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ABSTRACT

In this paper, we estimate the causal effects of tax refunds (cash-on-hand) on college enrollment using population-level administrative data from United States income tax returns. We exploit plausibly exogenous variation in tax refunds around two kink points in the federal income tax code, including the first kink point in the Earned Income Tax Credit benefit schedule and the 15%-25% tax bracket kink point. Non-parametric graphical evidence suggests that differences in tax refunds across these tax kink points have meaningful effects on enrollment. Using a Regression Kink Design, our results indicate that a $1,000 increase in tax refunds received in the spring of the high school senior year increases college enrollment the next fall by roughly 2 to 3 percentage points. The magnitude of these effects, combined with less-than complete take-up of student aid, may be evidence that tax refunds relax credit constraints.

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1. Introduction

What is the impact of cash-on-hand (disposable income) on college enrollment? Given the well documented private and social returns to higher education (Card, 1999; Goldin and Katz, 2009; Currie and Moretti, 2003; Moretti, 2004; Lochner, 2004, Milligan, Moretti and Oreopoulos, 2004), the answer to this question has important implications for youths and their families, and for society as a whole. It also has important implications for policymakers struggling to maximize the impact of limited student aid resources. However, untangling the independent effect of additional family income on college enrollment is difficult because family resources are likely to be endogenous to college attendance. In this paper, we exploit plausibly exogenous income that arises from policy nonlinearities in the tax code to estimate the impact of after-tax income on college enrollment. We study the effect of tax refunds received in the spring of the high-school senior year on college enrollment in the subsequent year using administrative population-level United States tax data. We use a Regression Kink Design (RKD) to relate the change in slope in tax refunds across these kink points to changes in the slope of the enrollment profile. Our results 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 2 to 3 percentage points. We find evidence that cash-on-hand in the senior year generates lasting effects, with increases in enrollment evident 7-8 years later.

We present evidence consistent with the idea that tax refunds relax credit constraints in several ways. First, we show that there is scope for binding constraints given the less-than complete take-up of traditional student aid and other tax benefits for higher education. By construction the setting in which we analyze has complete take-up of tax refunds. Second, we show that the timing of income has a substantive effect on college enrollment. We find that tax refunds received in the spring of the high-school junior year have a substantively smaller effect on college enrollment. Third, for lower-income families we find evidence that the enrollment response is larger in states that offer tax refunds tied to federal refundable credits. For states that provide state-level Earned Income Tax Credits, our results suggest that there is both a larger enrollment response to tax refunds and a larger change in cash-on hand, compared to states without state-level Earned Income Tax Credits.

The finding that tax-induced income differences affect educational outcomes is consistent with recent work. Dahl and Lochner (2012) present quasi-experimental evidence of the effects of tax benefits on test scores at early ages. They find that additional income in the form of more generous refundable tax credits results in meaningful test score gains. Specifically looking at college enrollment, Turner (2011) and Michelmore (2013) present quasi-experimental evidence that changes in after tax-income increase enrollment. Our findings are similar to the results reported by these two papers and are also comparable to findings from the student aid literature, which finds that an additional $1,000 of student aid increases college enrollment by roughly 2 to 4 percentage points (see Dynarski and Scott-Clayton 2013).

The results from this analysis are also relevant for the well-developed literature on credit constraints and college enrollment decisions.[1] However, an important distinction between our analysis and some earlier papers on credit constraints and college enrollment relates to the connection between student aid and the enrollment decision. In particular, estimates from some earlier studies focus on enrollment-contingent aid. Changes in enrollment-contingent aid reflect both a change in the relative price of college as well as income and liquidity effects. In contrast, our estimates reflect only income or liquidity effects and not price effects since tax refunds are not contingent on college enrollment. While there is a separate literature examining more permanent differences in family income and differences in college enrollment decisions (Acemoglu and Pischke 2001, Bailey and Dynarski 2011, Cameron and Taber 2004, Hilger, 2013; Keane and Wolpin 2001), it is not clear that the changes in permanent income would have the same effect on enrollment as changes in cash-on-hand in the high school senior year. Moreover, while other papers focus on the cross-sectional relationship between permanent income and college enrollment, we emphasize that the RKD estimates from this paper focus specifically on differences in cash-on-hand in the spring of the high school senior year.

[1] 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.

Since RKD (see Card Lee, Pei and Weber 2012) 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 (1) analyzing two distinct kink points, (2) examining how the estimates vary with different bandwidths, (3) splitting the sample in groups with larger and smaller tax changes at the kink points, (4) using alternative control functions that allow for nonlinear controls in the running variables, and (5) a variety of placebo tests. These results suggest that the effects we estimate result from tax kinks rather than from non-linear changes in the enrollment profile. We also show that the key identifying assumptions of RKD hold in this setting. We present evidence that the counts of individuals are smooth through the kink points, which is consistent with the assumption that individuals do not sort along the tax schedule. We also verify that a rich set of observables do not change slopes at the tax kink points. Intuitively, we interpret tax refunds as having a causal effect on college enrollment when all other covariates are smooth through the tax kinks.

This paper is organized as follows. Section 2 describes the tax kink points and data used in the empirical analysis. Section 3 presents the main empirical evidence on kinks in enrollment at the tax kink points. 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. Institutional Background & Data

2.1 Tax Kink Points

We analyze two kink points in the United States federal income tax schedule. The first kink point arises from the Earned Income Tax Credit benefit schedule. This kink is defined by the transition between the phase-in region and the maximum credit region. The second kink point arises from the change in marginal tax rates between the 15% tax bracket and the 25% tax bracket. In this section, we describe the details of these kink points.

The Earned Income Tax Credit (EITC) is a refundable tax credit that provides benefits to low-income working families. EITC amounts are primarily determined based on tax filing status, the number of qualifying children, and earned income. 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 are relatives who are under age 19 or permanently disabled and who resided with the tax filers for at least half of the year.[2] Earned income is primarily earnings from 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.[3]

The first EITC kink point arises between the phase-in and maximum credit portions of the benefit schedule. While the EITC benefit schedule varies across years, filing statuses (single and head of household versus married filing jointly) and number of qualifying children (0, 1, 2 and ≥ 3), within a given year the first kink point varies only by the number of qualifying children. The kink point is located just below $10,000 for taxpayers with one qualifying child and just about $12,000 for taxpayers with two or more qualifying children. Appendix Table 1 lists the specific earnings thresholds for each tax year. 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.

Figure 1A plots tax refunds as a function of earnings relative to the EITC kink points, pooling over all tax returns. The figure illustrates that tax refunds increase at a faster rate for earnings levels below the kink point because 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 on 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 other tax credits, particularly the Child Tax Credit, begin to phase-in at the first EITC kink point. The Child Tax Credit phases in at a

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[2] 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.
[3] IRS Publication 596 provides the official documentation of the rules and eligibility criteria for this credit.

rate of $0.10 per dollar up to $1,000.[4] As a result of these effects, 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 one, two, or three or more qualifying children) to roughly $0.10.

The other tax kink we analyze is occurs at the transition between the 15%-25% marginal tax rate brackets.[5] This kink point is based on taxable income, defined as total income net of adjustments, exemptions and deductions. This is the income measure that defines taxpayers' marginal tax rate brackets. Relative to the first EITC kink point this kink point occurs at a higher point in the income distribution at about $68,000 of taxable income for married filing joint families and at $45,500 for single-parent households. This kink point does not vary based on the number of children in a tax unit.

Figure 1B illustrates tax liability based on earnings relative to the 15%-25% kink point. For taxable income below the kink point, tax liability increases at a rate of $0.15 per dollar. As individuals earn more income, they are taxed at a higher marginal tax rate so that, to the right of the 15%-25% kink point, tax liability increases at a rate of $0.25 per dollar. Thus the slope change at the 15%-25% kink point is $0.10.

Figure 2 illustrates the changes in after-tax income at both the first EITC kink point and the 15%-25% kink point. As illustrated, both kink points lead to decreases in

[4] The Child Tax Credit (CTC) and Additional Child Tax Credit offer taxpayers benefits of up to $1,000 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. For the purposes of the CTC and ACTC, a qualifying child must be younger than age 17 at the end of the tax year. The amount of the CTC is equal to the taxpayer's tax liability up to a maximum of $1,000 per qualifying child. The ACTC is equal to the smallest of either $1,000 per qualifying child and the CTC, or a phase-in rate times earnings beyond a threshold. The maximum amount of the ACTC is $3,000 per tax return, and the phase-in rates and earnings thresholds vary across tax years. For tax years 2001 through 2007, the earnings thresholds were equal to the earnings thresholds for the first kink point in the EITC schedules for taxpayers with one qualifying child. In 2008, the ACTC threshold was reduced to $8,500; in 2009 onward, the earnings threshold has been $3,000. The phase-in rate was 10% for tax years 2001 through 2003, and then 15% for tax years 2004 onwards.

[5] We do not focus on other EITC kink points (specifically the kink points between the maximum credit and phase-out benefit regions and between the phase-out and zero-credit regions) because, for taxpayers with Adjusted Gross Income higher than the earnings threshold for the maximum credit, EITC benefits are based on the minimum of earned income and Adjusted Gross Income. Thus, the running variable that would be used in a regression kink design is poorly defined as it changes at the kink points of interest. We have explored analyzing a restricted sample that has earned income equal to AGI, but this is a highly selected sample as it is unusual to have no adjustments to earned income. Furthermore, when restricting this unusual sample, we find small but statistically significant evidence of bunching at the kink point between the maximum credit and phase-out regions, and this violates the identifying assumptions for a regression kink design. For more details on bunching at the phase-out portion of the EITC schedule, see Manoli and Turner (2014).

the slope of after-tax income as earnings increases from below the kink to above the kink. In Figure 2A, after-tax income increases at a slower rate above the kink because individuals are no longer getting increasing EITC benefits. In Figure 2B, after-tax income increases at a slower rate above the kink because individuals are taxed at a higher marginal tax rate above the kink point.

2.2. Data & Sample Construction

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 that belong to individuals who are 17 or 18 during the years 2001 to 2010. For these observations, we assign high school cohorts based on the month and year of birth. In each year from 2001-2010, 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 total 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.[6] Next, we look for tax returns that claim these individuals as dependents during the 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.[7]

To measure college enrollment, we use the 1098-T tax form.[8] To remain eligible for Title IV federal student aid, schools are required to send a 1098-T form to nearly all

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[6] This approach may misclassify some individuals. As long as this misclassification does not vary across the kink points 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.

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

[8] Nearly all observations that receive a 1098-T tax form receive only a single 1098-T. For individuals who receive more than one 1098-T, we use the form from the school with the largest value of education spending.

students, and to the IRS.[9] To obtain information on the institution of higher learning, we link these data to data from the Integrated Postsecondary Education Data System (IPEDS).[10] Chetty et al. (2011), Chetty, Friedman and Rockoff (2013a,b) and Turner (2013) use the 1098-T to measure college enrollment. Chetty et al. (2011) and Turner (2013) and 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.

To implement our empirical specification, we impose several sample selections. Appendix Table 2 shows the sample sizes after each restriction. First, we restrict our sample to observations that are with $3,000 ($2010) from each tax kink. One advantage of using population level U.S. tax data is the ability to select narrow bandwidths around each tax kink and still retain a large sample size. After imposing this restriction, we have roughly 1.8 million seniors at the EITC kink and 1.1 million at 15%-25% kink. Next, we remove observations that have self-employment income. As discussed in Section 3.3, we find evidence that self-employed individuals sort (or "bunch") along the tax schedule, which violates a key assumption of our empirical approach. For the EITC kink, we also remove returns with high levels of non-W2 wage income.[11] Non-W2 wage income, like self-employment income, is not subject to third party reporting, allowing individuals to sort along the tax schedule. After imposing these sample selections, we retain 870,792 at kink1 and 896,422 at the at 15%-25% kink.

Table 1 shows summary statistics for our analysis sample. College enrollment differs across the two tax kinks, with 19 percent of seniors at the EITC kink enrolling in college compared to 61 percent at the 15%-25% kink. More than 80 percent of families at the EITC kink are single-parent (head of household tax filers), whereas 75 percent of

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[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.

[10] For this merge we use the employer identification number (EIN) of the school. Unfortunately, the EIN is a voluntary field in the IPEDS survey. Roughly 12 percent of schools fail to report a valid EIN in the IPEDS, and some of the provided EINs do not match EINs reported in the tax data. We match just over 90 percent of all 1098-T forms to the IPEDS data. We retain non-matching observations.

[11] There are relatively fewer returns at kink15 with high levels of non-W2 wage income. The results are robust to dropping these returns. More importantly, the inclusion of these returns for kink15 does not violate our identifying assumptions as discussed in Section 3.3.

families are married filing jointly at the 15%-25% kink. By construction, income differs widely across the two kink points. On average, after-tax income is nearly $16,000 at the EITC kink, of which nearly $5,000 comes in the form of a tax refund. At this kink, all observations receive a tax refund. For the 15%-25% kink, after tax income on average is just over $83,000, with families owing roughly $7,300 in taxes. Yet, due to withholdings, 84 percent of families at the 15%-25% kink receive a tax refund.

3. Empirical Analysis 1: Senior Year Income & College Enrollment

3.1 Empirical Strategy: Regression Kink Design

To identify the impact of cash-on-hand on college enrollment we use a fuzzy regression kink design. In our setting, this approach relates the change in slope in the enrollment function to the change in slope of after-tax income at the tax kink. To implement the fuzzy RKD, we first estimate the change in the slope of college enrollment with respect to after-tax income at each tax kink point. By controlling for pre-tax income, variation in after tax income comes from differences in tax liability and tax refunds. Given that nearly all families in our sample receive tax refunds, this approach is similar to estimating the change in slope of the enrollment profile with respect to the tax refund. Next, we relate this change in the slope of the enrollment function to the change in the slope of after-tax income at each tax kink point.

We implement the fuzzy RKD strategy separately at the first EITC kink point and at the 15%-25% kink point. For the analysis of each kink point, we compute income relative to that kink point, denoted by *kinkdist*. For the first EITC kink point, we compute this distance using earned income (*kinkdist* = *earnedinc – kink).* The earned income level that corresponds to the kink point varies across groups based on tax year and number of qualifying children. For the 15%-25% kink point, we define this distance using taxable income (*kinkdist* = *taxableinc – kink).* The taxable income level that corresponds to the kink varies across groups based on tax year and filing status. (The exact income tax rules and income kink points are described in more detail in the institutional background section.) In the empirical analysis, the *kinkdist* 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 (2012) and Nielsen et al (2010), we consider the following constant-effect, additive model to examine the effects of refunds on college enrollment,

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

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. (We also consider later life enrollment measures.) The variables ATI_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 ATI_i variable measures after-tax income and $kinkdist_i$ measures the distance ($2010) relative to the specified kink point. The function *g(.)* is a continuous function. The after-tax income function, $ATI_i=ATI(kinkdist_i)$, 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

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

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

Even though the after-tax income function is deterministic and we observe data on earnings relative to the kink, we use a fuzzy RKD rather than a sharp RKD. The fuzzy approach allows us to empirically estimate the change in slope of after-tax income, and show that it matches the statutory slope change. By empirically estimating the change in the slope of tax refunds, we can help rule out the possibility that other variables affect after-tax income. 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.

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

$$enroll_i = \alpha kinkdist_i + \delta^{enroll} D_i * kinkdist_i + \alpha_2 X_i + u_i$$
$$ATI_i = \gamma kinkdist_i + \delta^{ATI} D_i * kinkdist_i + \gamma_2 X_i + v_i.$$

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

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

The vector of covariates includes dummies for year, state, filing status, number of kids, gender (of high-school student), and age (of high school student). Additionally, we include pre-tax income, denoted by PTI_i in the covariates. Pre-tax income is taken from the tax return data as earnings before taxes so that ATI and PTI differ only by the income tax amount: $ATI = PTI - tax$. By including PTI in the covariates, we ensure that we isolate the variation in ATI that arises from the tax kink point. 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 +/- $3,000 around the kink point, though we also examine the sensitivity of the estimated slope changes to different bandwidths. 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

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

in which we instrument for the after-tax income using the interaction $D_i * kinkdist_i$.

3.2. Enrollment Results

Figure 3 presents the main graphical evidence for the effects of changes in senior year after-tax income on college enrollment. For each kink, we construct these plots by computing average enrollment rates within $100 bins of income relative to the respective kink points. We generate the fitted values by using the individual-level data, 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 shows a kink in enrollment at the first EITC kink point and Figure 3B shows a kink point at the 15%-25% kink point.

Table 2 presents the quantitative results corresponding to this graphical evidence. For the first EITC kink pint, the estimated slope change in enrollment is 0.65 and the first stage change in the slope of after-tax income is 0.33. Using the IV specification to estimate the ratio of these two coefficients, the RKD estimates indicate that a $1,000 increase in after-tax income (tax refunds) causes roughly a 2 percentage point increase in college enrollment. To put this magnitude in context, the baseline college enrollment rate for this sample is 19 percent, the average tax refund is roughly $4,500, and average after-tax income is roughly $16,000. Also, as we discuss in further detail below, Table 9 shows that the average tuition costs at public 2-year colleges were roughly $2,700 in 2011-12 and average public 4-year colleges was $7,700. These prices suggest that tax refunds can pay for a meaningful portion of tuition costs that may be relevant for marginal college entrants with income in this range.

Next we turn to the results at the 15%-25% kink point. As indicated in Table 2, the reduced-form change in the slope of enrollment is 0.31, and the first stage change in after-tax income is 0.10 at the 15%-25% kink point. The RKD estimate therefore indicates that a $1,000 increase in after-tax income (tax refunds) causes roughly a 3 percentage point increase in college enrollment.[12] To put this magnitude in context, the baseline college enrollment rate for this sample is 61 percent, the average tax refund is roughly $2,600, and average after-tax income is roughly $83,000. Given the college prices in Table 9, tax refunds for families at the at the 15%-25% kink point can also cover large fractions of tuition costs that may be relevant for marginal college entrants.

In Table 3, we examine enrollment responses by institution type to try to distinguish between extensive and intensive margin responses. If there are meaningful intensive margin responses, we may observe decreases in part-time enrollment and enrollment at 2-year or public colleges and increases in full-time enrollment and enrollment at 4-year and private colleges, though admittedly these are imperfect measures of college quality. Alternatively, along the extensive margin we expect increases at 2-year or public colleges, or possibly at all types of colleges. At both the first EITC kink and the 15%-25% tax kink, the results suggest an increase in full-time enrollment, which may be evidence of movement along the intensive margin. In addition, the overall enrollment effect at the 15%-25% tax kink appears to result from a large increase in two-year enrollments. In terms of the extensive margin response, the results indicate an increase of all enrollment types at both kink points, though some of these estimates are not precise.

Table 4 presents evidence relative to intertemporal margins of response by examining changes in total years of schooling by 2011.[13] This analysis is restricted to earlier cohorts (senior year 2001-2003) because we do not yet observe more recent cohorts at older ages. If the effects we observe result from a shifting forward of enrollment then we expect no kink in total enrollment measured later in life. Figure 4

[12] Cash-on-hand effects may be relatively larger for individuals who receive larger lump-sum tax refunds as opposed to individuals who have higher incomes throughout a year due to relatively low withholdings. While we do find larger marginal effects amongst individuals with higher withholdings at the 15-25% kink (all individuals receive a refund at the first EITC kink point), the standard errors are sufficiently large that we cannot statistically rule out that the effects are equal across groups with higher and lower withholdings. We report these findings in Appendix Table 4. Overall, there is relatively little variation in tax refund receipt in the 15%-25% sample as roughly 84% of the sample receives a tax refund. While there is some evidence that taxpayers do not strategically adjust their withholdings (Jones, 2012), in this setting it is not clear that withholdings are exogenous to the college enrollment decision.

[13] 2011 is the last year in our sample. We find similar results when we look at outcomes at ages 24-25.

presents graphical evidence of kinks in total years of schooling by 2011, and Table 4 presents quantitative results. These results suggest that the effects of additional cash-on-hand in the high-school senior year have lasting effects, and does not simply pull forward college enrollment. At the first EITC kink, the results suggest that total full-time equivalent years of enrollment increase by 0.13 years per $1,000. At the 15%-25% tax kink this effect is 0.21 years. Consistent with this interpretation, we also find a positive effect on ever enrolling as an undergraduate, or as a graduate student.[14]

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. We find evidence that both of these key assumptions hold for both of the tax kinks that we analyze. This section briefly describes our checks on these assumptions.

Figures 5 and 6 presents evidence that other covariates are smooth through each tax kink point. Figure 5 shows that, at each tax kink point, there are no detectable changes in pre-tax income. Figure 6 goes a step further and shows that, at each tax kink point, there are no detectable changes in covariate predicted enrollment when predicting enrollment using a rich set of covariates from the tax data.[15] Although not shown, we find that each of these covariates are smooth through the tax kink.[16]

We also find evidence that the distribution of families near each tax kink point is smooth, consistent with the assumption that individuals are not sorting along the tax schedule. Figure 7 presents plots of the frequencies of taxpayers around each kink point. Prior to our sample restrictions, when we consider all tax returns within +/- $3,000 around the first EITC kink point, we find significant evidence of bunching around the

[14] The impact of this additional schooling on earnings is hard to quantify, because many students are still enrolled in college and because we can only observe these individuals at a relatively early age. In future work, we plan to quantify the effects of college enrollment for these individuals.

[15] The covariates used to predict enrollment are a linear control in pre-tax income and dummies for calendar year of the high school senior year, filing status, number of dependents, state, gender, and age in the high school senior year.

[16] The tax data do not contain data on federal student aid eligibility. Nonetheless, 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, and individuals in the 15%-25% sample generally have income sufficiently high so that they do not qualify for federal student aid.

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 we find no evidence of gross sorting in the sample.[17] Similarly, the frequencies for the 15%-25% kink point sample appear to be smooth through the tax kink point as well. Furthermore, the results in Table 8 present evidence that lagged income is smooth through each of the tax kink points. This provides evidence that individuals are not sorting along the tax schedule over time; specifically, individuals do not appear to always locate on one side of a tax kink point or the other across different tax years. Section 3.5 discusses the results in Table 8 in more detail.

3.4. Robustness

We examine the robustness of our RKD results with several strategies. We vary the bandwidths, we consider alternate control functions, and we analyze several placebo tests. These results support the basic assumptions of the RKD approach and suggest that exogenous variation in tax refunds across t from tax kink points drive our findings. This section describes each robustness check.

While our baseline results use a $3,000 bandwidth, the estimated effects are robust to alternate bandwidths. Figure 8A illustrates that the RKD estimates at the first EITC kink point are stable for a wide range of bandwidths. At the smallest bandwidths, the estimated coefficients are slightly larger than the baseline estimates, but the standard errors are sufficiently large that it is difficult to reject that the estimates are equal across the alternative bandwidths. With wider bandwidths, the sample is larger and the standard error bands are tighter. Similarly, Figure 8B illustrates that the RKD estimates at the 15%-25% kink are stable for a wide range of bandwidths.[18]

We find evidence that our results are robust to alternate control functions and to alternate bandwidth choices, though in some cases these estimates are not precise. Table 5 presents these additional results. Our baseline specification includes linear control

[17] We also exclude individuals with more than $1,000 difference between earned income and adjusted gross income to guarantee that taxpayers in the analysis sample are not on the phase-out portion of the EITC benefit schedule.

[18] At the first EITC kink, we consider at most a $3,000 bandwidth to avoid interactions with the second kink in EITC benefits (where the maximum benefit region meets the phase-out portion of the schedule). See Manoli and Turner (2014) for further discussion of these points. At the 15%-25% kink point, we are able to consider a wider range of bandwidths because there are no nearby tax kink points.

functions for earnings relative to the kink and the linear control is interacted with the indicator for being below the kink. With the alternative control functions, we add quadratic controls for the distance to the kink and we interact the higher order polynomial terms with the indicator for being on the left side of the kink. The results in Table 5 present the estimated slope changes reflected by the coefficients on $kinkdist_i*D_i$. With the more flexible quadratic control function, the estimated coefficients continue to indicate positive effects of additional income on college enrollment. However, the standard errors increase significantly so that many estimates with the quadratic control function are not statistically significant.

We also examine multiple placebo analyses to explore the possibility that the estimated slope change in enrollment results from a spurious non-linearity in the enrollment function at the tax kink points. In these placebo tests we select points on the earnings distribution where some families have a tax kink, but where our placebo samples do not have a tax kink. We can then test that there is not an enrollment kink at the placebo kink point for families in the placebo sample. Table 6 presents the results from the placebo analyses at each kink point.

For the first EITC kink, we conduct placebo analyses by splitting the sample based on the number of qualifying children. In our baseline analysis, we pool across all tax returns, but the statutory EITC kink point occurs at a different earnings level for one-child families than for two or three child families. We exploit this difference by testing for kinks in the enrollment function at these different earnings levels. For taxpayers with one child, we draw a placebo sample around the kink point for taxpayers with two or more qualifying children. As Figure 9A 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 9B 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 6 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.

For the 15%-25% kink point, we conduct placebo analyses using individuals who are just below or just above the 15%-25% kink point. The sample of taxpayers just below the 15%-25% kink point all face 15% marginal tax rates, and the sample of taxpayers just above the 25% kink point all face 25% marginal tax rates. The results in Table 6 verify that there is no evidence of kinks in the enrollment function for the taxpayers just above and just below the 15%-25% kink point.[19]

3.5 Additional Evidence

In Table 7, we investigate differences across states with and without state EITC programs. [20] Twenty-five states have state EITC programs that define a state refundable tax credit as a function of the federal refundable tax credit.[21] In these states, there is a larger change in after-tax income and in the total state plus federal tax refund than in states without state EITC programs. If after-tax income has a causal effect on college enrollment, we expect a larger slope change in enrollment at the first EITC kink point in states with state EITC programs compared to states without state EITC programs. The results in Table 7 provide evidence supporting this hypothesis. The results indicate that in states with state EITC programs, there is a larger slope change in after-tax income (including state refunds in addition to federal refunds) at the kink point, roughly $0.40

[19] In addition to these placebo analyses, we have also performed placebo analyses to verify that the largest slope change in the enrollment function occurs at the true tax kink points. In particular, we vary the tax kink point in $100 increments within +/- $500 of the true kink point. At each of these placebo kink points, we use the same RKD methodology and estimate the slope change in enrollment. The results verify that the RKD methods detect the largest slope change near the true tax kink points. However, we cannot reject that the estimates based on placebo kink points are smaller than the estimates based on the true kink point. The sample size required to reject this hypothesis would be significantly larger than our current sample size since it would require a lot of data to have sufficiently small standard errors to detect differences based on having a placebo kink point within +/- $500 of +/- $100 of the true tax kink point.

[20] To investigate differential results across groups with higher and lower EITC awareness, we have examined differences across individuals in high and low bunching areas. High and low bunching areas are defined based on the proportion of taxpayers with self-employment income near the first EITC kink point who bunch at the kink point (following Chetty, Friedman and Saez 2013). As shown in Appendix Table 3, we do not find a statistically significant difference across individuals in high and low bunching areas. We conclude that the estimated cash-on-hand effects are not driven by variation in EITC awareness. The finding of similar effects at a different tax kink pint further supports this conclusion.

[21] Details on which states have state EITC programs and the parameters of the programs are available on the NBER TAXSIM website (http://users.nber.org/~taxsim/state-eitc.html, accessed November 12, 2013).

versus about $0.33 in states with only the federal EITC. Concurrently, there is a larger slope change in enrollment in states with state EITC programs, though the standard errors are sufficiently large that the difference in slope changes across the two groups of states is not statistically significant.[22] Similarly, we find that even though the kink in after-tax income and enrollment are larger in states with state EITC programs, the RKD estimates are similar at roughly a 1.8 or 1.9 percentage point increase in enrollment per $1,000 increase in after-tax income. This evidence suggests that the source of income, either via state tax refunds or federal tax refunds may be unimportant in affecting college enrollment decisions. Intuitively, this may be the case since individuals frequently file their state and federal tax returns at the same time and hence receive the respective tax refunds at similar times.[23]

Consistent with the idea that tax refunds relax credit constraints, we find evidence that the timing of tax refunds has a meaningful effect on college enrollment. In particular, we find that the effect of a comparable tax refund received in the high-school junior year has a substantively smaller effect on college enrollment, compared to a refund received in the senior year. For this analysis, we draw the sample of returns that are near the two tax kink points during the high school *junior* year, and we compare these results with our baseline sample of families that are near the tax kink points during the high-school *senior* year. Table 8 shows these results.

For this analysis, we first verify that for the junior year samples there is no estimated kink *in senior year after-tax income* at either tax kink point. It is crucial to verify that senior year income is smooth in order to interpret the effect of junior year tax refunds on college enrollment independently. (This finding also supports the idea that individuals are not consistently selecting their location on the tax schedule. As a verification of our main results, we also show that income during the junior year is smooth for our analysis sample of families near these kinks during their senior year.) As expected, the results show that the slope changes in after-tax income in the junior year are

[22] Because of the additional state refundable tax credit, tax refunds in states with state EITC programs are roughly $600 larger than tax refunds in states without state EITC programs. Importantly, with the RKD methodology in the two groups of states, the identifying variation for the estimated effects of after-tax income on college enrollment comes from the slope changes at the tax kink points and not this level difference across states.

[23] We do not extend the analysis of state tax effects to the sample near the 15%-25% tax kink points because there are not kinks in state taxes at these points.

roughly \$0.32 and \$0.11 at the first EITC kink point and the 15%-25% kink point respectively. Based on the junior year, the slope change in enrollment for the first EITC kink point is 0.38, or roughly half the size of the slope change in enrollment for the first EITC kink point in the senior year. For the 15%-25% tax kink point, there is no statistically significant change in college enrollment based on the junior year tax kink point. Cash transfers to EITC-eligible taxpayers in the junior year may have persistent effects on college enrollment through effects on high school completion, though it is not possible to verify high school attendance or completion using the administrative tax records. High school completion rates are nearer to 100% for higher income households (see Table 4 in Chapman et al 2011).

4. Discussion

The RKD estimates of the effects of cash-on-hand on college enrollment indicate that additional cash transfer in the high school senior year have economically significant effects on college enrollment. In this section, we discuss estimates from related studies and we present further context for the magnitudes of the RKD estimates.

Children from higher-income families are relatively more likely to attend college (for examples see Bailey and Dynarski, 2011, and Table 302.30 in NCES 2013). We document this pattern in Figure 10A, which plots the cross-section relationship between (pre-tax) family income in the senior year and college enrollment in the following year for families with high-school seniors. In this figure, the cross-sectional relationship is steeper at lower levels of income, and levels off as income increases. However, the relationship between income and enrollment varies across school types. Figure 10B shows that the relationship for public institutions mirrors that of enrollment in general, while enrollment at private institutions has a nearly linear relationship that suggests \$1,000 of family income increases enrollment by roughly 0.1 percentage points through most of the distribution. Figure 10C suggests that four-year enrollment is monotonically increasing in family income, while two-year income increases until roughly \$100,000 of family income, then declines. These patterns suggest that the simple cross-sectional relationship between family income and enrollment shown in Figure 10A masks substantial differences in enrollment across school types for both a given income level and across families with different incomes.

While this cross-sectional pattern can be informative, the underlying causal relationship between family income and college attendance is difficult to identify. Intuitively, in Figures 10A-10C income is not randomly assigned so that interpreting the independent causal effect of family income is difficult. Recent work addresses this issue by exploiting quasi-experimental settings and finds mixed evidence on the impact of family resources on college enrollment. Hilger (2013) examines income changes following paternal job losses and finds relatively small impacts on youths' college enrollment decisions. In contrast, Turner (2010) exploits expansions in tax-based college aid and finds positive impacts on college enrollment and Michelmore (2013) exploits expansions in state EITC programs and finds positive effects of EITC benefits on high school completion and college enrollment. More generally, Dynarski and Scott-Clayton (2013) summarize quasi-experimental evidence from the student aid literature concluding that an additional $1,000 of student aid increases college enrollment by roughly two to four percentage points.

There are several reasons why tax refunds may have a meaningful effect on college enrollment. One, tax refunds for many families in the sample 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. Table 9 shows annual college tuition and fees by institution type and year. Two-year college tuition is roughly $2,000 and four-year public tuition is about $6,000. On average, the tax refund for families at the first kink in the EITC is $4,500 and for families near the 15-25% tax kink is about $2,600.

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. Dynarski and Scott Clayton (2013) and Dynarski, Scott-Clayton and Wiederspan (2013) present evidence that complexity in student aid eligibility and application attenuates the effectiveness of many programs. Informational frictions may limit take-up of financial aid for college, effectively resulting in binding credit constraints. Bettinger, Long, Oreopoulos and Sanbonmatsu (2012) highlight the role of complexity in preventing individuals from completing Free Applications for Federal Student Aid (FAFSAs). They find that providing youths with information on their likely aid package and help with completing the application increased college enrollment and the amount of aid received. Informational barriers also appear to impact high-achieving students. Hoxby and Avery (2012) find that many low-income high-achieving high-school students do not apply to selective colleges even though they would have access to generous student aid if they were admitted. Hoxby and Turner (2013) show that this differential pattern of application by income is ameliorated when children from low-income families are given additional information on their likely student aid packages.

Using data from the National Postsecondary Student Aid Study, we find evidence of information asymmetry and incomplete take-up of federal student aid. Table 10 presents percentages of enrolled students who do not apply for federal student aid (e.g. Pell grants). The evidence highlights that, at the lowest income levels (i.e. below $40,000 of income), between roughly 60% and 70% of enrolled students applied for aid. Below $40,000, virtually all of the enrolled students are likely to be eligible for aid. Table 11 presents evidence on reasons behind the incomplete take-up of aid. This table indicates that about 60% of low income students do not apply for aid because of perceived ineligibility. This percentage does not vary much by income levels even though eligibility for income levels above $50,000 decreases sharply with income. Debt aversion and complexity may be significant determinants of incomplete financial aid take-up. Turner (2012) and the U.S. GAO (2013) also find that take-up of tax-based aid is not complete, and that many students claim relatively smaller benefits when they are eligible for multiple programs. Incomplete take-up of federal student aid and failure to maximize other education tax benefits suggests that existing student aid programs may not effectively alleviate credit constraints. In contrast, in the RKD analysis tax refunds are independent of any other financial aid and take-up of tax refunds is 100% 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

In this paper 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, we find evidence of meaningful kinks in the enrollment-income profile at legislated tax kink points. Regression results indicate that an additional $1,000 of after-tax income in the spring of the high school senior year increases college enrollment by roughly two to three percentage points. Additionally, the results indicate that the additional cash-on-hand generates new enrollments rather than pulling forward in time enrollments.

Consistent with the interpretation that tax refunds in the high school senior year relax credit constraints, we find evidence that comparable tax refunds received in the junior year have a relatively smaller effect on college enrollment. While many tax benefits and financial aid programs offer aid with complicated forms or aid that arrives after individuals have financed their college costs, the results indicate that providing additional resources at the time when youths make college enrollment decisions could more effectively increase college enrollment. Providing additional family resources for college through the tax code insures 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, so that targeted tax benefits can relax binding credit constraints.

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Table 1: Summary Statistics

	EITC Kink 1		15%-25% Kink	
N	870,792		896,422	
	Mean	SD	Mean	SD
Enroll	0.19	0.39	0.61	0.49
Married Filing Jointly	0.17	0.37	0.75	0.43
Head of Household	0.83	0.37	0.25	0.43
Child Dependents	1.78	1.06	1.96	0.98
After-Tax Income	15,961	4,342	83,263	24,198
Taxes	-4,460	1,363	7,331	1,599
Pre-Tax Income	11,501	3,462	90,593	24,759
Has Refund	1.00	0.00	0.84	0.37

Notes: Income variables in 2010 dollars.

Table 2: After Tax Income and College Enrollment

	EITC Kink 1		15%-25% Kink	
	After Tax Income	Enrollment	After Tax Income	Enrollment
Slope Change at Kink	0.333	0.652	0.098	0.308
	[0.001]	[0.097]	[0.002]	[0.114]
Effect of $1000 increase in After Tax Income on Enroll	1.958		3.143	
	[0.290]		[1.16]	
Mean Tax	-4460		7331	
Mean Enrollment	19.00		61.00	
N	870,792		896,422	

Notes: In the top panel, each slope change coefficient is estimated from a separate regression using after-tax income or enrollment as the dependent variable. The effect of a $1,000 increase in after-tax income on enrollment is estimated using an instrumental variable specification that captures the ratio of the slope change coefficients. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax income. Robust standard errors are in brackets.

Table 3: Enrollment Types

	EITC Kink 1	15%-25% Kink
Enroll Full-time	1.72	2.23
	[0.268]	[1.20]
Mean Enroll Full-time	16	53
Enroll 2yr	0.67	2.43
	[0.20]	[0.98]
Mean Enroll 2yr	8	21
Enroll 4yr	1.17	0.95
	[0.21]	[1.12]
Mean Enroll 4yr	9	33
Enroll Public	1.21	2.75
	[0.25]	[1.20]
Mean Enroll Public	13	44
Enroll Private	0.48	0.97
	[0.12]	[0.71]
Mean Enroll Private	3	9

Notes: Each coefficient estimate captures the effect of a $1,000 increase in after-tax income on the specified enrollment type in each row. Each regression includes the full sample for the kink listed. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax income. Robust standard errors are in brackets.

Table 4: Outcomes in 2011, Cohorts 2001-2003

	EITC Kink 1	15%-25% Kink
Years of FTE Enrollment	0.14	0.21
	[0.03]	[0.12]
Mean Years of FTE Enollment	1.41	4.17
Ever Enroll Undergraduate	1.76	1.56
	[0.71]	[1.44]
Mean Ever Enroll Undergraduate	47	82
Ever Enroll Graduate	0.49	2.2
	[0.25]	[1.30]
Mean Ever Enroll Graduate	3	13
Currently Enrolled	1.83	-1.04
	[0.51]	[1.58]
Mean Currenlty Enrolled	14	22
N	239,937	297,088

Notes: Each coefficient estimate captures the effect of a $1000 increase in after-tax income on the specified outcome variable in each row. Each regression includes the full sample for the kink listed. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax income. The samples are restricted to high school senior cohorts 2001, 2002 and 2003. For each respective high school senior cohort, outcomes are through 2011. Robust standard errors are in brackets.

Table 5: Alternative Control Functions

Panel A: EITC Kink 1						
	Linear Model			Quadratic Model		
	BW=1000	BW=2000	BW=3000	BW=1000	BW=2000	BW=3000
Effect of $1000 Increase in After-Tax Income on Enroll	3.75	1.67	1.96	1.55	4.16	1.72
	[1.49]	[0.52]	[0.29]	[5.79]	[2.10]	[1.15]
N	299,084	589,476	870,792	299,084	589,476	870,792

Panel B: 15%-25% Kink						
	Linear Model			Quadratic Model		
	BW=1500	BW=3000	BW=4500	BW=1500	BW=3000	BW=4500
Effect of $1000 Increase in After-Tax Income on Enroll	2.00	3.14	1.27	-1.30	1.93	6.19
	[3.17]	[1.17]	[0.61]	[1.61]	[4.80]	[2.78]
N	452,758	896,422	1,335,566	452,758	896,422	1,335,566

Notes: BW refers to the choice of bandwidth around the kink point. Each coefficient estimate is based on estimating separate regressions using the sample within the specified bandwidth around the kink point. N refers to the sample sizes used in estimating each regression. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax income.

Table 6: Placebo Tests

	EITC Kink 1				15%-25% Kink		
	1 Child Actual	1 Child Placebo	2 Child Actual	2 Child Placebo	Actual, BW=2500	All 25%, BW=2500	All 15%, BW=2500
Slope Change in	0.343	0.002	0.324	0.004	0.097	0.000	0.001
After Tax Income	[0.001]	[0.002]	[0.001]	[0.002]	[0.003]	[0.001]	[0.001]
Slope Change in	0.570	0.038	0.729	-0.310	0.325	-0.012	-0.007
Enroll	[0.173]	[0.019]	[0.121]	[0.140]	[0.151]	[0.043]	[0.042]
N	264,766	365,104	558,308	409,507	748,805	700,433	781,277

Notes: Each coefficient estimate captures the effect of a $1000 increase in after-tax income on enrollment. Placebo samples that have no actual tax kink point are selected around each placebo tax kink point (see text for discussion and Figures 9A-9B). Each regression includes dummy

Table 7: State Tax Effects

	All Returns	Has State EITC	No State EITC
Slope Change in After-Tax Income	0.353	0.405	0.333
	[0.001]	[0.002]	[0.001]
Slope Change in Enroll	0.652	0.766	0.615
	[0.097]	[0.187]	[0.113]
Effect of $1000 Increase in After-Tax Income on Enroll	1.85	1.89	1.84
	[0.274]	[0.462]	[0.339]
Mean Enroll	19.3	19.4	19.2
Mean Taxes (State & Federal)	-4567	-4981	-4403
N	870,792	246,698	624,094

Notes: In the top panel, each slope change coefficient is estimated from a separate regression using after-tax income or enrollment as the dependent variable. The effect of a $1000 increase in After-Tax Income on Enrollment is estimated using an instrumental variable specification tht captures the ratio of the slope change coefficients. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax income. Robust standard errors are in brackets.

Table 8: Senior Year Effects vs. Junior Year Effects

	Kink 1 EITC Senior Year Sample	Kink 1 EITC Junior Year Sample	15%-25% Kink Senior Year Sample	15%-25% Kink Junior Year Sample
Slope Change in Senior	0.334	-0.028	0.097	0.087
Year After Tax Income	[0.001]	[0.050]	[0.002]	[0.086]
N	794,736	709,336	792,691	855,749
Slope Change in Junior	-0.018	0.319	0.002	0.105
Year After Tax Income	[0.028]	[0.001]	[0.011]	[0.002]
N	704,914	755,911	792,639	865,150
Slope Change in Enrollment	0.702	0.378	0.301	0.011
	[0.102]	[0.105]	[0.122]	[0.012]
N	794,736	755,911	792,691	865,150
Effect of $1000 Increase in	2.101	1.185	3.081	0.108
After-Tax Income on Enroll	[0.305]	[0.310]	[0.125]	[1.112]
N	794,736	755,911	792,691	865,150

Notes: Sample includes senior year cohorts 2002-2010. The tax data do not include the dependent-parent link in 2000 so it is not possible to link the 2001 cohort to the primary taxpayer claiming the dependent in the junior year. The sample size is smaller for the different year income as tax filing changes across years. The effect of $1,000 of after-tax income on enrollment matches column year income on enrollment in college in the first year after the senior year.

Table 9: Tuition and Fees by Institutional Control, 2001-2011

	Public		Not-for-Profit Private		For-Profit	
Academic Year	4-year	2-year	4-year	2-year	4-year	2-year
2001-02	4,770	1,762	21,204	10,378	14,136	13,574
2002-03	5,056	1,853	21,890	11,130	14,254	13,907
2003-04	5,609	2,081	22,726	11,723	15,161	14,703
2004-05	5,967	2,195	23,330	11,764	15,667	14,967
2005-06	6,119	2,213	23,709	11,800	15,226	14,819
2006-07	6,316	2,249	24,518	12,191	16,268	14,586
2007-08	6,388	2,215	25,076	12,672	15,742	14,364
2008-09	6,691	2,264	26,118	13,361	15,290	14,550
2009-10	7,030	2,399	26,829	13,288	14,108	15,903
2010-11	7,345	2,511	27,300	13,040	14,577	15,083
2011-12	7,701	2,647	27,686	14,193	13,819	13,834

Note: Dollars in 2011 dollars. Amounts for public institutions are for in-state enrollment. Source: National Center for Education Statistics, Digest of Education Statistics 2012, Table 349.

Table 10: 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 11: Non-application by Income

Total Income	Reason for not applying for federal student aid: Did not want to take on debt	Forms were too much work	Thought Ineligible
All Income Groups	**40**	**19**	**61**
0 to 10,000	41	22	58
10,001 to 20,000	42	21	59
20,001 to 30,000	45	19	62
30,001 to 40,000	43	21	60
40,001 to 50,000	43	21	60
50,001 to75,000	42	20	62
75,001 to 100,000	39	18	61
100,001 to 125,000	37	17	60
125,001 to 150,000	35	12	63
Greater than 150,001	33	15	63

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

Appendix Table 1: Tax Kink Points

	EITC Kink 1		15%-25% Kink	
Tax Year	1 Child	2+ Children	HoH	MFJ
2001	$7,140	$10,020	$36,250	$45,200
2002	$7,370	$10,350	$37,450	$46,700
2003	$7,490	$10,510	$38,050	$56,800
2004	$7,660	$10,750	$38,900	$58,100
2005	$7,830	$11,000	$39,800	$59,400
2006	$8,080	$11,340	$41,050	$61,300
2007	$8,390	$11,790	$42,650	$63,700
2008	$8,580	$12,060	$43,650	$65,100
2009	$8,950	$12,570	$45,500	$67,900
2010	$8,970	$12,590	$45,550	$68,000
2011	$9,100	$12,780	$46,250	$69,000

Notes: All dollar values are in nominal dollars. In Tax Years 2001 and 2002, the 15%-25% bracket refers to the 15%-27.5% and 15%-27% brackets respectively.

Appendix Table 2: Sample Restrictions

	EITC Kink 1	15%-25% Kink
Absolute distance to kink is no more than $3,000	1,815,711	1,112,996
Remove returns with self-employment income	1,062,328	896,422
Remove returns with more than $1,000 of non-W2 wag	870,792	NA
Final Sample Size	870,792	896,422

Apendix Table 3: EITC Kink 1 Estimates in High and Low Bunching Areas

	Full Sample TY01-09	High Bunching Areas	Low Bunching Areas
Slope Change in After-Tax Income	0.325	0.324	0.326
	[0.000827]	[0.00119]	[0.00115]
Slope Change in Enroll	0.664	0.684	0.650
	[0.101]	[0.147]	[0.140]
Effect of $1000 Increase in After-Tax Income on Enroll	2.044	2.112	1.998
	[0.312]	[0.453]	[0.430]
N	779,361	371,789	407,572

Notes: Chetty, Friedmand and Saez (2013) provide data on sharp bunching by 3-digit ZIP codes for tax years 1996 through 2009. In each tax year, we comput 5 percentile bins based on this sharp bunching measure. We then match the sharp bunching percentiles to our sample by 3-digit ZIP code. High bunching areas are defined as the 85th percentile and higher, and low bunching areas are below the 85th percentile. Each slope change coefficient is estimated from a separate regression using Tax or Enroll as the dependent variable. The effect of a $1000 increase in after-tax income on enrollment is estimated using an instrumental variable specification. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted pre-tax total income. Robust standard errors are in parentheses.

Appendix Table 4: Variation in Withholdings

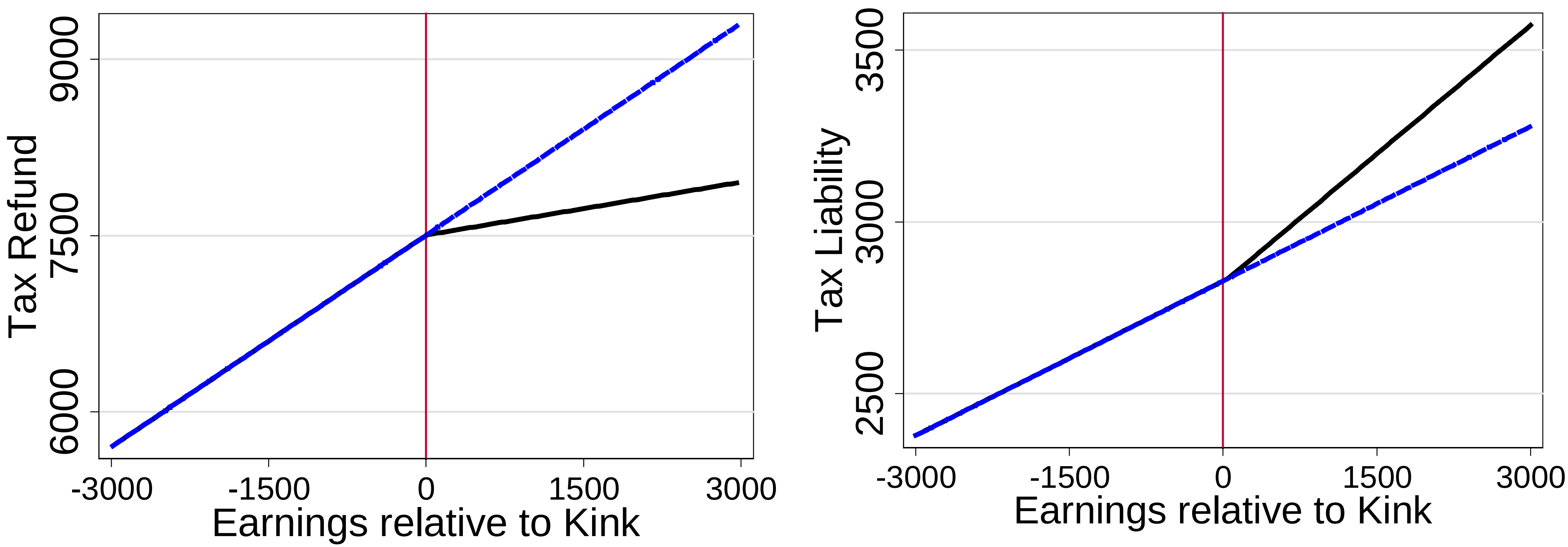
	15%-25% Kink Withholding Quartiles			
	Q1	Q2	Q3	Q4
Slope Change in After-Tax Income	0.106	0.102	0.102	0.0940
	[0.0137]	[0.00569]	[0.00589]	[0.0104]
Slope Change in Enroll	0.271	0.264	0.204	0.492
	[0.229]	[0.230]	[0.230]	[0.232]
Effect of $1000 Increase in After-Tax Income on Enroll	2.560	2.581	2.000	5.228
	[2.180]	[2.243]	[2.247]	[2.521]
Mean Enrollment %	61.15	61.47	60.55	59.57
Mean Taxable Income	58583	58607	58593	58621
Mean Federal Tax Liability	7059	7362	7403	7501
Mean Withholdings	6273	8639	10200	13534
Mean Refund	-265.2	1445	2967	6255
Mean Has Refund %	44.32	91.10	99.30	99.76
N	225,112	223,802	224,390	223,117

Notes: Withholding groups are constructed by computing quartiles of withholdings within each group that faces the same kink point and within each $100 bin of earnings relative to the kink point. Each quartile group therefore consists of individuals in the same quartile of withholdings controlling for earnings relative to the kink and the specific kink point for each filing status and tax year. Each slope change coefficient is estimated from a separate regression using Tax or Enroll as the dependent variable. The effect of a $1000 increase in after-tax income on Enrollment is estimated using an instrumental variable specification. Each regression includes dummy variables for calendar year, state, filing status, number of kids, gender, and age and a linear control in inflation adjusted AGI. Robust standard errors are in parentheses.

Figure 1. Tax Changes at Kink Points

A. EITC Kink 1
Change in Tax Refund

B. 15%-25% Kink
Change in Tax Liability

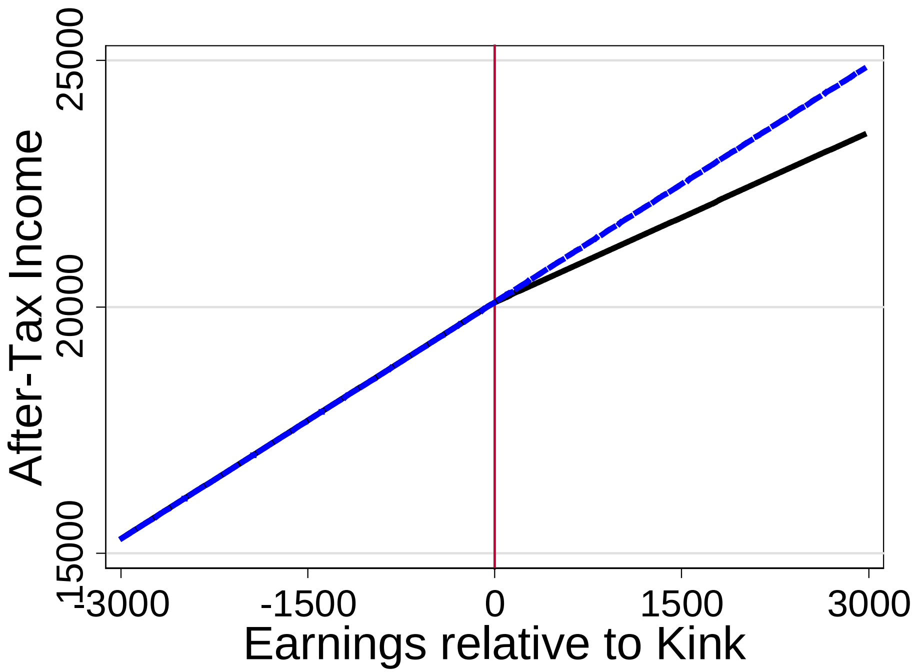


Notes: Each figure plots simulated federal tax refunds and tax liability for a married filing jointly taxpayer with two qualifying children and dependents in tax year 2009. W2 earnings vary in $100 increments across the different levels of earnings relative to the kink points. Simulated federal taxes are computed using the NBER TAXSIM tax calculator. Appendix Figures 1 and 2 plot empirical changes at the EITC kink 1 and 15%-25% tax kink points respectively.

Figure 2. After-tax Income Changes at Kink Points

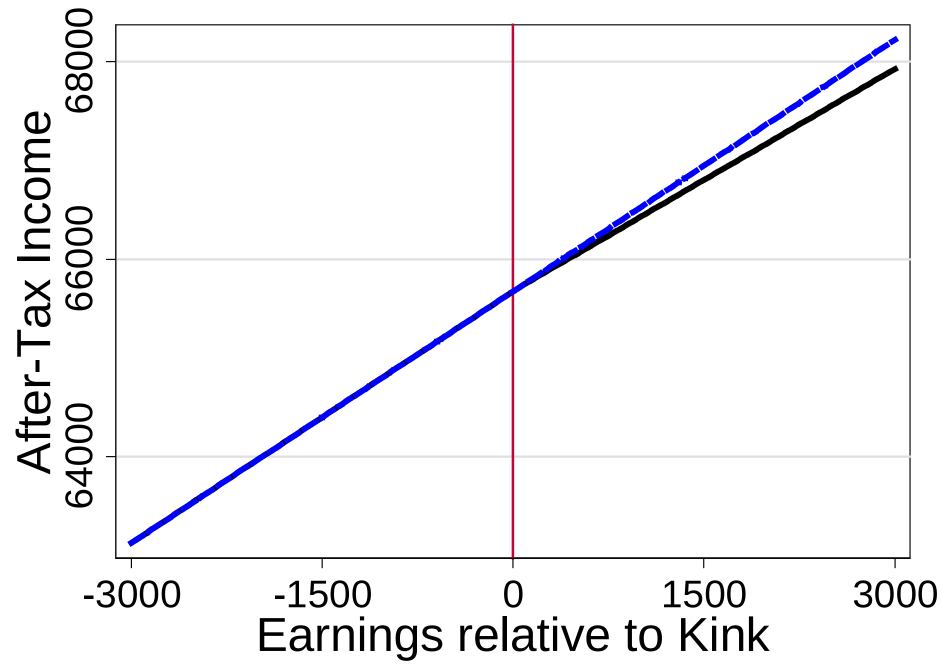
A. EITC Kink 1

Change in <u>After-Tax-Income</u>



B. 15%-25% Kink

Change in <u>After-Tax Income</u>

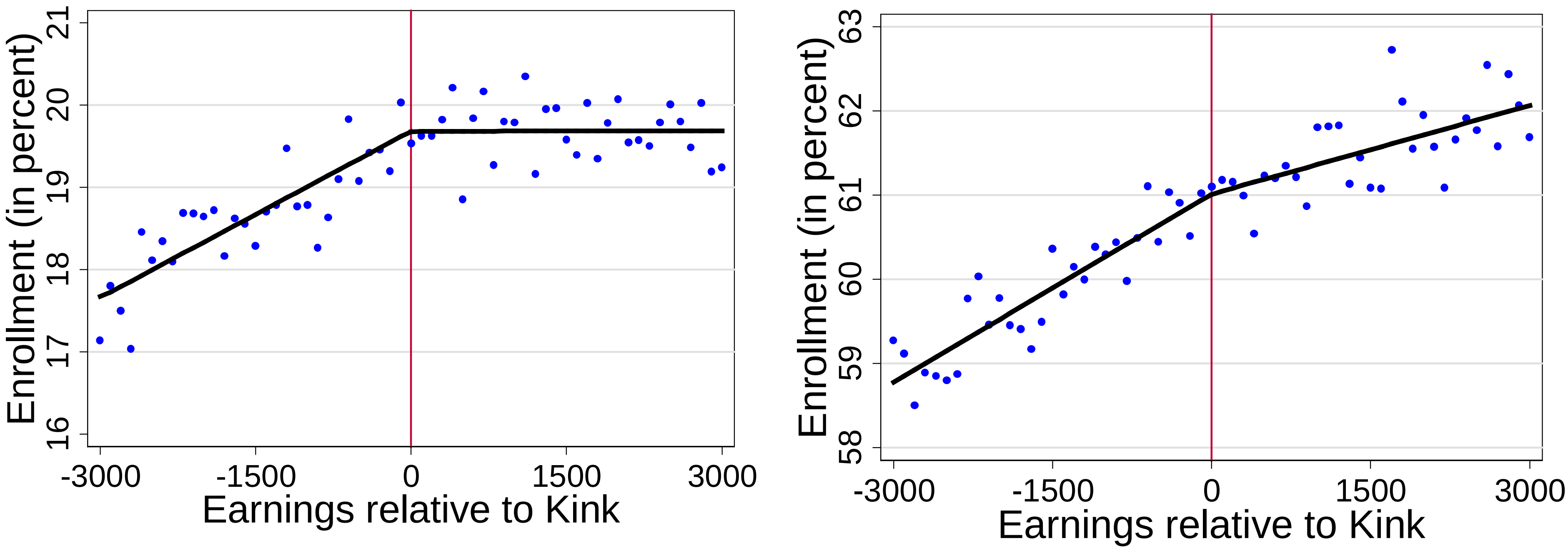


Notes: Each figure plots simulated after-tax income for a married filing jointly taxpayer with two qualifying children and dependents in tax year 2009. After-tax income is computed as pre-tax income (W2 earnings) minus total federal tax liability. W2 earnings vary in $100 increments across the different levels of earnings relative to the kink points. Simulated federal taxes are computed using the NBER TAXSIM tax calculator. Appendix Figures 1 and 2 plot empirical changes at the EITC kink 1 and 15%-25% tax kink points respectively.

Figure 3. Changes in Enrollment at Kink Points

A. EITC Kink 1
Change in <u>Enrollment</u>

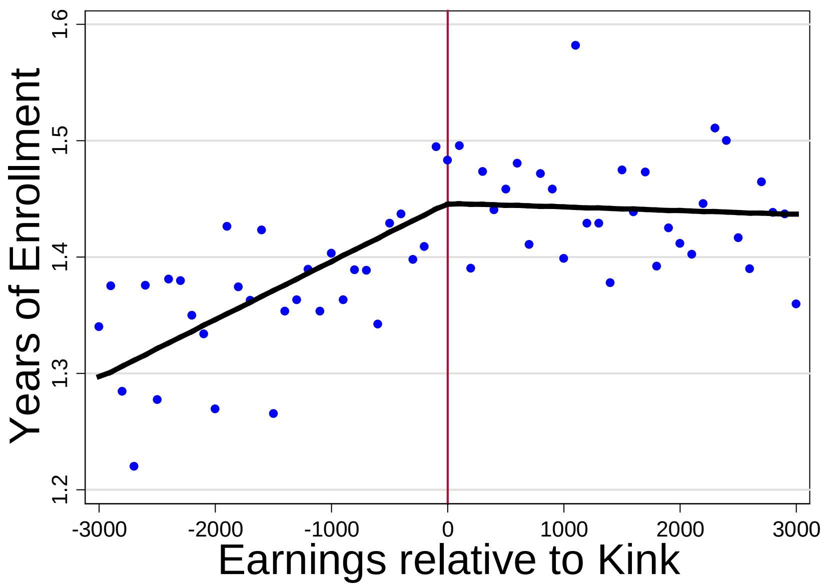
B. 15%-25% Kink
Change in <u>Enrollment</u>



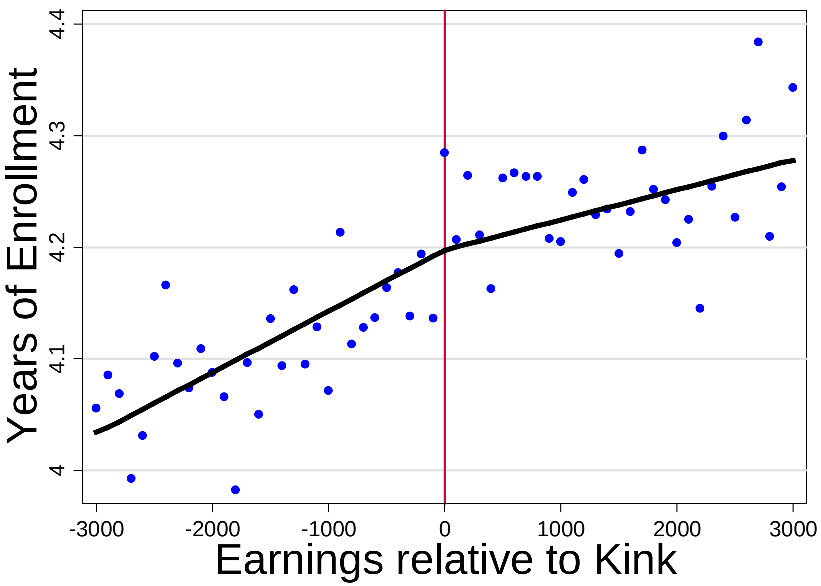
Notes: For each figure, the circles show mean enrollment rates within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values within each $100 bin of earnings relative to the kink points. Fitted values are obtained from regressions using the individual-level data in which 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. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Figure 4. Changes in Total Enrollment through 2011

A. EITC Kink 1
Change in <u>Total Enrollment</u>



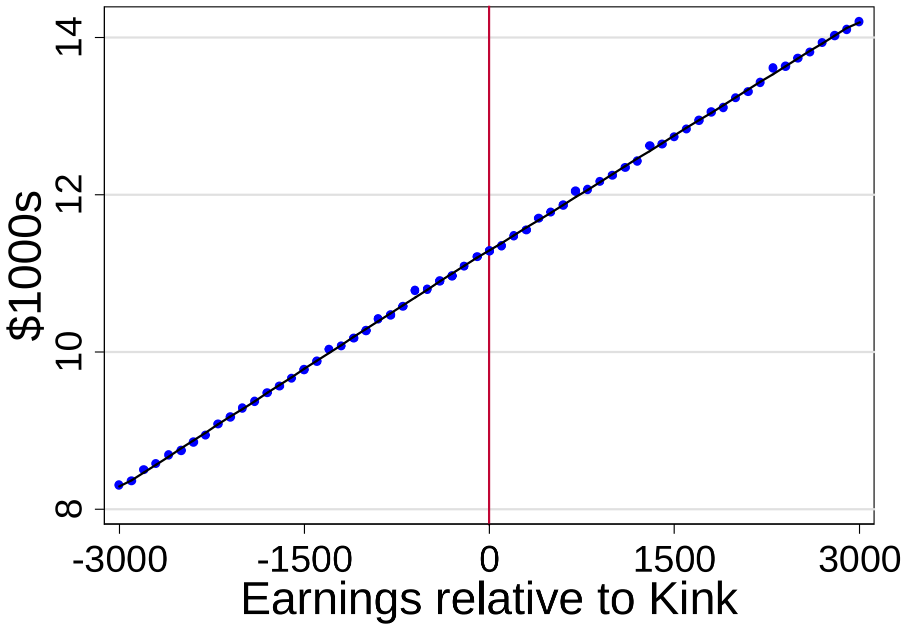
B. 15%-25% Kink
Change in <u>Total Enrollment</u>



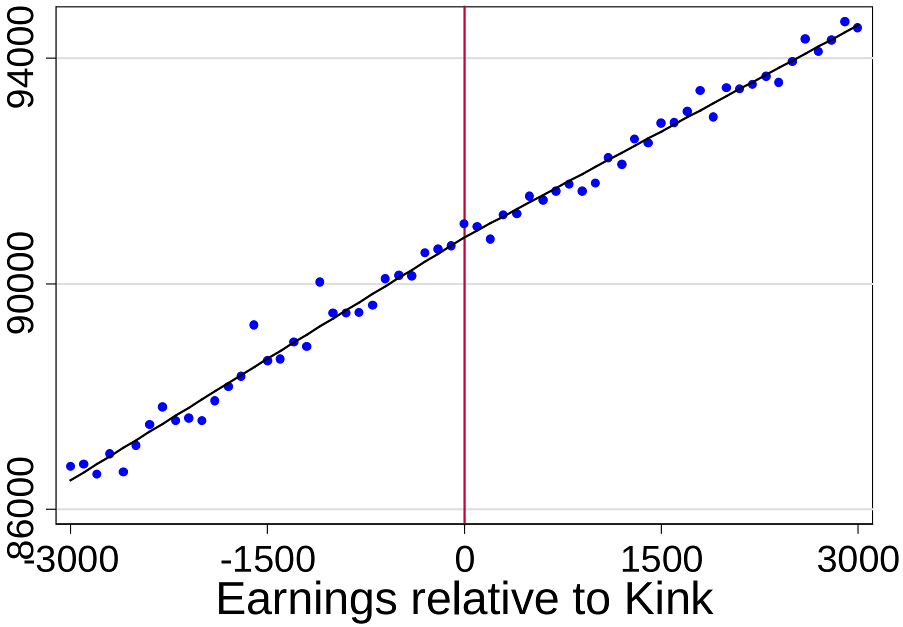
Notes: For each figure, the circles show mean total years of full-time equivalent enrollment through 2011 within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values within each $100 bin of earnings relative to the kink points. Years of full-time equivalent enrollment are computed based on assigning a value of one for a tax year with full-time enrollment indicated on a 1098-T form, and a value of 0.5 for a tax year with part-time enrollment indicated on a 1098-T form. Fitted values are obtained from regressions using the individual-level data in which years of full-time equivalent 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. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Figure 5. Smoothness in Pre-tax Income

A. EITC Kink 1
Pre-tax Income



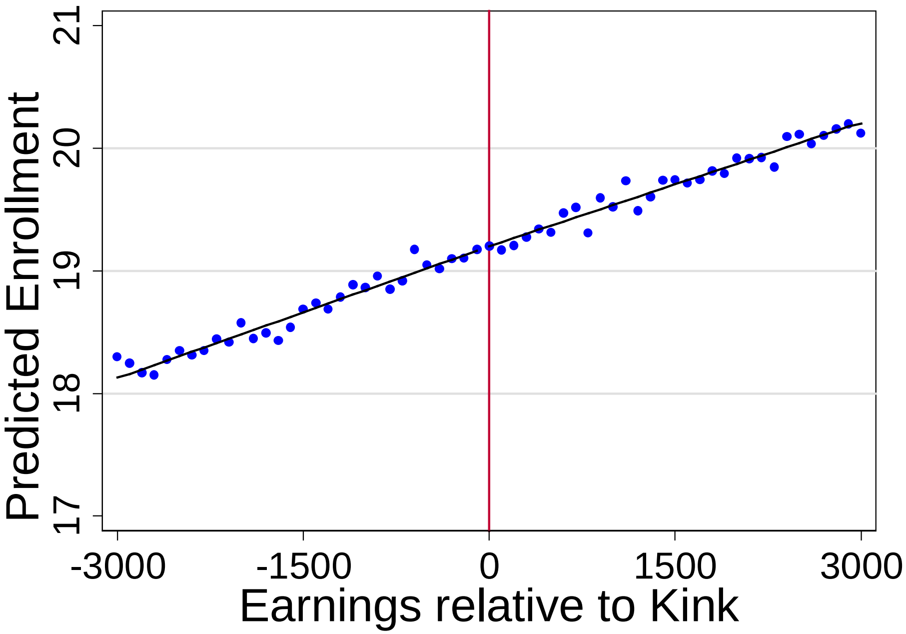
B. 15%-25% Kink
Pre-tax Income



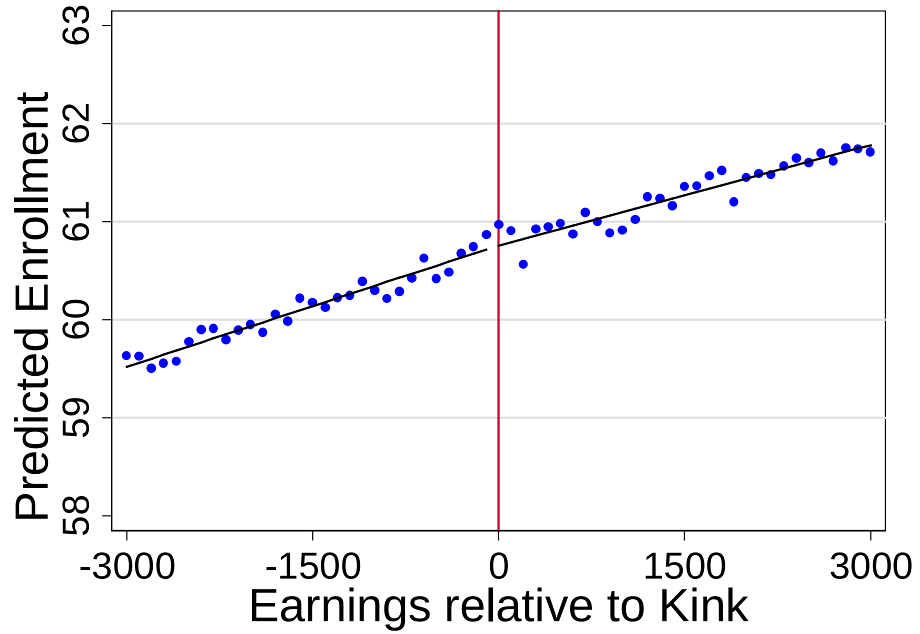
Notes: For each figure, the circles show mean pre-tax income within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values within each $100 bin of earnings relative to the kink points. Fitted values are obtained from regressions using the individual-level data in which pre-tax income 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. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Figure 6. Smoothness in Covariates

A. EITC Kink 1
Predicted Enrollment



B. 15%-25% Kink
Predicted Enrollment

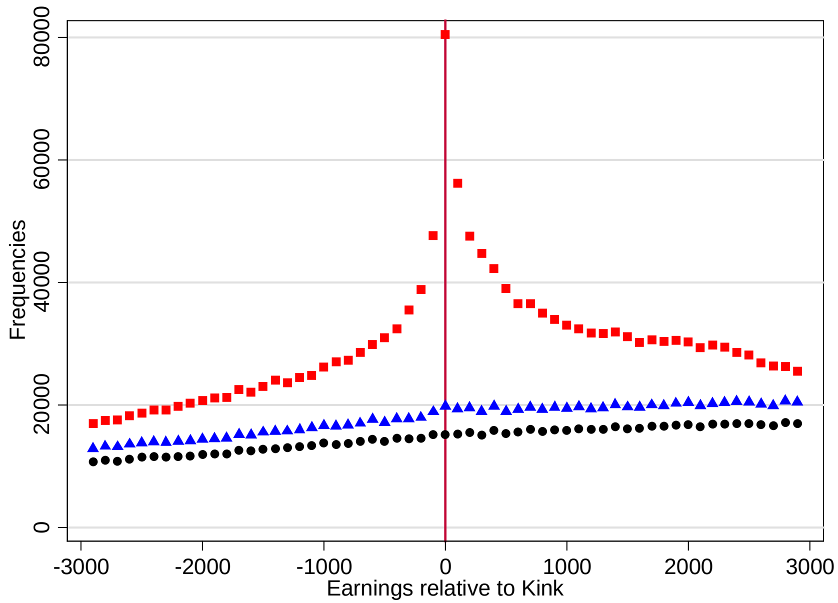


Notes: For each figure, the circles show mean predicted enrollment rates within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values of predicted enrollment rates within each $100 bin of earnings relative to the kink points. For each individual, predicted enrollment is computed by regressing an enrollment indicator on pre-tax income and dummies for calendar year, filing status, number of dependents, state, gender, and age in the high school senior year. 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. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Figure 7. No Sorting Across Tax Kink Points

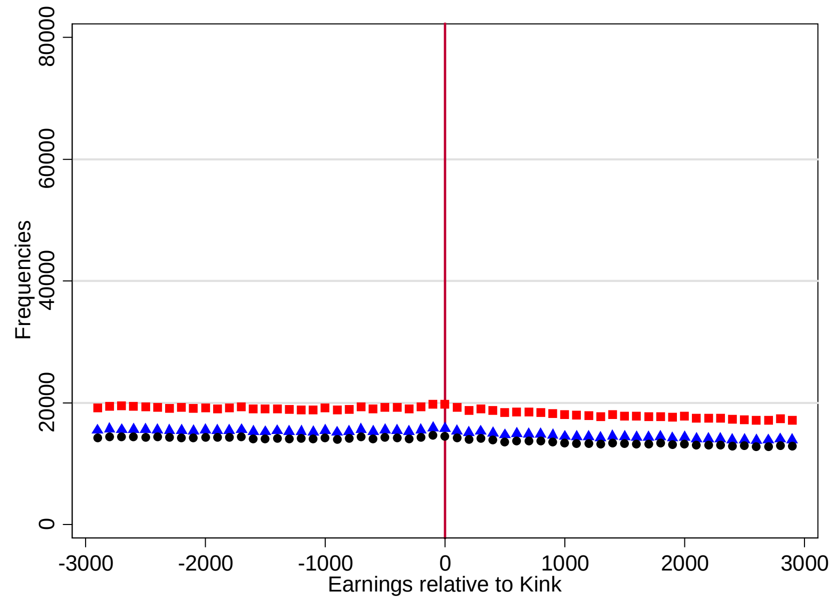
A. EITC Kink 1

Frequencies



B. 15%-25% Kink

Frequencies

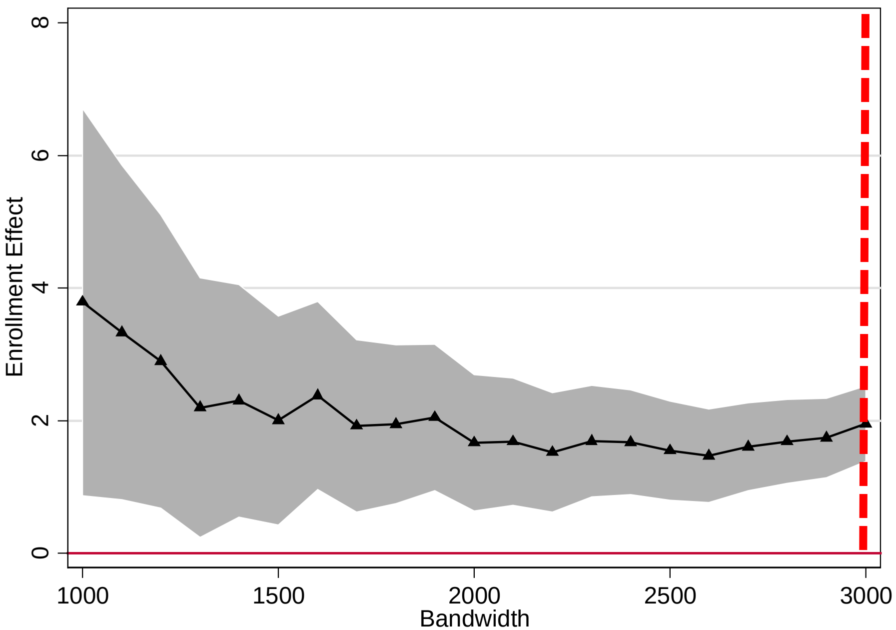


Notes: Each figure plots the number of tax returns within $100 bins around each tax kink point. The red squares are frequencies including the self-employed; the blue triangles are frequencies when excluding the self-employed and the black circles are frequencies when excluding individuals with a difference between W2 wages and wages reported on the 1040 form of more than $1000. This difference is attributable to non-third party verified wages. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively.

Figure 8. Estimates by Alternative Bandwidths

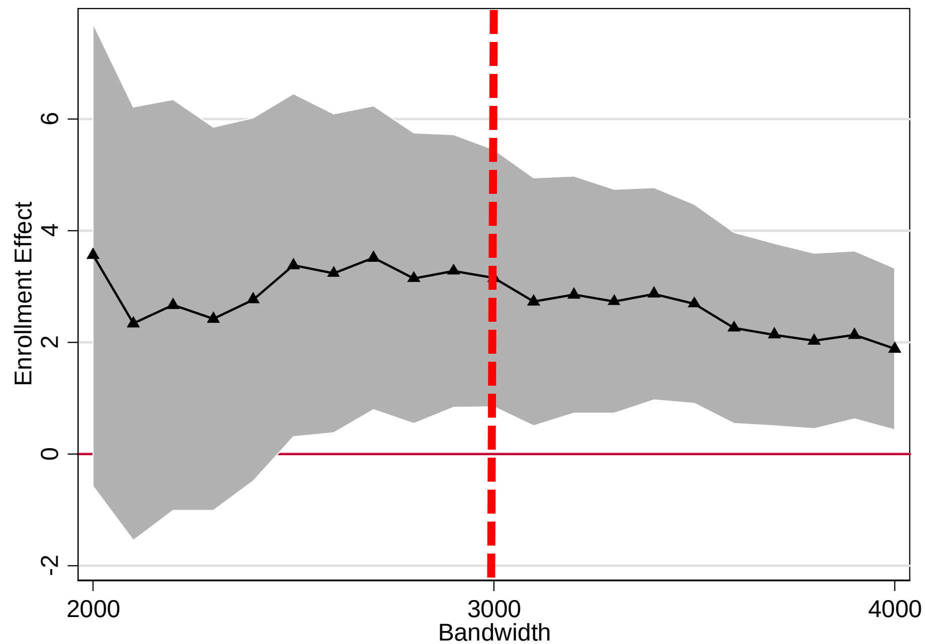
A. EITC Kink 1

Effects of $1000 Increase in After-Tax Income



B. 15%-25% Kink

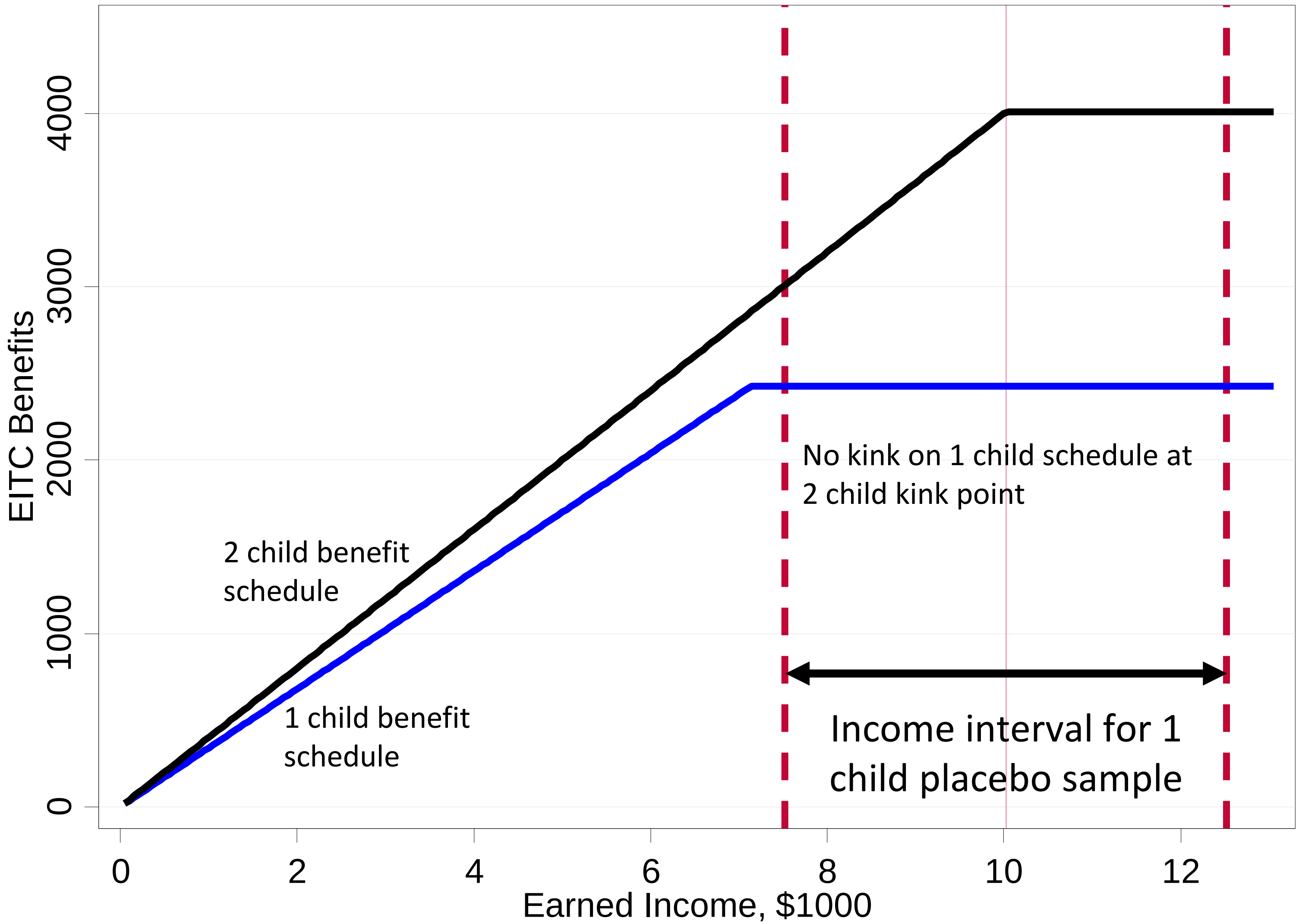
Effects of $1000 Increase in After-Tax Income



Notes: Each figure plots estimated effects of an additional $1000 of after-tax income (cash-on-hand) in the high school senior on college enrollment using different bandwidths around each tax kink point. Bandwidths are varied in $100 increments between $1000 and $3000 for EITC kink 1 and between $2000 and $4000 for the 15%-25% kink point. See text for discussion of this range of bandwidths. For each bandwidth, the enrollment effects are estimated using an instrumental variables regression specification in which enrollment is regressed on after-tax income, and after-tax income is instrumented for using the interaction between a dummy variable for earnings less than the tax kink point and a linear control in earnings relative to the tax kink point. The baseline estimates are from using a bandwidth of +/- $3000 of earnings relative to the tax kink point. All dollar values are adjusted to 2010 dollar values prior to imposing bandwidth cutoffs.

Figure 9. EITC Kink 1 Placebo Tests

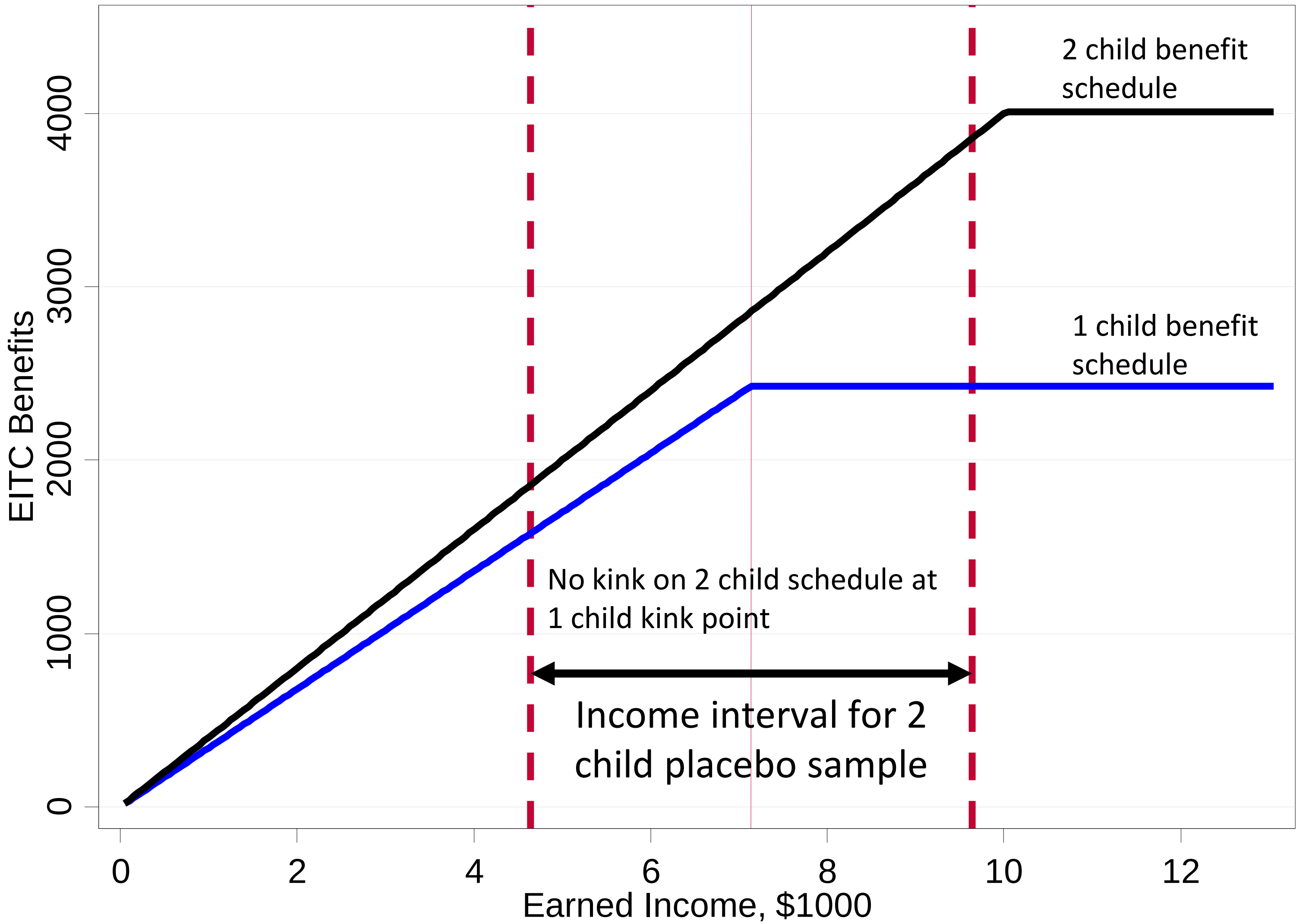
A. Placebo test for Taxpayers with 1 Qualifying Child, Draw sample of 1 child EITC returns around 2 child kink point



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

Figure 9. EITC Kink 1 Placebo Tests

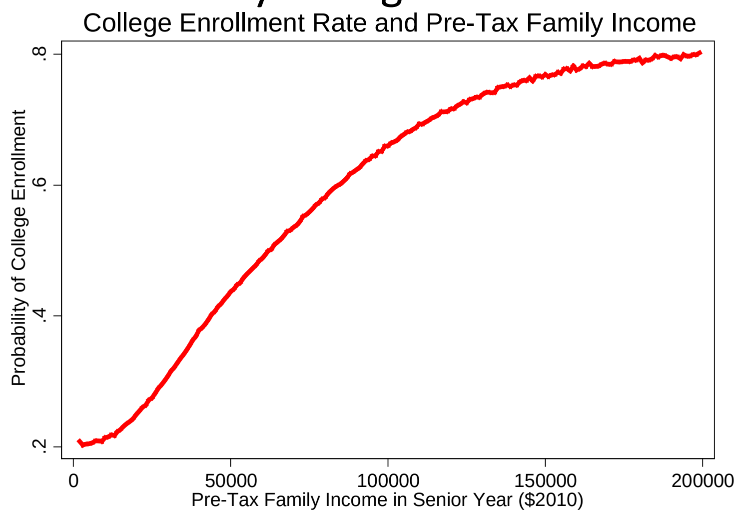
B. Placebo test for Taxpayers with 2+ Qualifying Children, Draw sample of 2+ children EITC returns around 1 child kink point



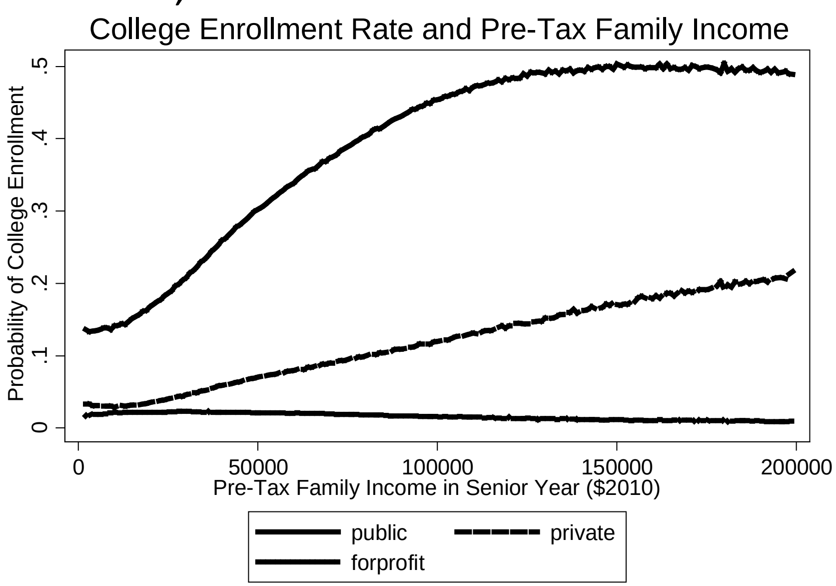
Notes: This figure plots simulated EITC benefit schedules for taxpayers with 1 and 2 qualifying children.

Figure 10. College Enrollment by Senior Year Family Income

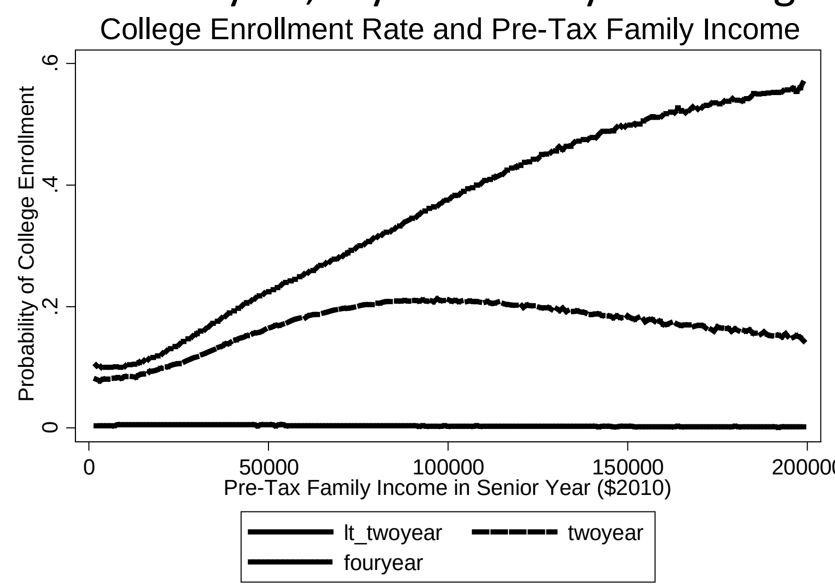
A. Any College Enrollment



B. Public, Private & For-Profit Schools



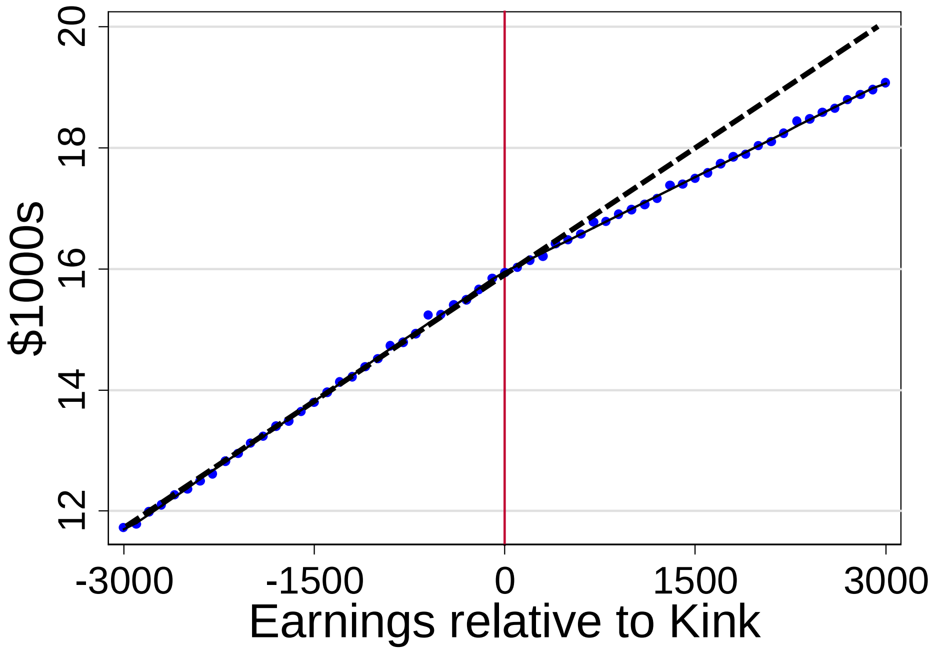
C. 2-year, 4-year & < 2-year Colleges



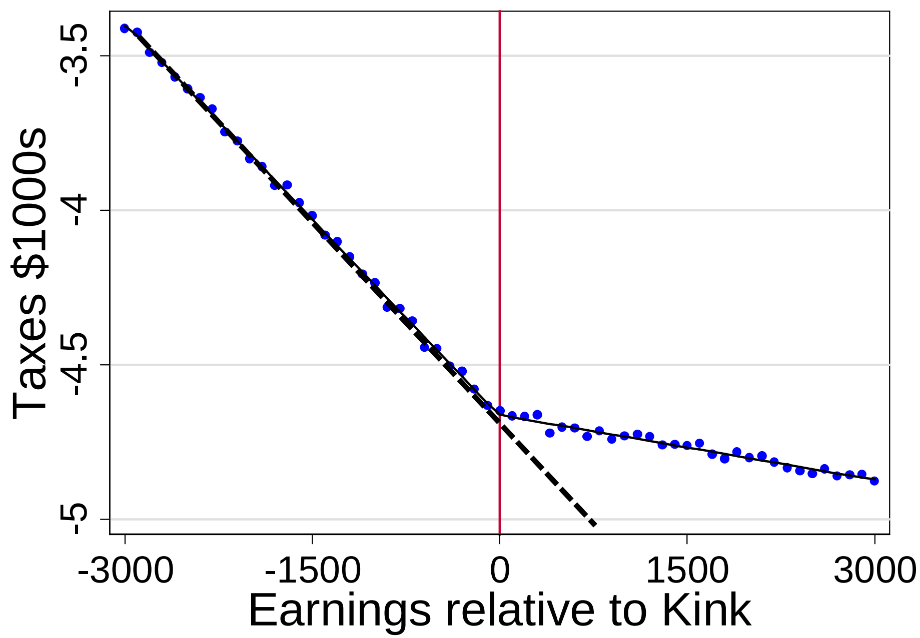
Notes: Each figure plots mean enrollment rates for high school seniors against pre-tax income in the high school senior year. Mean enrollment rates are computed as the average enrollment rate within $100 bins of pre-tax income. For each calendar year, high school seniors are identified as individuals who are age 17 in the calendar year and born in January through August or age 18 in the calendar year and born in September through December. Pre-tax income is based on total income for individuals who claim the high school senior as a dependent on their tax return for the tax year corresponding to the high school senior year. College enrollment is measured based on observing a 1098-T tuition form for the high school senior for the year immediately following the high school senior year. The type of college is determined based on merging information on school type from the Integrated Post Secondary Education Data System to the 1098-T data using school identification numbers.

Appendix Figure 1. Empirical Changes at EITC Kink 1

A. After-Tax Income



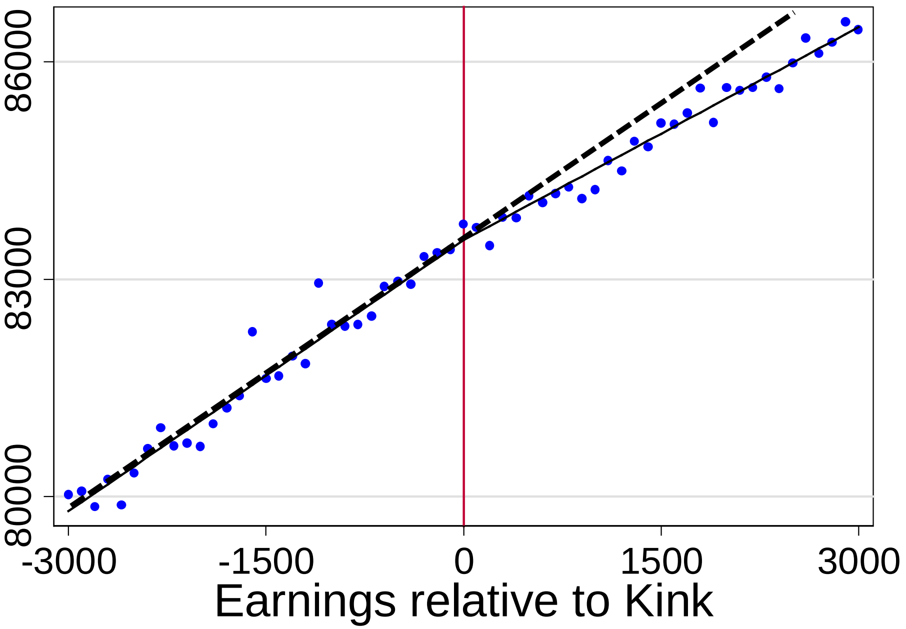
B. Tax Liability



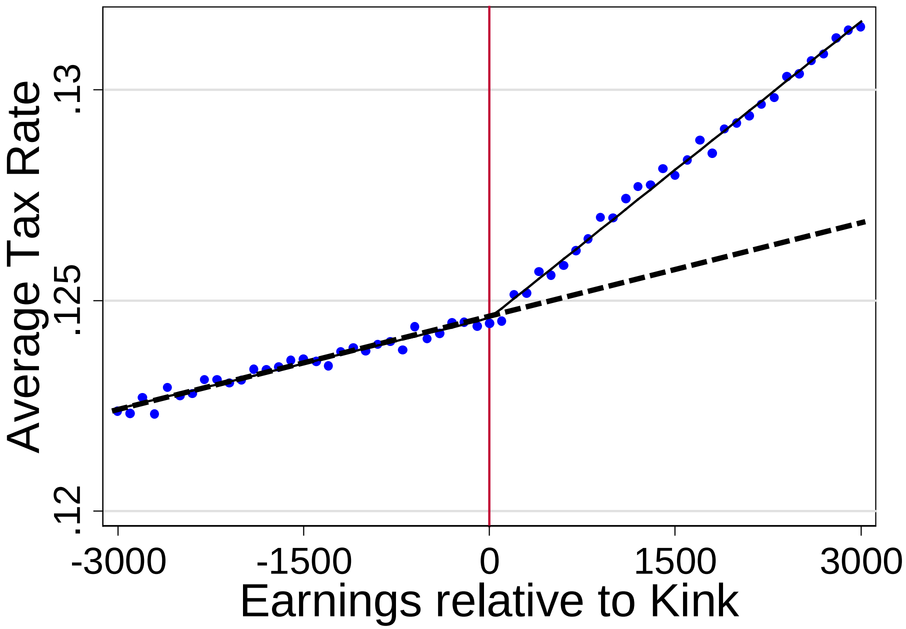
Notes: For each figure, the circles show mean after-tax income or tax liability within each $100 bin of earnings relative to the tax kink points. The solid lines show fitted values within each $100 bin of earnings relative to the kink points. Fitted values are obtained from regressions using the individual-level data in which after-tax income or tax liability 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. The dotted lines depict counterfactual values based on assuming a constant slope from earnings less than the tax kink points. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.

Appendix Figure 2. Empirical Changes at 15%-25% Kink

A. After-Tax Income



B. Average Tax Rate



Notes: For each figure, the circles show mean after-tax income or average tax rates within each $100 bin of earnings relative to the tax kink points. Average tax rates are computed by dividing total tax liability by pre-tax income. 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 after-tax income or average tax rate 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. The dotted lines depict counterfactual values based on assuming a constant slope from earnings less than the tax kink points. Earnings relative to the tax kink points is computed using earned income and taxable income for EITC kink 1 and the 15%-25% kink respectively. $100 bins are assigned based on rounding earnings relative to the kink point to the nearest $100 amount.