	-0.75	-0.83	-0.71	-0.73	-0.11
number of observations	23,783,288	23,783,288	7,915,372	7,915,372	7,670,236	7,670,236	7,670,236	10,600,587	10,600,587

Source: Authors' estimates based on de-identified IRS data. We show robust clustered standard errors and t-statistics. Each cluster is a group of tax filers who receive identical higher education tax credits if they make the same college attendance and payment choices. The estimates are based on equation (6) in the text. They are for 19- and 22-year-olds in the 3 years before and after the introduction of the AOTC (2006 through 2011).

Appendix Table 1
College Assessment Taking and Scores by Household Income
19 and 20 Year Olds in 2008

household income category	took any college assessment (ACT, SAT, or PSAT)	average math score (SAT scale)	average verbal score (SAT scale)
0-10k	35.0%	458	452
10-20k	35.4%	436	429
20-30k	39.0%	444	437
30-40k	43.1%	457	451
40-50k	47.5%	470	466
50-60k	51.6%	481	476
60-70k	54.6%	489	484
70-80k	58.7%	496	491
80-90k	63.1%	503	497
90-100k	67.6%	510	503
100-110k	72.8%	516	509
110-120k	74.4%	522	514
120-130k	75.9%	527	518
130-140k	80.3%	533	523
140-150k	82.5%	538	528
150-160k	83.3%	542	532
160-170k	85.7%	546	535
170-180k	87.2%	550	539
180-190k	89.9%	553	541
190-200k	89.9%	556	544

Notes: Individuals who were 19 or 20 years old in 2008 are associated with the 2008 income of the filer of whom they were a dependent at the age of 17. All scores are converted to the SAT© scale.

Appendix Table 2
Expenditures on Tax Credits that Coincide More and Less with Third Party Reports, tax filers of all ages in 2011, billions of $2011

	using minimum/stringent assumptions on 3rd party reports			using maximum/generous assumptions on 3rd party reports		
household income category	tax expenditures on credits within $500 of those based on third party reports	tax expenditures on credits that are at least $500 more than those based on third party reports	actual and potential tax expenditures on credits (including those not taken) that are at least $500 less than those based on third party reports	tax expenditures on credits within $500 of those based on third party reports	tax expenditures on credits that are at least $500 more than those based on third party reports	actual and potential tax expenditures on credits (including those not taken) that are at least $500 less than those based on third party reports
0-10k	0.38	0.56	1.07	0.41	0.44	1.68
10-20k	0.74	1.25	1.45	0.81	1.02	2.22
20-30k	1.22	1.19	2.01	1.36	0.87	2.85
30-40k	0.72	0.73	1.42	0.81	0.53	2.06
40-50k	0.66	0.55	1.27	0.75	0.39	1.83
50-60k	0.52	0.38	1.05	0.59	0.25	1.52
60-70k	0.45	0.52	0.94	0.50	0.43	1.35
70-80k	0.45	0.34	0.91	0.50	0.26	1.29
80-90k	0.43	0.41	0.79	0.47	0.34	1.11
90-100k	0.40	0.17	0.65	0.44	0.11	0.90
100-110k	0.33	0.14	0.51	0.35	0.10	0.72
110-120k	0.20	0.08	0.37	0.21	0.05	0.53
120-130k	0.12	0.04	0.27	0.12	0.02	0.40
130-140k	0.11	0.04	0.24	0.11	0.02	0.34
140-150k	0.09	0.05	0.20	0.09	0.04	0.29
150-160k	0.08	0.03	0.17	0.08	0.01	0.25
160-170k	0.05	0.02	0.12	0.05	0.01	0.17
170-180k	0.01	0.00	0.04	0.01	0.00	0.06
180-190k	0.00	0.00	0.00	0.00	0.00	0.00
190-200k	0.00	0.00	0.00	0.00	0.00	0.00
total	6.98	6.51	13.48	7.68	4.88	19.56

Notes: Authors' calculations based on de-identified IRS data. The important third party report for these calculations is Form 1098t.