Cash-on-Hand & College Enrollment:

Evidence from Population Tax Data and the Earned Income Tax Credit

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Abstract: We estimate causal effects of tax refunds (cash-on-hand) on college enrollment using population-level administrative data from United States income tax returns. We implement two separate research designs based on tax refunds from the Earned Income Tax Credit (EITC). First, we exploit a nonlinearity in the tax refund schedule that results from the kink point between the phase-in and maximum credit portions of the schedule. Second, we use policy expansions in the EITC phase-out region. Both approaches yield similar results that suggest tax refunds received in the spring of the high school senior year have meaningful effects on college enrollment.

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1. Introduction

College enrollment varies significantly by family income. About one in five youths from the lowest income families attend college compared to more than four out of five youths from the highest income families, and this pattern has been stable over time (Chetty et al 2014). A key concern is the extent to which this pattern of enrollment reflects how limited financial resources prevent low-income students from attending college. In an attempt to ensure access to higher education for low-income households, federal and state governments devote billions of dollars each year to student aid programs that lower the price of college (College Board, 2014). Yet, it is not clear how additional *family income* impacts college enrollment. Given the significant private and social benefits of college education,[1] it is important to determine how family income affects college enrollment, and if additional family resources can impact college attendance. However, quantifying these effects is challenging since households with higher family income may also have longer planning horizons, high college preparedness, and other factors that cause high college enrollment, making it difficult to separate causal effects from correlations.

In this paper, we exploit quasi-experimental variation in family income to overcome previous challenges and isolate causal effects of family income on college enrollment. In particular, we study the effects of tax refunds received in the spring of the high school senior year ("cash-on-hand") on college enrollment in the subsequent year using administrative population-level tax data from the United States. The quasi-experimental variation in tax refunds arises from policy nonlinearities and policy expansions in the tax code. These nonlinearities and expansions cause observationally similar households to receive different tax refunds, and we examine subsequent college enrollment rates.

Our use of population-level tax data allows us to characterize the behavior of the *entire cohort of high-school seniors* affected by key aspects of the Earned Income Tax Credit (EITC). Access to the universe of tax returns allows us to implement two separate research designs in very close proximity to affected families while still retaining a very

[1] See Card (1999), Currie and Moretti, (2003), Moretti (2004), Lochner (2004) and Milligan, Moretti and Oreopoulos (2004) and Goldin and Katz (2009).

large sample size. First, we use a Regression Kink Design (RKD) to relate the change in slope in tax refunds across a tax kink point generated by the EITC, to changes in the slope of the enrollment profile. Second, we use a difference-in-differences (DD) identification that exploits policy changes in the EITC benefit schedules across family structures over time. In both cases, the use of population-level administrative tax data allows us to create samples with narrow bandwidths around key portions of the EITC schedule so that we can plausibly isolate variation in tax refunds that result from the non-linear refund schedule driven by the EITC.

As a benchmark, we first document the cross-sectional relationship between family income in the high school senior year and college enrollment rates the following school year. Next, we implement the RKD and DD research designs to estimate the causal effects of cash-on-hand on college enrollment. Consistent with the cross-sectional benchmark, the results from the two separate research designs indicate that an additional $1000 of after-tax income from tax refunds that arrive in the spring of the high school senior year increases college enrollment by roughly 0.4 to 0.7 percentage points. The timing of tax refunds appears to be a key factor, as refunds arrive when many youths are finalizing their college enrollment decisions. We find no evidence that tax refunds received in the spring of the high school *junior* year affect college enrollment. We also find some suggestive evidence that cash-on-hand in the senior year generates new enrollments as opposed to just affecting the timing of enrollments, though these findings are not precise.

Our unique research designs offer multiple contributions to the literature examining short-run variation in family income on college enrollment.[2] First, the research designs allow us to examine the impacts of lump-sum payments that arrive in the spring of the high school senior year, which is precisely a time when high school students are making college enrollment decisions. We are able to compare the effects of tax

[2] For evidence on the effects of long-run and short-run variation in family income on college enrollment, see Ellwood and Kane (2000), Shea (2000), Acemoglu and Pischke (2001), Carneiro and Heckman (2002), Keane and Wolpin (2001), Cameron and Taber (2004), Plug and Vijverberg (2005), Belley and Lochner (2007), Lovenheim (2011), Bailey and Dynarski (2011), Hilger (2013), Michelmore (2013), and Lovenheim and Reynolds (2013).

refunds in the senior year to effects of tax refunds in the junior year to understand the importance of timing.

Second, the research designs contribute estimates of income effects to the literature examining how tax policies and student aid policies affect college enrollment.[3] Previous studies generally focus on education tax credits and student aid policies that provide enrollment-contingent aid. Such aid policies typically operate through price effects, as they lower the relative price of college enrollment if a student enrolls in college. In contrast, our findings highlight income effects from non-contingent aid, as the tax refunds we study are not contingent on college enrollment. While tax refunds need not be spent on higher education, the lump-sum payments may help households cover any out-of-pocket college costs. Our findings support the idea that additional cash-on-hand increases college enrollment for families that benefit from the EITC, but it is not clear how our results extend to other areas of the income distribution. Recent work that examines the impact of enrollment-contingent tax-based federal student aid over a broader segment of the income distribution (Bulman and Hoxby, 2014) finds no enrollment effects.[4] Beyond the student aid literature, this study also builds upon earlier studies documenting how tax policies affect child outcomes over the life-cycle. [5]

Third, our research designs contribute a highly credible strategy to estimate causal effects. In particular, our analysis is based on a large sample size: nearly all high school seniors in the United States between 2001 and 2011. This population-level administrative data allows us to implement a research design based on slope changes around tax kink points. Since it is unlikely that other factors change exactly at the tax kink points, this

[3] For evidence on credit constraints, student aid and college enrollment decisions, see van der Klaauw (2002), Dynarski (2003), Stinebrickner and Stinebrickner (2008), Nielsen, Sorensen and Taber (2010), Gurgand, Lorenceau and Melonio (2011), Lochner and Monge-Naranjo (2011), and Solis (2012). These papers primarily exploit quasi-experimental variation in enrollment-contingent student aid. Dynarski and Scott-Clayton (2013) summarize the student aid literature and indicate that additional $1000 of student aid increases college enrollment by roughly 2 to 4 percentage points. For evidence on the effects of education tax credits on college enrollment, see Long (2004), Turner (2011), LaLumia (2012) and Bulman and Hoxby (2015).

[4] Bulman and Hoxby (2015) study the American Opportunity Tax Credit. Unlike the EITC from the high-school senior year, this credit provides students and their families with a benefit after they incur college costs. This timing difference may also account for the different patterns of enrollment.

[5] Hoynes, Miller and Simon (2014) present estimates of the impacts of EITC benefits on birth weight; Dahl and Lochner (2012) present estimates of the impacts of EITC benefits on early age test scores; Michelmore (2013) studies the impacts of state and federal EITC benefits on college enrollment, though the identification strategies and treatment populations differ from those used in this study.

research design offers highly credible estimates of causal effects. This study relates to a growing literature that develops and applies RKD as an empirical strategy to estimate causal effects based on policy nonlinearities.[6] Since RKD relies on identifying kinks in the enrollment-income profile, it is important to distinguish between kinks and nonlinearities in the enrollment-income function. We consider multiple strategies to address this methodological concern, including multiple placebo analyses and estimates from a separate identification strategy.

This paper is organized as follows. Section 2 describes the data, institutional background and cross-sectional analysis. Section 3 presents the main empirical analysis to estimate causal effects of tax refunds on college enrollment. Section 4 discusses evidence on liquidity and informational constraints to provide some context for the estimates presented in Section 3. Section 5 discusses the conclusions from the analysis.

2. Data & Background

2.1 Data

To analyze the effect of cash on hand on college enrollment we use information from the population of U.S. tax returns and from the Social Security Administration (SSA). To focus on high school seniors, we create our sample by first pulling all Social Security Numbers (SSNs) from the SSA data for individuals who are 17 or 18 during the years 2001 to 2011. For these observations, we assign high school cohorts based on the month and year of birth. In each year, individuals who were 18 as of December 31 and who were born in September through December and individuals who were 17 as of December 31 and who were born January through August define a cohort of seniors. In aggregate, this approach matches well to the number of high school seniors reported by the Department of Education. For example, for 2007 the U.S. Department of Education reports a total of 4.21 million high school seniors, whereas we find 4.09 million in the tax data.[7] Next, we look for tax returns that claim these individuals as dependents during the

[6] See Calonico, Cattaneo, and Titiunik (2014), Landais (forthcoming), Card Lee, Pei and Weber (2015), Ganong and Jaeger (2014), Marx and Turner (2014), Card, Johnston, Leung, Mas and Pei (2015), and Hansen, Nguyen and Waddell (2015).

[7] This approach may misclassify some individuals. In particular, since we do not have data directly from schools on their senior students, their graduation and subsequent enrollment, our ability to specifically identify high school seniors, on-time high school graduation, and college enrollment may be limited in the tax data. However, such misclassification is not likely to be problematic for our specifications. In the RKD

sample period, retaining information on family structure (married, number of dependents) and income from the 1040 tax form. Given our focus on tax returns claiming high school seniors, we restrict the sample to returns that file as either head of household or married filing jointly.[8]

To measure college enrollment, we use the 1098-T tax form. To remain eligible for Title IV federal student aid, schools are required to send a 1098-T form to nearly all students, and to the IRS.[9] Chetty et al. (2011) and Chetty, Friedman and Rockoff (2013a,b) also use the 1098-T to measure college enrollment. Chetty et al. (2011) find that enrollment from as measured by the 1098-T form is comparable to enrollment reported in other data including the Current Population Survey and the U.S. Department of Education.[10]

2.2 Cross-Sectional Analysis

Before turning to the institutional background on the EITC and the causal analysis, we start by documenting the cross-sectional relationship between family income in the high school senior year and college enrollment rates. This relationship may serve as a useful benchmark for the magnitudes of the causal effects of cash-on-hand and college enrollment.

Figure 1 presents graphical evidence on the cross-sectional relationship between family income and college enrollment. We construct this figure as follows. First, we restrict the sample to households with total income in the calendar year of the start of the

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case, as long as this misclassification does not vary across the EITC kink point we examine, this will not have an effect on our estimates. Intuitively, measurement error in defining the senior year may impact the average enrollment rate but should not have a differential effect on the slope of the enrollment profile at the tax kink. Further, we find evidence that the age profile is smooth through the tax kinks. For the difference in difference analysis, as long as the misclassification is constant across the different family structures affected by the policy change, then the measurement error will be differenced out.

[8] There are relatively few married filing separate or qualifying widower returns claiming a high school senior.

[9] This form is used to verify educational expenses for certain tax-based aid programs. Exceptions to the 1098-T filing rule include: courses for which no credit is earned; nonresident alien students; and students whose qualified tuition is covered by a formal billing arrangement between the institution and the student's employer. As a check we also verify that our enrollment results do not change when we use data from the universe of Pell grant recipients, including those with Pell grants that cover all of their education costs who may not receive a F1098-T form.

[10] Unfortunately the F1098-T form does not indicate the type of school (public, private, for-profit, 4-year, 2-year etc.) and a cross-walk for school information is only available in a subset of the years that we study. As a result, we are unable to include this information in the analysis.

senior year between $1000 and $50000.[11] Next, we create $1000 bins of total income. Within each of these bins, we compute mean enrollment rates based on enrollment of the high school senior dependent in the subsequent calendar year or two years after the high school senior year. The graphical evidence highlights an almost linear relationship between family income in the senior year and college enrollment the following year. When using enrollment measured two years after the start of the high school senior year, the enrollment rates are higher and the linear relationship appears unchanged. The lines in Figure 1 are generated from a regression of enrollment on total income. (Appendix Table 1 presents the estimated enrollment-income gradients.) Based on the cross-sectional regressions for the full sample, a $1000 increase in income appears to correlate with a 0.50 percentage point increase in enrollment (standard error of 0.013). When we split the sample based on filing status and number of children the enrollment-income gradient appears to be slightly lower for married filing jointly taxpayers (ranging from 0.32 to 0.41) versus head-of-household taxpayers (ranging from 0.45 to 0.63). Within filing status, the estimated enrollment-income gradients do not appear to vary much across households with one or two dependent children, but the gradients are slightly lower for taxpayers with 3 or more dependents.

2.3 EITC: Background

The EITC is a refundable tax credit that provides benefits to low-income working families. As the credit is refundable, taxpayers may benefit from the EITC even when they have no tax liability. The EITC amounts are primarily determined based on tax filing status, the number of qualifying children, and income.[12] Taxpayers who file married but not jointly may not claim the EITC, though in practice nearly all taxpayers claiming the EITC are either head of household or married filing jointly. Qualifying children for the EITC are relatives who are under age 19 or permanently disabled and who resided with the tax filers for at least half of the year.[13] As implied by the name, the

[11] Total income is the sum of all reported income (line 22 of the 1040). We restrict to individuals with at least $1000 to remove high-wealth individuals who have temporarily low income because of large income losses from business activity.
[12] Eligibility for the EITC also includes a ceiling on investment income, from such sources as dividends, rental properties etc. In 2014, the limit on investment income was $3350.
[13] Children between ages 19 and 24 can also count as qualifying children if they were full-time students for any five months of the calendar year.

EITC requires families to have earnings to claim the credit. Earnings include wages, salaries and tips and net earnings from self-employment. Benefits from unemployment insurance, workers compensation, food stamps, Medicaid, TANF, SSI, social security, disability and child support do not count as earned income. In the case that a taxpayer's adjusted gross income differs from their earned income, benefits are computed using both income measures and the EITC benefit amount is the lower of the two amounts.[14]

2.4 EITC Kink 1: Phase-in and maximum benefit region

Within a given year the first EITC kink point varies only by the number of qualifying children. (Appendix Table 2 lists the specific earnings thresholds for each tax year for the EITC as well as the earnings thresholds for the Child Tax Credit.[15]) In the phase-in portion, benefits increase by $0.34, $0.40 and $0.45 per dollar of earned income based on one, two, or three or more qualifying children respectively. In some years, the CTC begins to phase in at the first EITC kink point so that tax refunds continue to increase as earnings increase in the maximum credit region of the EITC benefit schedule.

To provide some intuition for our RKD specification at the first EITC kink point, Figure 2A plots a simulated example of the change in tax refunds around this point. The figure plots tax refunds as a function of earnings relative to the EITC kink point. The figure illustrates that tax refunds increase at a faster rate for earnings levels below the kink point because EITC benefits increase in the phase-in region. To the right of the kink point, EITC benefits no longer continue to phase-in since individuals are in the maximum credit region. Intuitively, the slope of tax refunds decreases as tax refunds no longer increase at the higher rate. Tax refunds still continue to increase to the right of the kink because the Child Tax Credit begins to phase in at the first EITC kink point. The Child Tax Credit phases in at a rate of $0.10 per dollar. For taxpayers with two or more qualifying children, the slope change in tax refunds at the first EITC kink point is roughly $0.30 because the slope changes from about $0.40 (the weighted average over the EITC phase-in rates based on the fractions of taxpayers with two, or three or more qualifying

[14] IRS Publication 596 provides the official documentation of the rules and eligibility criteria for this credit.

[15] IRS Publication 972 provides the official documentation of the rules and eligibility criteria for this credit. The Child Tax Credit (CTC) and Additional Child Tax Credit offer taxpayers benefits of up to $1000 per qualifying child. These two tax credits are effectively a single tax credit with the CTC being the non-refundable portion and the ACTC being the refundable portion.

children) to roughly $0.10 (the Child Tax Credit phase-in rate). For taxpayers with one qualifying child, the CTC does not apply since the qualifying child must be younger than age 17. For these taxpayers, the slope change in tax refunds at the first EITC kink point is roughly $0.34 because the slope changes from $0.34 (the EITC phase-in rate) to 0.

Although Figure 2A suggests that the EITC benefit schedule is a function solely of earned income, in reality the benefit schedule is more complicated. For taxpayers with Adjusted Gross Income higher than the earnings threshold for the maximum credit, EITC benefits are based on the minimum of benefits computed using earned income and benefits computed using Adjusted Gross Income. As a result of this complication, we, use a regression-kink design (RKD) at the first kink point only.[16] As described below, we exploit policy induced variation at the second kink point in a difference-in-differences (DD) specification at the second kink point.

2.5 EITC Phase-Out Expansions

We also exploit policy changes in the EITC schedule to estimate the causal effects of tax refunds on college enrollment. The federal EITC benefit schedule increased the income eligibility range for the EITC for married filing jointly taxpayers relative to head-of-household taxpayers. In 2001, the phase-out portion of the benefit schedule was identical for head-of-household and married filing jointly taxpayers. In 2002, the point at which the EITC begins to phase out increased by $1000 for married filing jointly households but not head of household taxpayers. In subsequent years, this point expanded out further for married filing joint families. Specifically, the differences in the income level where benefits begin to phase out were $1000 between 2002 through 2004, $2000 between 2005 through 2007, $3000 in 2008, $5000 in 2009, $5010 in 2010 and $5080 in 2011. The specific kink point values for each year, filing status and number of qualifying children are shown in Appendix Table 3.

[16] We have explored using a regression kink design at the second and third EITC kink points using a restricted sample that has earned income equal to AGI. This is a highly selected and limited sample as it is unusual to have no adjustments to earned income. Furthermore, when restricting to this unusual sample, we find small but statistically significant evidence of sorting along the running variable (i.e. bunching at the kink point between the maximum credit and phase-out regions), and this violates the identifying assumptions for a regression kink design.

Figure 2B illustrates how the statutory schedule changes for the phase-out portion of the EITC[17]. As shown by the dashed lines in the figure, the point at which the EITC begins to phase out for joint returns expands over time, relative to non-joint returns. Figure 2C highlights how this expansion impacts the value of the EITC for families during this period; this figure plots the difference in EITC between head-of-household and married filing jointly taxpayers with two qualifying children at $25000, $35000 and $45000 of household income. For income values at the lower end of the phase-out region, some married filing jointly taxpayers move from benefits on the phase-out to the maximum credit. At slightly higher income levels, married filing jointly taxpayers move to higher benefit levels but still remain on the phase-out. At even higher income values, some married filing jointly taxpayers move from not being eligible for any EITC benefits to being eligible for roughly $1000 in EITC benefits or less.

2.5 Analysis Samples

We impose several sample restrictions to create the analysis samples. For the EITC Kink 1 analysis, we restrict the sample to only include individuals that are -$6000 to +$3000 (in earned income) around the first EITC kink point. (We restrict to at most +$3000 to avoid interactions with the second kink point where the credit becomes a function of both earnings at Adjusted Gross Income or AGI.) Additionally, we exclude taxpayers with any self-employment income and high non-W2 wage income. We impose these restrictions because these income sources cannot be third party verified, and previous studies (see Saez 2010 and Chetty, Friedman and Saez 2012) highlight evidence of these individuals sorting along the tax schedule which violates the identifying assumptions behind the RKD approach Card et al (2015).

For the EITC phase-out DD analysis, we focus the analysis around the region where benefits are completely phased out. In this region, the EITC is a function of AGI and not earnings, allowing us to abstract from complications that arise when taxpayers transition between the two incomes measures as the primary income source for determining the credit. To create the sample, we restrict the analysis to taxpayers with

[17] This figure focuses on the case in which earned income is exactly equal to AGI to illustrate the expansions. While the figure plots nominal benefit values, we note that the benefit values have been indexed to the Consumer Price Index to that real EITC benefits for different groups based on filing status and number of qualifying children have remained constant between 2001 and 2011.

AGI from $28281 to $41132. These points correspond to $5000 below the common completely phased-out point in 2001, and the completely phased out point for joint returns in 2011 respectively. Additionally, we exclude taxpayers with any self-employment income and taxpayers with more than a $10000 difference between their total wage income and their AGI. We impose these restrictions to isolate taxpayers who are actually on the phase-out portion of the EITC schedule.[18]

Table 1 shows summary statistics for the analysis samples. The EITC Kink 1 sample consists of roughly 1.4 million high school seniors, while the EITC DD sample consists of roughly 2.6 million high school seniors. Compared to the EITC Kink 1 analysis sample, the EITC DD sample has higher enrollment rate (20 percent compared to 31 percent), higher after-tax income (roughly $16000 versus $39000), lower tax refunds (about $3700 versus $4600) and a higher fraction of married filing jointly taxpayers (roughly 37 percent versus 18 percent).

3. Empirical Analysis

3.1 Regression Kink Design

To identify the impact of cash-on-hand on college enrollment near the first EITC kink point we use a fuzzy regression kink design. This approach relates the change in the slope of the enrollment function to the change in slope of tax refunds at the tax kink point. To implement the fuzzy RKD, we estimate both the change in the enrollment-income profile and the tax refund-income profile at EITC Kink 1. The estimate of the impact of cash-on-hand on college enrollment is the ratio of these slope changes at the tax kink point. We compute earned income relative to that kink point, denoted by *kinkdist*. This measure allows us to pool the data across groups to estimate changes in the slopes of enrollment and after-tax income at each kink point. We exploit differences in the location of these kink points across groups in the placebo tests.

Following Card et al (2015) and Nielsen et al (2010), we consider the following constant-effect, additive model to examine the effects of refunds on college enrollment,

$$enroll_i = \beta refund_i + g(kinkdist_i) + \varepsilon_i.$$

[18] For taxpayers with AGI greater than EITC Kink 2 (the beginning of the phase-out region), EITC benefits are computed based on the minimum of benefits calculated using AGI and benefits based on using earned income.

The subscript *i* refers to the individual who is a high school senior. The variable $enroll_i$ is an indicator equal to one if individual *i* enrolls in college in the year after his or her high school senior year. The variables $refund_i$ and $kinkdist_i$ are based on tax returns filed in the spring of individual *i*'s senior year on which individual *i* is claimed as a dependent. The $refund_i$ variable measures the tax refund and $kinkdist_i$ measures the distance ($2011) relative to the specified kink point. The function *g(.)* is a continuous function. The tax refund function, $refund_i = refund(kinkdist_i)$, is assumed to be a continuous and deterministic function of earnings (equivalently of earnings relative to the kink point) with a slope change at the kink point (i.e. at *kinkdist*=0). If *g(.)* and $E(\varepsilon|kinkdist=k)$ have derivatives that are continuous in *kinkdist* at *kinkdist* = 0, then the fuzzy RKD estimator is given by

$$\beta = \frac{\lim_{k\to 0^+} \frac{\partial E[enroll|kinkdist = k]}{\partial k}|_{k=0} - \lim_{k\to 0^-} \frac{\partial E[enroll|kinkdist = k]}{\partial k}|_{k=0}}{\lim_{k\to 0^+} \frac{\partial E[refund|kinkdist = k]}{\partial k}|_{k=0} - \lim_{k\to 0^-} \frac{\partial E[refund|kinkdist = k]}{\partial k}|_{k=0}}.$$

The numerator of this expression captures the change in the slope of the conditional expectation of enrollment with respect to income at the kink point. The denominator reflects the change in the slope of tax refunds at the kink point.

Even though the tax refund function is deterministic we use a fuzzy RKD rather than a sharp RKD. The fuzzy approach allows us to empirically estimate the change in slope of tax refunds and show that it matches the statutory slope change. The trade-off of using the fuzzy RKD in place of the sharp RKD is a potential loss of precision. By estimating the denominator in the expression above, there should be relatively larger standard errors of the reduced form effect of after-tax income on enrollment, compared to using a sharp RKD and imposing the statutory slope change. As a result, implementing the fuzzy RKD should result in relatively more conservative inferences about the impact of tax refunds on enrollment, compared to using a sharp RKD specification.

We estimate the changes in enrollment and after-tax income, for the above numerator and denominator respectively, using regressions of the following form

$$enroll_i = \alpha kinkdist_i + \delta^{enroll} D_i * kinkdist_i + \alpha_2 X_i + u_i$$

$$refund_i = \gamma kinkdist_i + \delta^{refund} D_i * kinkdist_i + \gamma_2 X_i + v_i.$$

where D_i is an indicator variable equal to one if earnings fall below the kink point, i.e. $D_i = 1(kinkdist_i < 0)$. The variable X denotes a vector of covariates included in the regressions. The fuzzy RKD estimator is then given by

$$\hat{\beta} = \frac{\widehat{\delta^{enroll}}}{\widehat{\delta^{refund}}}.$$

The vector of covariates includes dummies for year, filing status, and number of kids. Intuitively, the coefficient $\hat{\beta}$ reflects the impacts on enrollment of additional cash-on-hand coming from increases in tax refunds, or equivalently from increases in after-tax income, in the spring of the high school senior year.

When estimating these enrollment and refund regressions for each kink point, we choose a baseline bandwidth of (-\$6000,+\$3000) around the kink points. The choice of -\$6000 is motivated by choosing a lower bound that does not get too close to the zero earned income threshold; since the lowest value of EITC Kink 1 is \$7140 in 2001, a distance of -\$6000 relative to this kink point is just slightly above the zero earnings threshold. The choice of the +\$3000 is motivated by choosing the highest bound that does not reach the beginning of the phase-out region (i.e. the lowest value of EITC Kink 2, see Appendix Tables 2 and 3 for key EITC points). As a result, the (-\$6000,+3000) bandwidth gives the largest possible bandwidth that does not overlap with any other tax kink points. The large bandwidth also allows us to account for nonlinearity in the enrollment-income profile that is separate from discontinuous changes at the tax kink point.

While it is possible to use different bandwidths for the numerator and denominator, we present results based on using the same bandwidths for the enrollment and after-tax income regressions. In this case we estimate the fuzzy RKD using an instrumental variables approach based on estimating the following regression

$$enroll_i = \beta refund_i + kinkdist_i + \varepsilon_i$$

in which we instrument for tax refunds using the interaction $D_i * kinkdist_i$.

3.2 Regression Kink Estimates

Figure 3 presents the main graphical evidence for the regression kink analysis. Figure 3A plots tax refunds against earnings relative to the kink point, and Figure 3B plots enrollment against earnings relative to the kink point. We construct these plots by computing average tax refunds and enrollment rates within $100 bins of income relative to the respective kink points. We generate the fitted values by using the individual-level data and regressing the enrollment indicator on $kinkdist_i$ and $kinkdist_i{*}D_i$, and then we plot the average of the fitted values in each $100 bin of income relative to the kink. Figure 3A highlights a kink in tax refunds at the first EITC kink point and Figure 3B shows a kink in enrollment rates at the same kink point.

Table 2 presents the quantitative results corresponding to the graphical evidence in Figure 3. The estimated slope change in enrollment is -0.15 and the first stage change in the slope of after-tax income (tax refunds) is -0.34. Using the IV specification to estimate the ratio of these two coefficients, the RKD estimates indicate that a $1000 increase in after-tax income (tax refunds) causes roughly a 0.43 percentage point increase in college enrollment. The remaining columns in Table 2 show similar results for 1 and 2 child households separately, though the standard errors are larger given the smaller sample sizes. We discuss the magnitude of the estimated enrollment effects in more detail below. We note that the RKD estimate is consistent with the cross-sectional estimates of the enrollment-income gradient (see Figure 1 and Appendix Table 1). We also note that tax refunds may be sufficient to cover significant portions of out-of-pocket costs, particularly at 2-year public colleges, for many students (see the summary statistics on tax refunds in Table 1 and the distributions of college costs in Table 8).

3.3 Identifying Assumptions

Identification with the RKD methodology requires that (1) other covariates do no change in the tax kink points and that (2) taxpayers do not sort along the tax schedule. This section presents evidence that both of these key assumptions hold at the first EITC kink point.

To examine if any covariates change at the tax kink point, we regress enrollment on a set of covariates, obtain predicted enrollment values, and then test for a kink in predicted enrollment using the above RKD regression specifications. Intuitively, if the aggregate effect of the covariates in our specification has a kink at the tax kink point, then the predicted enrollment values will also have a kink.[19] However, since none of the covariates are expected to change at the tax kink point, we can verify that there is no evidence for a kink in the covariate predicted enrollment rates. In addition to dummies for year, filing status and number of kids, we also include linear controls for senior year income and junior year income (i.e. income in the calendar years of the start of the senior and junior years respectively) when computing covariate predicted enrollment values.

Figure 4A presents the graphical analysis of covariate predicted enrollment. The plot shows that there are no detectable changes in covariate predicted enrollment when predicting enrollment using a rich set of covariates from the tax data. Additionally, while the tax data do not contain data on federal student aid eligibility, we have verified that there are no specific changes in federal student aid eligibility that correspond to the income levels of the tax kink points. Individuals in the first EITC kink sample generally qualify for zero Expected Family Contribution and maximum Pell grants.

To study sorting along the tax schedule, we examine frequencies of taxpayers around the kink point. Figure 4B presents plots of the frequencies of taxpayers around EITC Kink 1. Prior to our sample restrictions (i.e. when we include all tax returns around the first EITC kink point), we find significant evidence of bunching around the kink point. This is consistent with previous evidence in the income tax literature (see Saez 2010 and Chetty et al 2013). After excluding individuals with self-employment earnings or other non-third party verified income, as well as individuals with more than a $1000 difference between earned income and AGI, we find no evidence of sorting along the tax schedule in the sample.[20]

3.4. Robustness

We examine the robustness of our RKD results by allowing for nonlinearity in the enrollment-income profile and by conducting multiple placebo analyses. First, to allow

[19] Note that it is possible for the aggregate effect of the controls to be smooth through the kink while the individual controls have offsetting kinks. We do not find any evidence for this possibility. Instead, we find no evidence that each control has a kink. We use the predicted enrollment measure as a convenient way to summarize this overall finding.

[20] We follow Card et al (2015) and formally test for a kink in the frequencies by estimating a series of polynomial models using the binned frequencies. The polynomial models allow the first and higher order derivatives to change at the kink point, and we test for a kink in the frequencies based on whether or not there is a statistically significant change in the linear piece of the polynomial at the kink point. Overall, the frequencies appear smooth.

for underlying nonlinearity in the enrollment-income profile, we follow Card et al (2015) and regress enrollment on nonlinear controls in senior and junior year income, obtain the enrollment residuals, and then test for a kink in the enrollment residuals. Second, we demonstrate that the largest kink in tax refunds, and the largest kink in the enrollment profile, occurs at the true tax kink point. This helps us to rule out the possibility that our observed kink results from a relatively larger kink nearby the actual tax kink point. Third, to account for nonlinearity in the enrollment-income profile, we take advantage of the fact that EITC Kink 1 is at different income levels for different groups of taxpayers. This fact implies that we can account for a common enrollment-income relationship across groups that is not co-linear with earnings relative to the kink.

Table 3 presents the results when allowing for nonlinearity in the enrollment-income profile following Card et al (2015). In particular, the table shows results when allowing for a linear control in senior year income, a 5th order polynomial in senior and junior year income each, and a 5th order spline in senior and junior year income each. Overall, the estimated slope changes in the enrollment residuals are similar to the estimated slop changes in the enrollment measure. This result is consistent with our interpretation that the RKD estimates are not spuriously driven by a nonlinear enrollment-income relationship.

Next, we show that the largest tax kink points in the enrollment profile and in tax refunds occur at the statutory kink point. For this analysis, we vary a placebo kink around the true kink point and verify that the largest estimated kink in tax refunds and enrollment occurs at the true EITC kink point. We choose a distance from the true kink point *p = -4000, -3900, …, +2000* and define a placebo kink point based on this distance, *pkink = kink1 + p*. Using this placebo kink point, we define earnings relative to the placebo kink point, $pkinkdist_i$ and an indicator $D_i^p = 1(pkinkdist_i < 0)$. We then estimate the slope changes in tax refunds and enrollment at the placebo kink using the following regressions,

$$enroll_i = \alpha_1 pkinkdist_i + \alpha_2 D_i^p + \delta^{enroll,p}[D_i^p * pkinkdist_i] + \alpha_2 X_i + u_i$$

$$refund_i = \gamma_1 pkinkdist_i + \gamma_2 D_i^p + \delta^{refund,p}[D_i^p * pkinkdist_i] + \gamma_2 X_i + v_i.$$

We then plot the estimated slope changes, $\delta^{enroll,p}$ and $\delta^{refund,p}$, for each of the placebo kink points *p = -4000, -3900, …, +2000* and verify that the highest estimated slope changes occurs at the true kink point.

Figure 5 presents the estimated slope changes when varying the placebo kink points in $100 increments around the true EITC kink points. Figure 5A presents the estimated placebo slope changes for tax refunds, and Figure 5B presents the estimated slope changes for enrollment. The dotted lines in the respective plots highlight the estimated slope changes at the true kink points. The plots highlight that for both tax refunds and enrollment, the highest estimated kink points seem to occur at the true kink points. This is consistent with the assumption that the RK estimates result from the kink in tax refunds at the statutory kink point, and not from a spurious nonlinear relationship between income and enrollment at this point.

A novel aspect of our sample is that the EITC kink point occurs at different income levels based on the number of qualifying children (see Figure 2A). In our baseline analysis, we pool across all tax returns. To help rule out the possibility that our estimated kink results from a spurious relationship between income and enrollment that corresponds to the income levels associated with these kink points, we test for the presence of kink points at key income points for unaffected groups in the following way. For taxpayers with one child, we draw a placebo sample around the kink point for taxpayers with two or more qualifying children. As Figure 6A illustrates, around this placebo kink (the kink point for two or more children), families with one qualifying child are all on the maximum credit (plateau) portion of their actual benefit schedule and do not face an actual tax kink. For taxpayers with two or more qualifying children, we draw a placebo sample around the kink point for taxpayers with one qualifying child. As Figure 6B illustrates, around this placebo kink (the kink point for one qualifying child), families with two or more qualifying children are all on the phase-in portion of their actual benefit schedule and do not face an actual tax kink. The results in Table 4 verify that at the placebo kink points for the first EITC kink point, we do not find any evidence of kinks in enrollment in the placebo samples.[21]

[21] While the two-child and pooled results do have a point estimate that suggests an enrollment kink, the standard errors are relatively large and we cannot rule out that there is no kink in these cases.

3.5 Timing of Income and Enrollment

Our baseline results relate tax refunds in the high school senior year to college enrollment the next year. To determine the relative importance of the timing of tax refund payments, we examine whether tax refunds in the spring of the high school junior year also affect college enrollment. For this analysis, we replicate the RKD *based on income in the high school junior year*. In particular, we draw the sample of returns that are around the first EITC kink point in the high school *junior year*.[22]

We expect that the impact of cash on hand in the junior year will have a substantially smaller impact on college enrollment. Intuitively, unlike tax refunds that arrive in the spring of the high school senior year, tax refunds that arrive in the spring of the junior year arrive well before students make their enrollment decisions. While it is possible that some forward looking households save these tax refunds, the households in the sample are relatively low income and are therefore may be unable to save these funds an entire year.

Table 5 presents regression kink estimates for both the senior year and junior year samples showing smaller effects in the junior year. The first column in Table 5 for the senior year sample verifies the baseline estimates for the subset of families we also observe filing tax returns in the high school junior year. In particular, the results show an estimated slope change in after-tax income of roughly 0.35 and a corresponding slope change in enrollment of roughly 0.14. For this sample, the results also show no evidence of a kink in junior year income based on senior year earned income relative to the kink point.[23] In the column for the junior year sample, the results show that the slope changes in after-tax income in the junior year are roughly 0.32 at the first EITC kink point, and the slope change in after-tax income in the senior year is an order of magnitude smaller at roughly 0.03. However, in contrast to the enrollment effects from the tax refunds in the senior year, the junior year results show no significant or substantive changes in enrollment around the kink point. Together, the estimates indicate that changes in tax

[22] Similar to the analysis based on tax returns from the high school senior year, we examine evidence on the identifying assumptions for the regression kink analysis in the high school junior year, and we verify (1) that taxpayers do not sort along the tax schedule in the junior year and (2) that there is no kink in covariate predicated enrollment.

[23] This pattern is consistent with the idea that taxpayers do not sort along the EITC benefit schedule. Intuitively, if taxpayers were selecting to be on one side of the kink, we should see persistence in this location decision across the junior and senior years.

refunds in the high school senior year affect college enrollment, but changes in tax refunds in the high school junior year do not.

We next examine the persistence of the enrollment effects from tax refunds received in the spring of the high school senior year by measuring the impact on enrollment two years after the senior year. If the additional income causes new enrollments, then we expect that, similar to the kink in college enrollment rates one year after the high school senior year, there would be a kink in college enrollment rates two years after the high school senior year.

Table 6 presents the presents the RKD estimates using college enrollment two years after the high school senior year as the dependent variable. We estimate these coefficients using the same sample and first stage, reduced form and IV regression specifications as the baseline RKD estimates. Thus, the first stage estimates in Table 6 are identical to those in Table 2. Comparing the reduced form estimates in Tables 2 & 6, we see that the kinks in college enrollment two years after the high school senior year are estimated to be slightly smaller in magnitude, and the standard errors for these estimates are slightly larger. We cannot formally reject the hypothesis that these reduced form estimates are equal, or that the reduced form estimates in Table 6 are statistically different from zero. As a result, the findings in Table 6 are at most suggestive that the tax refunds in the high school senior year result in lasting enrollment effects.[24]

3.6 EITC Phase-Out Evidence: Differences-in-Differences Analysis

In addition to the RKD analysis, we also estimate the effects of cash-on-hand on college enrollment based on a separate identification strategy. In this approach, we exploit policy-induced variation from the expansion of the phase-out portion of the EITC schedule for married filing jointly taxpayers relative to head-of-household taxpayers. To capitalize on the policy changes, we implement a differences-in-differences analysis that compares differential enrollment rates for children from married families to children from non-married families over time.

[24] As a further test, for earlier cohorts we able to measure the impact of tax refunds in the senior year on cumulate enrollment by age 25. Like the results in Table 6, these results suggest that the tax refunds increased the total number of years of college enrollment, though as the estimates are not precise we cannot reject that there is no effect.

We estimate the effects of cash-on-hand by regressing enrollment on EITC benefits, and we instrument for EITC benefits using year dummies interacted with a dummy for married filing jointly filing status. This IV approach exploits the policy expansions that differentially expanded the EITC eligibility range for married-filing joint families, relative to head of household families, over time. The key identifying assumption with this approach is that there are no other factors beyond the EITC expansion that are also differentially changing across families during this time period. The first stage regression equation is

$$refund_i = \sum_{t=2002}^{2011} \gamma_t [1(year_t = t) * 1(filstat_i = MFJ)] + \delta^{refund} X_i + u_i$$

where $refund_i$ captures tax refunds received by high school senior *i*'s household in the spring of the high school senior year, $filstat_i$ captures the household's filing status, and X_i captures covariates. The covariates include dummies for filing status, year, number of kids, $1000 AGI bins, and $1000 bins for differences in wage income and AGI. The second stage equation is

$$enroll_i = \beta refund_i + \delta X_i + \varepsilon_i$$

where, as in the RKD analysis, $enroll_i$ is an indicator variable equal to 1 if individual i enrolls in college (has a 1098-T) in the calendar year after high school senior year. The reduced form equation is then identical to the first stage equation except that $refund_i$ is replaced with $enroll_i$. We cluster the standard errors based on year, filing status, and $1000 AGI bins.

Table 7 presents the results from the EITC DD analysis. The baseline estimates are in Columns (1)-(3). The first stage results in Column (1) confirm the increase in tax refunds for married filing jointly taxpayers relative to head-of-household taxpayers. Tax refunds are expressed in $1000s of dollars, so the estimated coefficients can be re-scaled by $1000 to gauge the magnitudes of the average increases in refund differences across the years. For example, the 2003*joint coefficient in Column (1) is 0.098, which suggests that the differential effect on tax refunds for joint, relative to non-joint, families in 2003, relative to 2001, was nearly $100 as a result of the policy expansion. The IV estimate for the effect of EITC benefits (cash-on-hand) on college enrollment is roughly 0.62. This

The estimates in columns (6)-(8) and (11)-(13) of Table 7 demonstrate these estimates are robust to including a variety of additional income, year and demographic controls.

Similar to the RKD analysis, we also examine persistence in the context of the DD analysis. The reduced form and IV estimates based on using enrollment two years after the high school senior year as the dependent variable are presented in Columns (4) and (5) of Table 7 respectively. Consistent with the RKD estimates, these estimates suggest that additional tax refunds received in the spring of the high school senior year cause primarily new enrollments.

3.7 Comparing the RKD and DD Approaches & Estimates

Overall, the DD estimates are slightly larger than the RKD estimates. For both the RKD and DD, the estimates are significantly and meaningfully different than zero. Yet, the standard errors of the RKD and the DD estimates are sufficiently large so that we cannot reject that these estimates are equal. Likewise, we cannot reject that these estimates are equal to the cross-sectional estimates of the enrollment-income gradient. Despite this pattern, we discuss several reasons why the DD estimates could differ from the RKD estimates below.

One potential reason the DD estimates could differ from the RKD estimates is that these two estimates are drawn from samples at different points of the income distribution. As shown in Table 1, mean after tax income for the DD sample is just over $38,000, more than double the mean of about $15,000 for the RKD sample near the EITC kink point. It is likely that the income sensitivity of college enrollment differs across the income distribution, perhaps in a non-monotonic way. The income difference across our two samples may be large enough so that this difference in income sensitivity is reflected in our estimates.

Another potential reason that the DD estimates may differ from the RKD estimates is because of differences in the sources of identifying variation. In the RKD setting, we exploit quasi-random variation in *transitory income*. In this setting, our identification rests on the assumption that taxpayers find themselves on one side or the other of the tax kink in a random manner. In contrast, for the DD estimates, we exploit policy-induced variation that differentially impacts married filing joint families starting in 2002. Unlike the RKD setting, families impacted by the policy change could experience a change in *permanent income* (so long as they remain eligible for the EITC). It is possible that higher after-tax income over several years has a larger enrollment effect than the higher after-tax income in only one year.

Price effects are another reason that the DD estimates could exceed the RKD estimates. Full-time students between ages 19 and 24 remain qualifying children for the EITC. To the extent that taxpayers know this feature of the EITC program, there is a relatively larger incentive for children of married filing jointly taxpayers to enroll in college than for children of head-of-household taxpayers. This price effect should not be an issue in the RKD analysis to the extent that families do not sort across the kink point. Intuitively, if families are not selecting their location in the subsequent year, then there is no change in anticipated benefits in the following across the tax kink point in the senior year.

4. Discussion

There are multiple reasons why tax refunds in the spring of the high school senior year may have a meaningful effect on college enrollment. First, tax refunds for many families in the analysis samples are large enough to have a substantive effect on college enrollment, and they arrive in a lump sum at a time when many youths make their enrollment decisions. Based on data from the National Postsecondary Student Aid Study (NPSAS), Table 8 shows the distribution of annual college tuition and fees net of grant aid by institution type and year. Based on this distribution of costs and the summary statistics on tax refunds in Table 1, tax refunds could cover a significant portion of overall college costs or out-of-pocket college costs, particularly at 2-year and 4-year public colleges where students may not have room-and-board costs if they are living at home.

Another reason that tax refunds in the spring of the high school senior year could be economically significant is because of credit constraints or informational constraints.[25] Even though financial aid may be widely available, we present evidence of information asymmetry and incomplete take-up of financial aid which suggests that existing programs

[25] For evidence on credit and information constraints in education tax credits, financial aid and college enrollment, see Bettinger, Long, Oreopoulos and Sanbonmatsu (2012), Hoxby and Avery (2012), Turner (2012), Hoxby and Turner (2013), Dynarski and Scott Clayton (2013) Dynarski, Scott-Clayton and Wiederspan (2013) and U.S. GAO (2013).

may not effectively alleviate credit and information constraints for all students. Table 9 presents percentages of enrolled students who do not apply for federal student aid (e.g. Pell grants) using NPSAS data. The evidence highlights that, at the lowest income levels (i.e. below $40000 of income), roughly 50% to 70% of enrolled students applied for aid. Below $40000, virtually all of the enrolled students are likely to be eligible for aid. Yet as shown in Table 10, about 60% of low income students who do not apply for aid believed they were not eligible. This percentage does not vary much by income levels even though eligibility for income levels above $50000 decreases sharply with income.

In contrast to traditional financial aid, tax refunds in the spring of the high school senior year are independent of any other financial aid. Furthermore, in our analysis samples, take-up of tax refunds is complete by construction. As a result, the tax refunds that we study may effectively alleviate credit constrains for families with high school seniors, allowing youths from these families to attend college.

5. Conclusions

We examine the impacts of cash-on-hand in the high school senior year on college enrollment. Using administrative population-level United States tax data and multiple identification strategies, we find evidence of meaningful effects of tax refunds in the spring of the high school senior year on college enrollment. Regression results indicate that an additional $1000 of after-tax income in the spring of the high school senior year increases college enrollment by roughly 0.50 percentage points.

Consistent with the interpretation that tax refunds in the high school senior year relax credit constraints, we find evidence that tax refunds received in the junior year have a relatively smaller effect on college enrollment. Additionally, the results indicate that permanent increases in tax refunds may have larger impacts on enrollment than transitory increase in tax refunds in a single year. While many tax benefits and financial aid programs offer aid with complicated forms or aid that arrives after individuals have financed their college costs, our findings are based on income that arrives prior to incurring any enrollment costs when many youths are finalizing their enrollment plans. Providing additional family resources for college through the tax code ensures that take-up is complete among tax filers, which may increase the effectiveness of the transfers. In the context of student aid, it is likely that most marginal youths are from tax filing families,[26] so that targeted tax benefits can relax binding credit constraints. Studying the impact of tax refunds on higher education outcomes remains an interesting avenue for future work. In related current work we exploit a randomized experiment to test if increasing awareness and take-up of tax benefits for higher education increases college enrollment.

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[26] Chetty et al. (2014) show since the mid-1980s roughly 97% of a given birth cohort appears in the tax data during their teenage years.

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Table 1: Summary Statistics

	EITC Kink 1 Sample		EITC Diff-in-Diff Sample	
N	1,427,447		2,575,763	
	Mean	SD	Mean	SD
Enroll (1 year after HS)	20.47	40.35	31.29	46.37
Enroll (2 Years after HS)	25.02	43.31	35.98	47.99
Married Filing Jointly	0.18	0.39	0.37	0.48
Head of Household	0.82	0.39	0.63	0.48
Child Dependents	1.69	0.88	1.89	0.59
After-Tax Income	15,675.05	14,312.42	38,932.71	4,378.32
Taxes	-4,647.98	1,681.53	-3,698.00	1,990.86
Pre-Tax Income	11,027.07	13,936.86	35,234.71	3,981.64
Has Refund	1.00	0.01	0.99	0.12

Notes: Dollar values are CPI adjusted to 2011 dollars. The EITC Kink 1 Sample is based on [K1 - $6000, K1 + $3000], and the EITC Diff-in-Diff Sample is based on [min K3 - $5000, max K3].

Table 2: RKD Estimates

	Full Sample		1 Child		2+ Children	
	First Stage	Reduced Form	First Stage	Reduced Form	First Stage	Reduced Form
	Refund	Enrollment	Refund	Enrollment	Refund	Enrollment
Slope Change	-0.343	-0.147	-0.337	-0.152	-0.333	-0.153
	(0.002)	(0.060)	(0.001)	(0.107)	(0.001)	(0.060)
Effect of $1000 on Enrollment (IV)	0.430		0.450		0.493	
	(0.175)		(0.317)		(0.230)	
N	1,427,447		465,745		961,702	

Notes: Each coefficient is estimated from a separate regression. Each regression includes dummy variables for senior year, number of children and filing status. Standard errors are clustered based on $100 bins of earnings relative to the kink point.

Table 3: Accounting for Nonlinearity in Income

	Base Controls	Linear Control	Income Polynomial	Senior & Junior Polynomial	Senior & Junior Spline
Slope Change in Enrollment	-0.147	-0.145	-0.137	-0.159	-0.151
	(0.060)	(0.060)	(0.060)	(0.068)	(0.069)
Effect of $1000 on Enrollment (IV)	0.430	0.415	0.392	0.452	0.429
	(0.175)	(0.171)	(0.169)	(0.193)	(0.195)
N	1,427,447	1,427,447	1,427,447	1,235,355	1,235,355

Notes: Each coefficient is estimated from a separate regression. The bandwidth is [-$6000, +$3000]. Each regression includes dummy variables for the senior year, number of children and married filing jointly filing status; income controls are specified in the column headings. Standard errors are clustered based on $100 bins of earnings relative to the kink point. The "Linear Control" and "Income Polynomial" refer to controls based on income in the senior year.

Table 4: Kink Point Switch Placebo Tests

	1 Child Actual	1 Child Placebo	2 Child Actual	2 Child Placebo	Pooled Actual	Pooled Placebo
Slope Change in Refund	-0.332	0.015	-0.320	0.005	-0.328	0.040
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Slope Change in Enrollment	-0.364	-0.040	-0.562	0.303	-0.494	0.120
	(0.194)	(0.234)	(0.154)	(0.229)	(0.106)	(0.185)
N	284,604	329,606	525,623	268,608	810,227	598,214

Notes: Each coefficient is estimated from separate regressions. The bandwidth is +/-$2,500. Each regression includes dummy variables for the senior year, number of children and married filing jointly filing status, as well as a linear control in senior year income. Standard errors are clustered based on $100 bins of earnings relative to the kink point. For the 2+ Child samples, senior years after 2007 are omitted because of interactions with the CTC for the placebo kink points.

Table 5: Senior Year vs. Junior Year

	Senior Year Sample	Junior Year Sample
Slope Change in Senior Year Refund	-0.345	-0.027
	(0.002)	(0.005)
Slope Change in Junior Year Refund	0.001	-0.322
	(0.004)	(0.002)
Slope Change in Enrollment	-0.144	-0.007
	(0.069)	(0.078)
N	1,235,355	1,197,827

Notes: Each estimate is from a separate regression with the dependent variable listed in the row heading and the sample listed in the column heading. Standard errors are clustered based on $100 bins of earnings relative to the kink point.

Table 6: Enrollment 2 Years After High School

	Full Sample		1 Child		2+ Children	
	First Stage Refund	Reduced Form Enrollment	First Stage Refund	Reduced Form Enrollment	First Stage Refund	Reduced Form Enrollment
Slope Change	-0.343	-0.096	-0.337	-0.133	-0.335	-0.097
	(0.002)	(0.072)	(0.001)	(0.107)	(0.001)	(0.094)
Effect of $1000 on Enrollment (IV)	0.282		0.395		0.289	
	(0.209)		(0.316)		(0.278)	
N	1,427,447		465,745		961,702	

Notes: Each coefficient is estimated from a separate regression. Each regression includes dummy variables for senior year, number of children and filing status. Standard errors are clustered based on $100 bins of earnings relative to the kink point.

Table 7: EITC Diff-in-Diff Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	First Stage	Reduced Form	IV	Reduced Form	IV	First Stage	Reduced Form	IV	Reduced Form	IV	First Stage	Reduced Form	IV	Reduced Form	IV
Dependent Variable:	Refund	Enroll	Enroll	Enroll2	Enroll2	Refund	Enroll	Enroll	Enroll2	Enroll2	Refund	Enroll	Enroll	Enroll2	Enroll2
Effect of $1000 Increase in			0.619		0.716			0.541		0.587			0.713		0.895
EITC Benefits on Enrollment			(0.262)		(0.262)			(0.248)		(0.251)			(0.239)		(0.247)
(Senior year = 2003)*Joint	0.0977	-0.537		0.402		0.107	-0.541		0.358		0.110	-0.475		0.382	
	(0.0336)	(0.448)		(0.483)		(0.0197)	(0.453)		(0.490)		(0.0166)	(0.354)		(0.443)	
(Senior year = 2004)*Joint	0.171	-0.343		0.666		0.171	-0.226		0.751		0.174	-0.351		0.780	
	(0.0266)	(0.462)		(0.447)		(0.0190)	(0.454)		(0.428)		(0.0168)	(0.347)		(0.356)	
(Senior year = 2005)*Joint	0.243	0.516		1.712		0.205	0.616		1.748		0.211	0.532		1.668	
	(0.0388)	(0.422)		(0.448)		(0.0202)	(0.420)		(0.451)		(0.0187)	(0.347)		(0.396)	
(Senior year = 2006)*Joint	0.442	0.750		2.050		0.409	0.832		2.084		0.401	0.843		2.230	
	(0.0375)	(0.481)		(0.492)		(0.0229)	(0.472)		(0.482)		(0.0215)	(0.391)		(0.450)	
(Senior year = 2007)*Joint	0.434	0.909		1.705		0.406	1.004		1.735		0.401	0.971		1.776	
	(0.0336)	(0.445)		(0.432)		(0.0226)	(0.429)		(0.421)		(0.0228)	(0.340)		(0.350)	
(Senior year = 2008)*Joint	0.456	0.492		0.825		0.428	0.571		0.796		0.429	0.557		0.847	
	(0.0324)	(0.467)		(0.461)		(0.0229)	(0.468)		(0.467)		(0.0232)	(0.386)		(0.423)	
(Senior year = 2009)*Joint	0.689	-0.126		0.769		0.664	-0.123		0.706		0.662	-0.0476		1.053	
	(0.0303)	(0.437)		(0.432)		(0.0235)	(0.443)		(0.437)		(0.0247)	(0.327)		(0.372)	
(Senior year = 2010)*Joint	1.202	1.027		1.954		1.185	1.028		1.850		1.195	1.079		2.097	
	(0.0349)	(0.442)		(0.424)		(0.0290)	(0.432)		(0.409)		(0.0297)	(0.375)		(0.383)	
(Senior year = 2011)*Joint	1.143	0.257		1.207		1.125	0.306		1.154		1.157	0.526		1.471	
	(0.0356)	(0.436)		(0.425)		(0.0293)	(0.429)		(0.422)		(0.0278)	(0.348)		(0.402)	
(Senior year = 2012)*Joint	0.797	0.593		1.063		0.801	0.503		1.065		0.811	0.709		1.425	
	(0.0352)	(0.454)		(0.421)		(0.0251)	(0.450)		(0.423)		(0.0243)	(0.409)		(0.404)	
Includes dummies for:	Filing Status					Filing Status					Filing Status * AGI bins				
	Number of Kids					Number of Kids * Senior Year					Number of Kids * Senior Year				
	Senior Year														
	$1000 AGI bins					$1000 AGI bins					$1000 AGI bins * Senior Year				
	$1000 |Wage -AGI| bins					$1000 |Wage -AGI| bins					$1000 |Wage -AGI| bins * Senior Year				

Notes: For all regressions, the sample size is 2,575,763 observations. Standard errors, reported in parentheses, are clustered on senior year, filing status, number of children and $1000 AGI bin groups. For the IV estimates, EITC benefits are instrumented for using dummies for filing status interacted with senior year. "Enroll" denotes and indicator for enrollment in the calendar year one after the calendar year of start of the high school senior year, and "enroll2" denotes an indicator for enrollment in the calendar year that is two years after the calendar year of the start of the high school senior year.

Table 8: Tuition and Fees minus All Grants, 2000-2012

Type of Institution	Year	$0	$1 - 500	$501 - 1,500	$1,501 - 3,000	$3,001 - 5,000	$5,001 or more
Public 4-year	1999-00	24.4	4.5	8.6	22.8	25.3	14.4
	2003-04	26.0	3.6	6.3	13.6	24.5	26.0
	2007-08	28.3	2.8	5.5	7.6	16.0	39.8
	2011-12	30.5	2.5	4.8	7.0	9.1	46.1
Private not-for-profit 4-year	1999-00	12.0	2.1	3.8	7.2	10.9	64.0
	2003-04	9.8	1.6	3.7	5.9	8.2	70.9
	2007-08	9.9	1.6	2.0	3.1	6.0	77.3
	2011-12	14.5	1.0	2.4	2.6	6.0	73.4
Public 2-year	1999-00	29.9	16.8	25.3	22.8	3.5	1.746 !
	2003-04	31.4	8.6	22.5	25.8	9.2	2.5
	2007-08	36.1	5.5	18.2	24.8	13.6	1.8
	2011-12	48.7	4.9	11.9	15.3	15.4	3.7
Private for-profit	1999-00	3.977 !	3.950 !	2.819 !	10.6	14.1	64.5
	2003-04	5.3	0.635 !!	2.932 !	3.6	13.1	74.4
	2007-08	3.402 !	1.646 !	2.8	4.5	7.7	79.9
	2011-12	2.4	0.403 !!	1.3	2.630 !	3.4	89.8

Notes: The above table is created using NPSAS data and the PowerStats tool by NCES. The NPSAS data sample size was 95,000 for 2011-12; 113,500 for 2007-08; 79,900 for 2003-04; and 50,000 for 1999-2000. The subsample used in this table includes individuals between ages 18-20, who are full-time/full-year students. The rows show different type of institutions and the columns show different cost intervals for tuition minus all grants.

! Interpret data with caution. Estimate is unstable because the standard error represents more than 30 percent of the estimate.

!! Interpret data with caution. Estimate is unstable because the standard error represents more than 50 percent of the estimate.

Source: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study (NPSAS). PowerStats Tool available at http://nces.ed.gov/datalab/powerstats/default.aspx

Table 9: Applications for Federal Aid by Income

Percentage of enrolled students who applied for federal aid			
Total Income	**2000**	**2004**	**2008**
All Income Groups	**49**	**58**	**58**
0 to 10,000	72	71	73
10,001 to 20,000	66	73	74
20,001 to 30,000	53	71	70
30,001 to 40,000	44	60	62
40,001 to 50,000	40	56	58
50,001 to75,000	41	48	49
75,001 to 100,000	36	46	49
100,001 to 125,000	35	41	43
125,001 to 150,000	32	38	40
Greater than 150,001	30	38	42

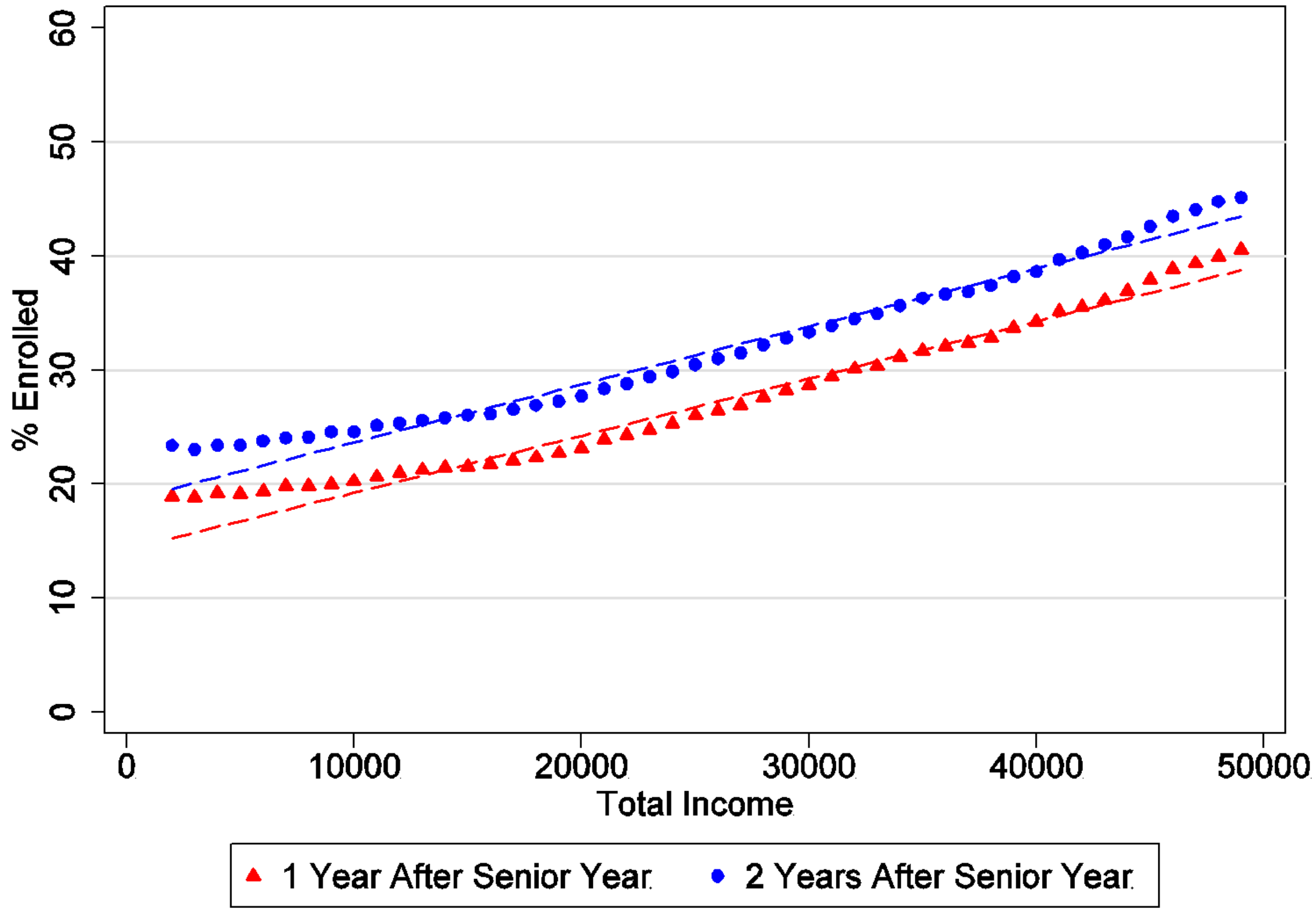
Notes: Data is from U.S. Department of Education, National Center for Education Statistics, 1999-2000, 2003-04, 2007-2008 National Postsecondary Student Aid Study.

Table 10: Non-Application by Income

	Reason for not applying for federal student aid				
Total Income	**Did not want to take on debt**	**Forms were too much work**	**No information on how to apply**	**No Need**	**Thought Ineligible**
All Income Groups	**40**	**19**	**23**	**51**	**61**
0 to 10,000	41	22	28	41	58
10,001 to 20,000	42	21	29	46	59
20,001 to 30,000	45	19	27	37	62
30,001 to 40,000	43	21	24	41	60
40,001 to 50,000	43	21	28	41	60
50,001 to75,000	42	20	24	48	62
75,001 to 100,000	39	18	23	55	61
100,001 to 125,000	37	17	16	64	60
125,001 to 150,000	35	12	12	68	63
Greater than 150,001	33	15	15	70	63

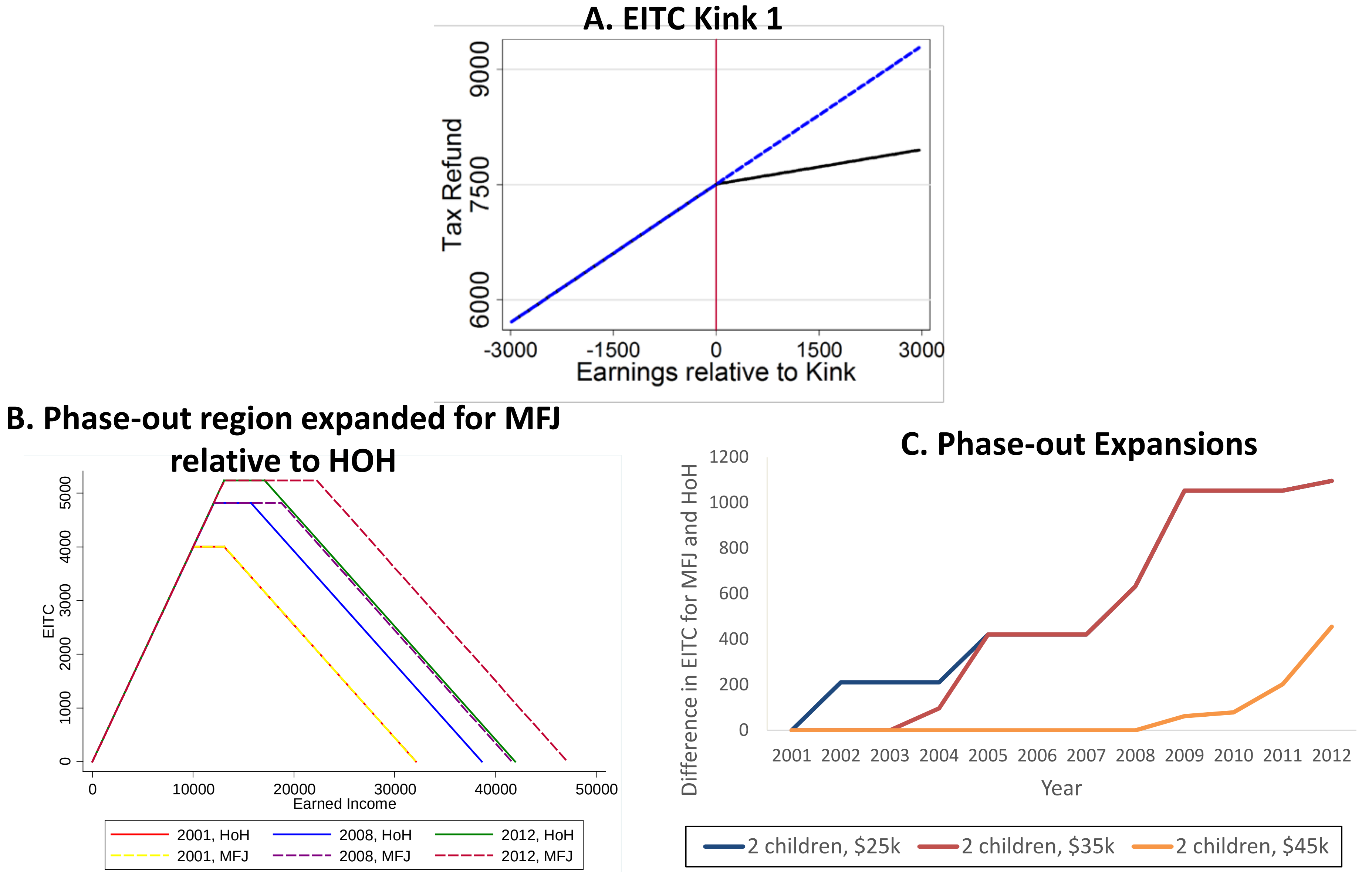
Source: Data is from U.S. Department of Education, National Center for Education Statistics, 2007-2008 National Postsecondary Student Aid Study.

Figure 1. Income & College Enrollment



Notes: This figure plots college enrollment against total income. College enrollment is measured in the year after the high school senior year and two years after the high school senior year. Total income is measured in the calendar year of the start of the high school senior year. Total income is CPI-adjusted to 2011 dollars. Total income is measured as the sum of all income reported on the tax return (line 22 on Form 1040).

Figure 2. Institutional Background

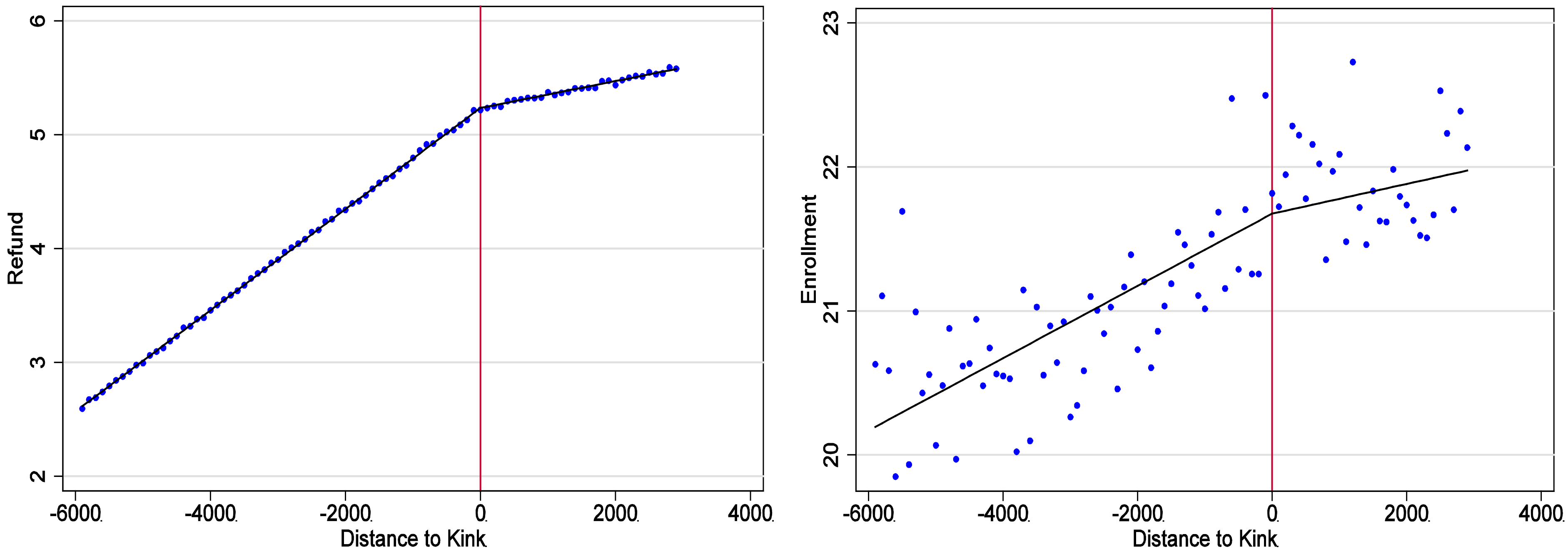


Notes: Panel A plots simulated federal tax refunds for a married filing jointly taxpayer with two qualifying children and dependents in tax year 2009. W2 earnings vary in $100 increments across earnings relative to the kink points. Simulated federal taxes are computed using the NBER TAXSIM tax calculator. Panel B shows EITC expansion from 2001- 2012 for individuals with two children. The solid lines represent the EITC schedules for household filing (HoH) and dashed lines represent the EITC schedules for married taxpayers jointly filing (MFJ). Panel C shows the difference between the EITC benefits for MFJ and HoH for the years 2001-2012. Each series varies the levels of earnings for families with 2 children.

Figure 3. Regression Kink Estimates

A. Change in Tax Refund

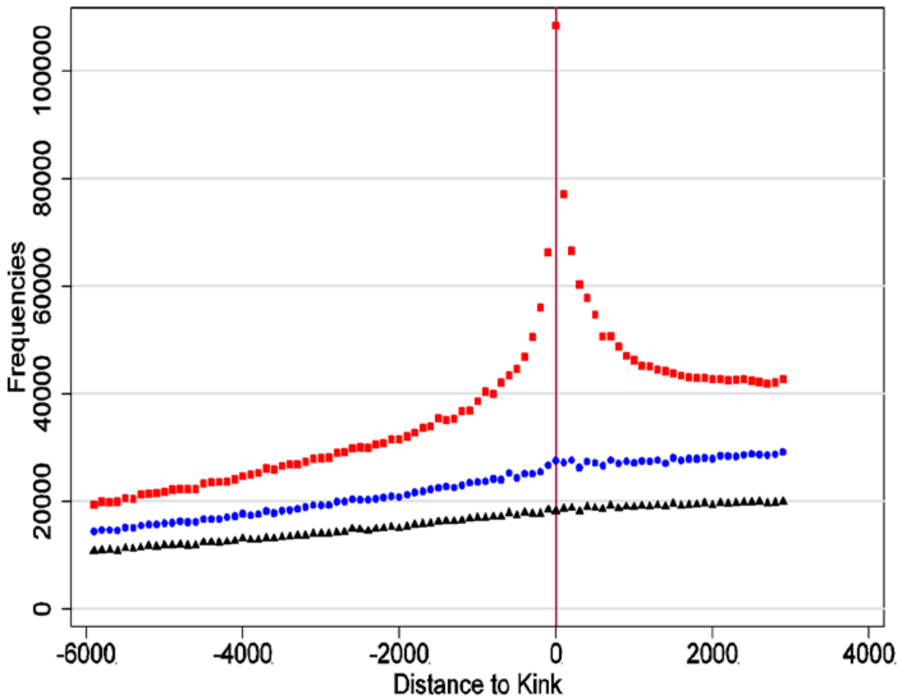
B. Change in Enrollment



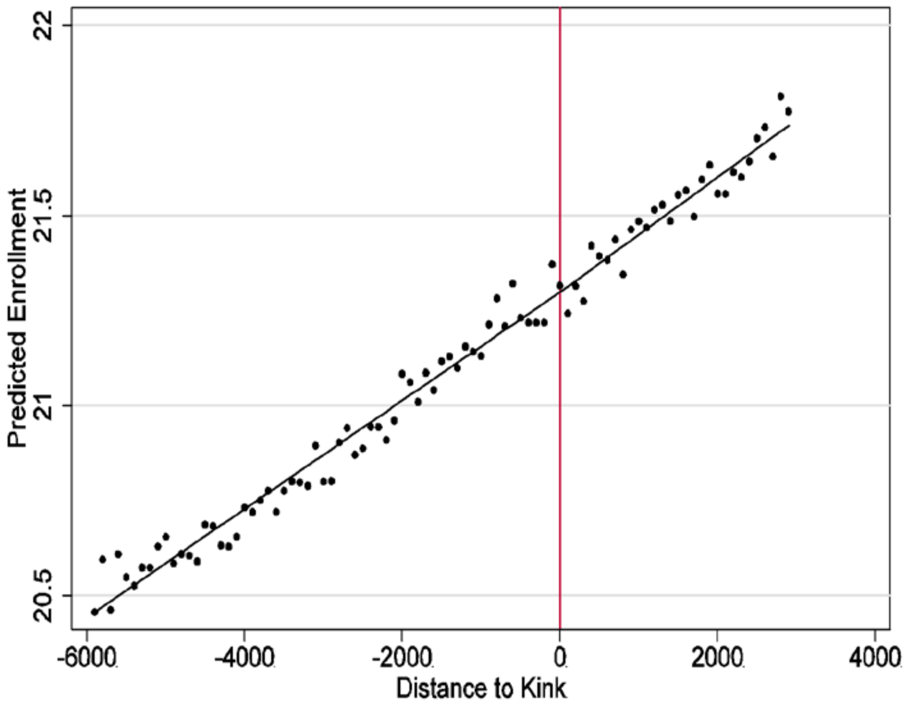
Notes: For each figure, the circles show mean tax refund and enrollment rate within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values within each $100 bin of earnings relative to the kink points. Fitted values are obtained from regressions using the individual-level data in which tax refund or an enrollment indicator is regressed on a linear control for earnings relative to the kink point, a dummy for earnings less than the kink point and an interaction between the dummy variable and the linear control. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Figure 4. Evidence on Identifying Assumptions

A. Frequencies



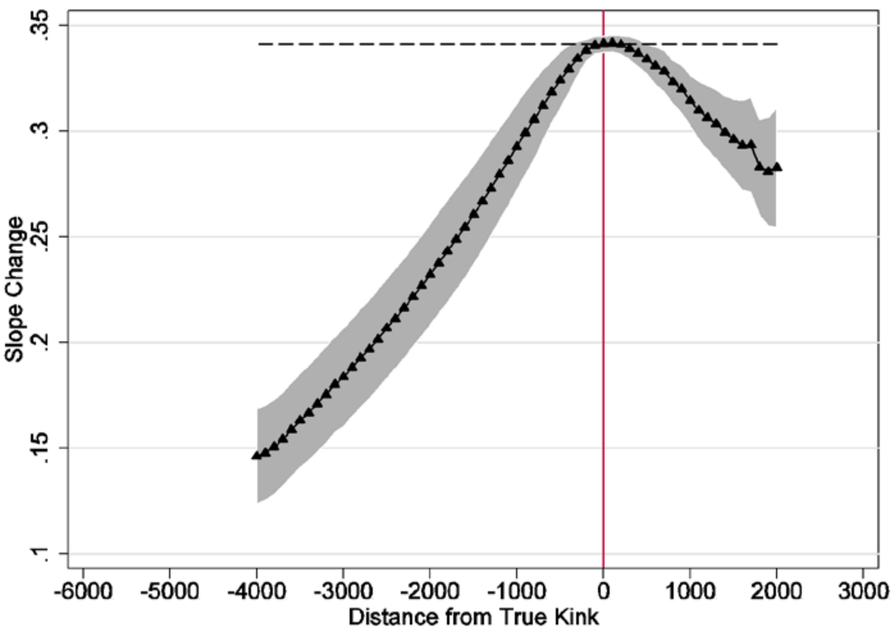
B. Predicted Enrollment



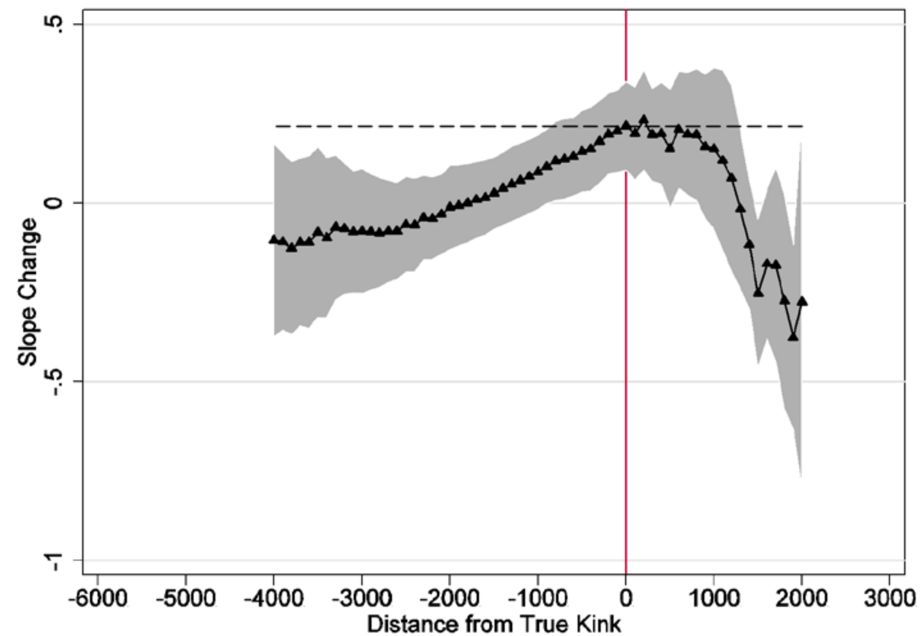
Notes: Panel A plots the number of tax returns within $100 bins around each tax kink point. The red squares are frequencies including the self-employed; the blue triangles are frequencies when excluding the self-employed and the black circles are frequencies when excluding individuals with a difference between W2 wages and wages reported on the 1040 form of more than $1000. This difference is attributable to non-third party verified wages. For Panel B, the circles show mean predicted enrollment rates within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values of predicted enrollment rates within each $100 bin of earnings relative to the kink points. For each individual, predicted enrollment is computed by regressing an enrollment indicator on dummies for calendar year, filing status, and number of dependents and linear controls for senior and junior-year income. Fitted values are obtained from regressions using individual-level data in which predicted enrollment is regressed on a linear control for earnings relative to the kink point, a dummy for earnings less than the kink point and an interaction between the dummy variable and the linear control.

Figure 5. Placebo Analysis

A. Change in Tax Refund



B. Change in Enrollment

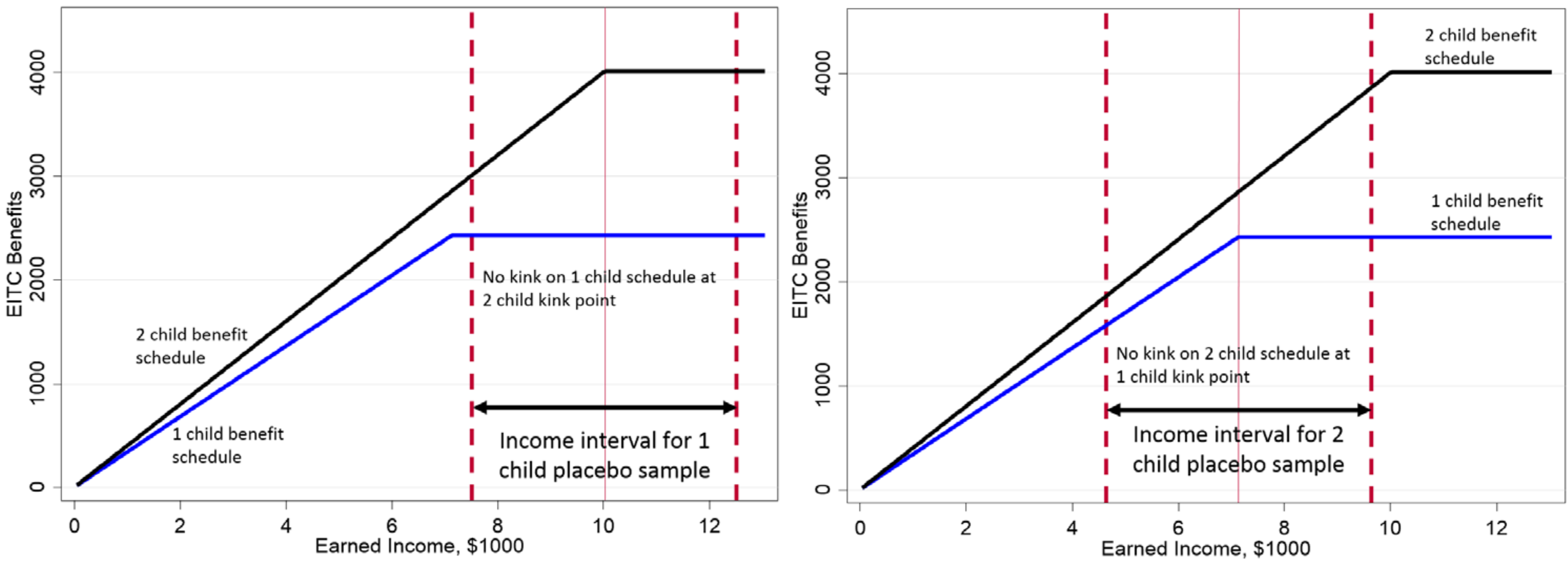


Notes: Figure 5 represents the estimated slope changes when varying the placebo kink points in $100 increments around the true EITC kink points. In particular, placebo kink = kink1+p, where p ϵ {-4000, - 3900, …, +2000}. For each figure, the triangles show the slope change in tax refund and enrollment rate relative to the placebo kink points. The dotted lines show the estimated slope change at the true kink point. Fitted slope changes are obtained from regressions using the individual-level data in which tax refund or an enrollment indicator is regressed on a linear control for earnings relative to the placebo kink points, a dummy for earnings less than the kink point and an interaction between the dummy variable and the linear control. Each figure also shows the 95% confidence interval bands around the estimates. Panel A shows the placebo results for the first stage and panel B shows the placebo results for the reduced form estimation.

Figure 6. EITC Kink 1 Placebo Tests

A. Placebo test for Taxpayers with 1 Qualifying Child, Draw sample of 1 child EITC returns around 2 child kink point

B. Placebo test for Taxpayers with 2+ Qualifying Children, Draw sample of 2+ children EITC returns around 1 child kink point



Notes: This figure plots simulated EITC benefit schedules for taxpayers with 1 and 2 qualifying children.

Appendix for Online Publication

Appendix Table 1: Income & College Enrollment

	Full Sample	Married Filing Jointly			Head of Household		
		1 Child	2 Children	3+ Children	1 Child	2 Children	3+ Children
Slope of College Enrollment with respect to Total Income	0.501	0.383	0.407	0.323	0.628	0.625	0.451
	(0.0139)	(0.0155)	(0.0226)	(0.0264)	(0.0153)	(0.0160)	(0.0166)
N	10,968,344	852,738	1,234,216	1,277,890	2,922,751	3,223,395	1,457,354

Notes: The slope coefficient are estimated by regressing an indicator for college enrollment in the year after the high school senior year on CPI-adjusted total income in the senior year. Each estimate reports the estimated coefficient from a separate regression. Standard errors are reported in parentheses. Standard errors are clustered based on $1000 bins of CPI-adjusted total income. Total income is the sum of all income reported on the tax return (line 22 on Form 1040). The full sample consists of all high school seniors with CPI-adjusted total income between $1000 and $50,000 (2011 dollars).

Appendix Table 2: Tax Kink Points

	EITC Kink 1		Child Tax Credit		
Tax Year	1 Child	2+ Children	kink	Rate	max
2001	$7,140	$10,020	$10,000	10	$600
2002	$7,370	$10,350	$10,350	10	$600
2003	$7,490	$10,510	$10,500	10	$1,000
2004	$7,660	$10,750	$10,750	15	$1,000
2005	$7,830	$11,000	$11,000	15	$1,000
2006	$8,080	$11,340	$11,300	15	$1,000
2007	$8,390	$11,790	$11,750	15	$1,000
2008	$8,580	$12,060	$8,500	15	$1,000
2009	$8,950	$12,570	$3,000	15	$1,000
2010	$8,970	$12,590	$3,000	15	$1,000
2011	$9,100	$12,780	$3,000	15	$1,000

Notes: All dollar values are in nominal dollars.

Appendix Table 3: EITC Phase-Out Expansion

Panel A: 1 Child

	Head of Household		Married Filing Jointly		Kink Point Difference: MFJ - HOH
	Kink 2	Kink 3	Kink 2	Kink 3	
Year	Beginning of Phase-Out	Ending of Phase-Out	Beginning of Phase-Out	Ending of Phase-Out	
2001	13,090	28,281	13,090	28,281	0
2002	13,520	29,201	14,520	30,201	1,000
2003	13,730	29,666	14,730	30,666	1,000
2004	14,040	30,338	15,040	31,338	1,000
2005	14,370	31,030	16,370	33,030	2,000
2006	14,810	32,001	16,810	34,001	2,000
2007	15,390	33,241	17,390	35,241	2,000
2008	15,740	33,995	18,740	36,995	3,000
2009	16,420	35,463	21,420	40,463	5,000
2010	16,450	35,535	21,460	40,545	5,010
2011	16,690	36,052	21,770	41,132	5,080

Panel B: 2 Children

	Head of Household		Married Filing Jointly		Kink Point Difference: MFJ - HOH
	Kink 2	Kink 3	Kink 2	Kink 3	
Year	Beginning of Phase-Out	Ending of Phase-Out	Beginning of Phase-Out	Ending of Phase-Out	
2001	13,090	32,121	13,090	32,121	0
2002	13,520	33,178	14,520	34,178	1,000
2003	13,730	33,692	14,730	34,692	1,000
2004	14,040	34,458	15,040	35,458	1,000
2005	14,370	35,263	16,370	37,263	2,000
2006	14,810	36,348	16,810	38,348	2,000
2007	15,390	37,783	17,390	39,783	2,000
2008	15,740	38,646	18,740	41,646	3,000
2009	16,420	40,295	21,420	45,295	5,000
2010	16,450	40,363	21,460	45,373	5,010
2011	16,690	40,964	21,770	46,044	5,080

Panel C: ≥ 3 Children

	Head of Household		Married Filing Jointly		Kink Point Difference: MFJ - HOH
	Kink 2	Kink 3	Kink 2	Kink 3	
Year	Beginning of Phase-Out	Ending of Phase-Out	Beginning of Phase-Out	Ending of Phase-Out	
2001	13,090	32,121	13,090	32,121	0
2002	13,520	33,178	14,520	34,178	1,000
2003	13,730	33,692	14,730	34,692	1,000
2004	14,040	34,458	15,040	35,458	1,000
2005	14,370	35,263	16,370	37,263	2,000
2006	14,810	36,348	16,810	38,348	2,000
2007	15,390	37,783	17,390	39,783	2,000
2008	15,740	38,646	18,740	41,646	3,000
2009	16,420	43,279	21,420	48,279	5,000
2010	16,450	43,352	21,460	48,362	5,010
2011	16,690	43,998	21,770	49,078	5,080

Notes: Technical documentation on EITC program eligiblity and benefit rules are available in IRS Publication 596. Nominal dollar values are listed. Historical EITC parameters are available at www.taxpolicycenter.org/. Beginning in 2002, the phase-out points for married filing jointly taxpayers were higher than the phase-out points for head-of-househod filers. Conditional on the number of qualifying children, the differences between the phase-out points for head-of-household and married filing jointly taxpayers is 0 in 2001, \$1000 in 2002-2004, \$2000 in 2005-2007, \$3000 in 2008, \$5000 in 2009, \$5010 in 2010, \$5080 in 2011.

Appendix Table 4: Sample Restrictions

EITC K1 Sample		EITC DD Sample	
Initial Sample Extraction	3,300,836	Initial Sample Extraction	17,320,571
Excluding any students who died, late filers, returns with any self-employment income	2,009,259	Restricting to [min K3 - $5000, max K3]	5,295,011
Excluding returns with differences between taxpayer entered values & computer verified values	1,954,188	Excluding returns with earned income less than K1 (not on phase-out)	3,222,997
Excluding returns with AGI great than EITC Kink 2 (returns on the phase-out)	1,743,738	Excluding returns with self-employment income	2,717,866
Excluding returns with more than $1000 difference between W2 income and Total Earned Income	1,427,447	Excluding returns with more than $10000 difference between AGI and wage income	2,575,763
Final Sample	1,427,447	Final Sample	2,575,763

Notes: The initial sample extraction for the EITC K1 sample consists of all tax returns within a bandwidth of [-$6000, +$3000] around EITC K1. The initial sample extraction for the EITC DD sample consists of all tax returns with AGI in [10000, 65000].