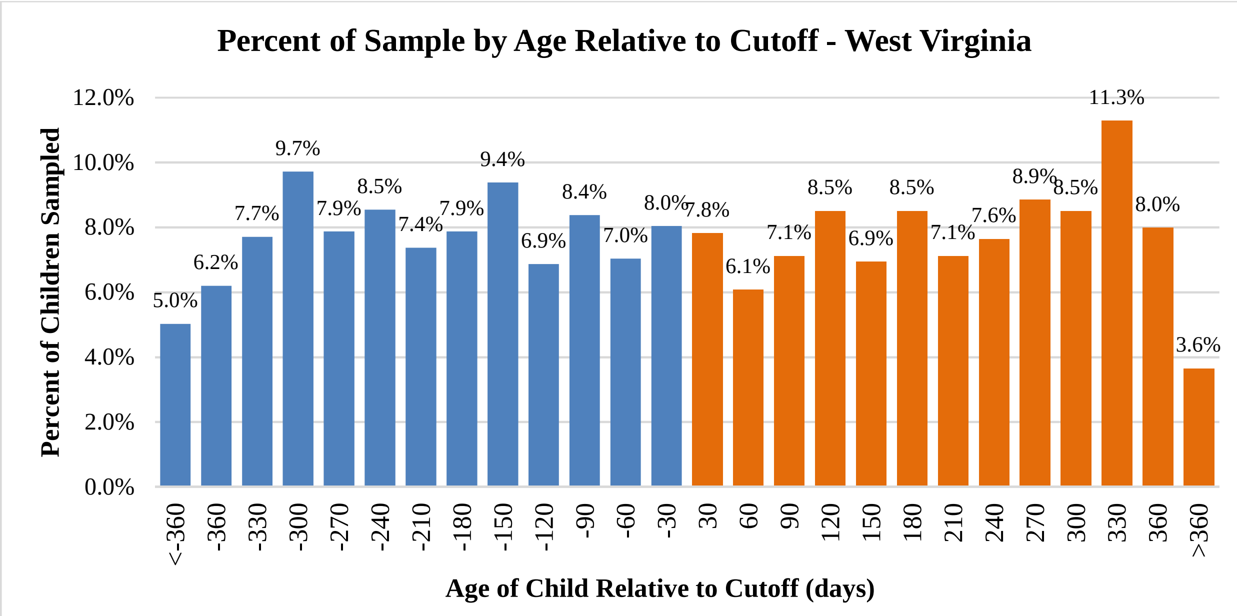
Appendix A.

Full Estimations and Methodology.

Birth Date Distribution in The Sample

Figure A1. Birth Date Distribution (WV). This illustrates how children in the sample are distributed relative to cutoff date.



RDD Estimation Method

An RDD method

This evaluation employs a regression-discontinuity (RD) design. The RD design compares two groups of children who select, and are selected by, a state prekindergarten program, taking advantage of the stringent age (birth date) cutoff that states use in defining enrollment eligibility to define groups. This design is conceptually easier to understand by taking the extreme case: consider two children who differ only in that one was born the day before the age cutoff and the other the day after. When both are about to turn 5 years old the slightly younger child will enter the preschool program and the slightly older child will enter kindergarten having already attended the preschool program. If both are tested at that time, the difference in their scores provides an unbiased estimate of the preschool program's effect. Obviously, if only children with birthdays one day on either side of the age cutoff were included in a study, the sample size would be unreasonably small. However, the approach can be applied to wider age ranges around the cutoff. In fact, all children entering kindergarten from the state preschool program, and all children beginning preschool in the same year can be included in the study using RD statistical techniques.

To estimate the effects of the prekindergarten programs on children's test scores we used a single equation model for each outcome measure. The model accounted for the number of days between birthdates and the enrollment cut-off dates for each sample child, gender, and low-income status. Analyses were conducted using raw scores. In the single equation model, the effect of attending the preschool program is estimated at the birth date cut-off for enrollment. A "treatment" variable was defined by assigning all children with birth date after cut-off date with a value of one (treatment) and all other children a value of zero (comparison). The selection variable (the age difference between birth date and cut-off date) was rescaled so that zero-point corresponded to the cut point. Thus, children in the treatment group had positive values, and children in the comparison group had negative values. An interaction term was constructed by multiplying the cut-off dummy variable by the rescaled selection variable.

As there is no *a priori* expectation that the estimated relationship should be linear, we estimated higher order polynomial forms of the equation, including squared and cubic transformations of the selection variable (the difference between birth date and cut-off date) and its interaction with the cut-off dummy variable), and therefore we analyzed higher order polynomials, although the figures below only show the linear fitted estimation.

For the regression discontinuity design to be effective, programs must adhere to a fairly strict use of a birth-date cut-off date for program enrollment to determine whether children are enrolled into the kindergarten or prekindergarten program based on their age. To address the issue of children whose enrollment does not follow the birth date cutoff, we conducted the parametric analyses with the full sample including the cases that violate the assignment rule. The full sample estimates may be viewed as intent-to-treat (ITT) estimates. Intent to treat (ITT) estimates is the average difference between children who are eligible and not eligible, regardless of children end up following their assignment rule or not. In addition, we conducted instrumental variable (IV) analyses in which we treat students' true assignment into pre-K as an instrument for their actual participation (Hahn et al., 2001; Jacob & Lefgren, 2004; Lee & Lemieux, 2010; van der Klaauw, 2008).

Finally, we conducted separate analyses for low income children and females to estimate there effects, separate from the rest of the children in the sample.

Full Results

Part I: Full Sample. Analyses in this section are for the full sample.

Table 1-1. WV RDD ITT Analysis Result

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	7.042**	4.137	5.714	-4.101[b]
		(2.42)	(3.34)	(3.34)	(5.20)
TOPEL	Linear	10.403***	9.192***	9.039***	11.169***[a]
		(0.97)	(1.29)	(1.35)	(1.79)
WJ-AP	Quadratic	1.901***	1.453*	1.836*	1.964*[a]
		(0.53)	(0.65)	(0.71)	(0.92)
DCCS	Linear	0.105	0.085	0.050	0.048
		(0.06)	(0.07)	(0.08)	(0.09)
DCCS New	Linear	1.538*	1.329	0.893	0.370
		(0.64)	(0.77)	(0.81)	(0.98)
PT	Linear	1.338*	1.197	1.474	0.274[b]
		(0.58)	(0.73)	(0.80)	(1.27)

Robust standard errors in parentheses
* $p < .05$, ** $p < .01$, *** $p < .001$ [a] Quadratic functional forms are identified in WJ-AP, and TOPEL six month ITT adjusted estimates, and WJ-AP IV adjusted estimates.
[b] Cubic functional forms are identified in PPVT and PT six month ITT adjusted estimates.

Table 1-2. WV RDD IV Analysis Result

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	7.628**	4.738	6.925	-5.843[b]
		(2.59)	(3.78)	(4.02)	(7.84)
TOPEL	Linear	11.269***	10.528***	10.954***	14.695***[a]
		(1.02)	(1.39)	(1.49)	(2.22)
WJ-AP	Quadratic	2.059***	1.664*	2.225**	2.585*[a]
		(0.56)	(0.73)	(0.81)	(1.12)
DCCS	Linear	0.114	0.097	0.061	0.056
		(0.07)	(0.08)	(0.09)	(0.11)
DCCS New	Linear	1.666*	1.522	1.083	0.438
		(0.69)	(0.86)	(0.97)	(1.16)
PT	Linear	1.449*	1.371	1.786	0.390[b]
		(0.62)	(0.82)	(0.94)	(1.79)

Robust standard errors in parentheses
* $p < .05$, ** $p < .01$, *** $p < .001$ [a] Quadratic functional forms are identified in WJ-AP, and TOPEL six month IV adjusted estimates, and WJ-AP IV adjusted estimates.
[b] Cubic functional forms are identified in PPVT and PT six month IV adjusted estimates.

Table 1-3. Effect Size of Estimates

		PPVT		TOPEL		WJ-AP		DCCS		DCCS New		PT	
		Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size
12 month	ITT	7.04**	0.31**	10.40***	1.07***	1.45*	0.32*	0.11	0.18	1.54*	0.26*	1.34*	0.23*
	IV	7.63**	0.33**	11.27***	1.16***	1.66*	0.36*	0.11	0.20	1.67*	0.29*	1.45*	0.25*
6 month	ITT	-4.10[b]	-0.18[b]	11.17[a]	1.14[a]	1.96[a]	0.43[a]	0.05	0.08	0.37	0.06	0.27[b]	0.05[b]
	IV	-5.84[b]	-0.25[b]	14.70[a]	1.51[a]	2.59[a]	0.56[a]	0.06	0.10	0.44	0.08	0.39[b]	0.07[b]

Robust standard errors in parentheses

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Quadratic functional forms are identified in both ITT and IV adjusted estimates for WJ-AP twelve month as well as WJ-AP and TOPEL six month.

[b] Cubic functional forms are identified in both ITT and IV adjusted estimates for PPVT and PT six month.

Figures 1 below depict the discontinuity at the cutoff, for the 12 months full sample, for the different measures in the study. The discontinuity and the fitted estimation over the observed outcomes for the children in the sample, are further supported by these figures.

Figure 1_1. Linear fit for scatter plot of PPVT score of full sample (12 month)

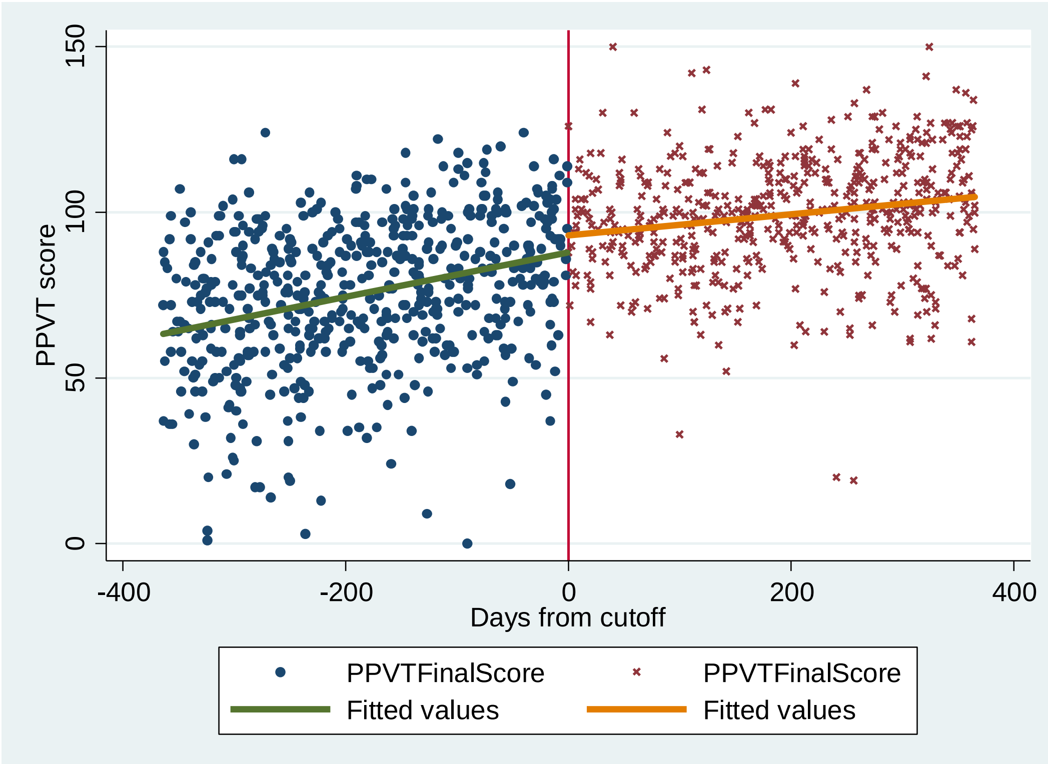


Figure 1_2. Linear fit for scatter plot of WJ AP score of full sample (12 month)

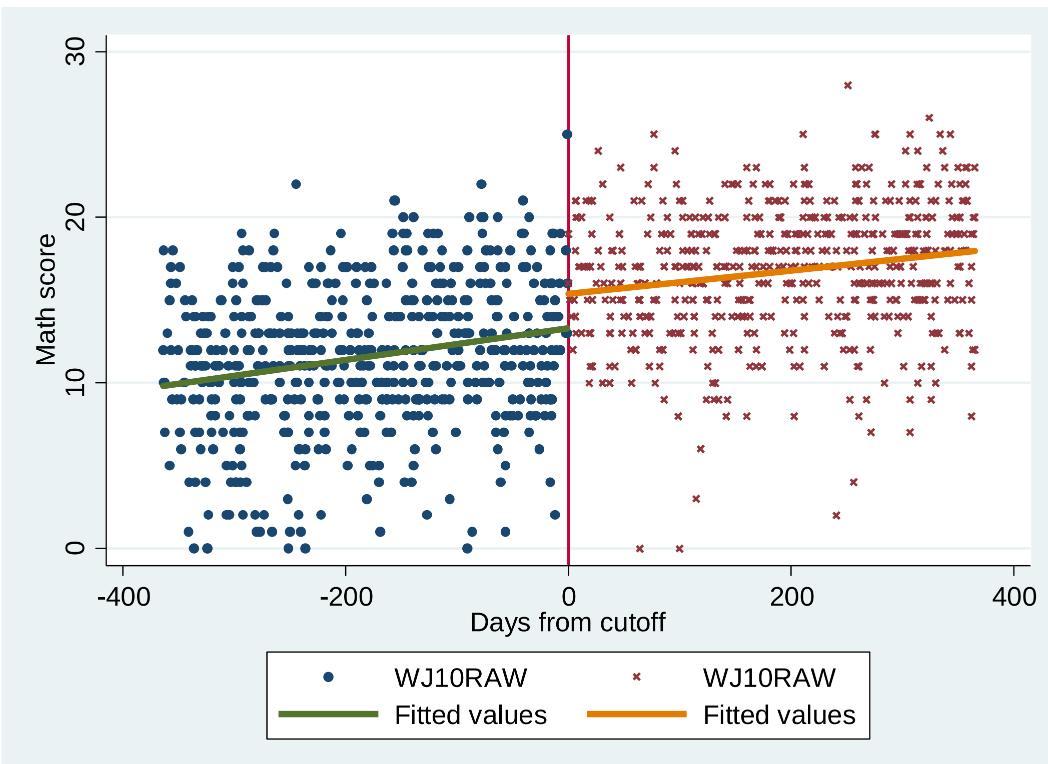


Figure 1_3. Linear fit for scatter plot of TOPEL score of full sample (12 month)

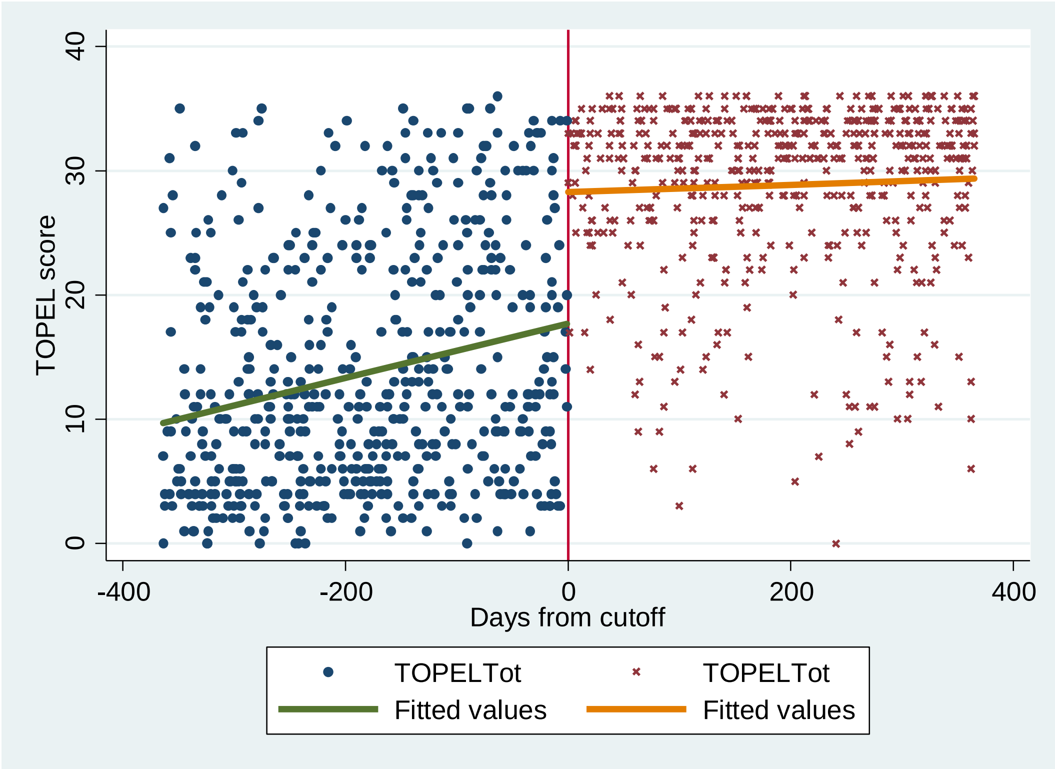


Figure 1_4. Linear fit for scatter plot of DCCS score of full sample (12 month)

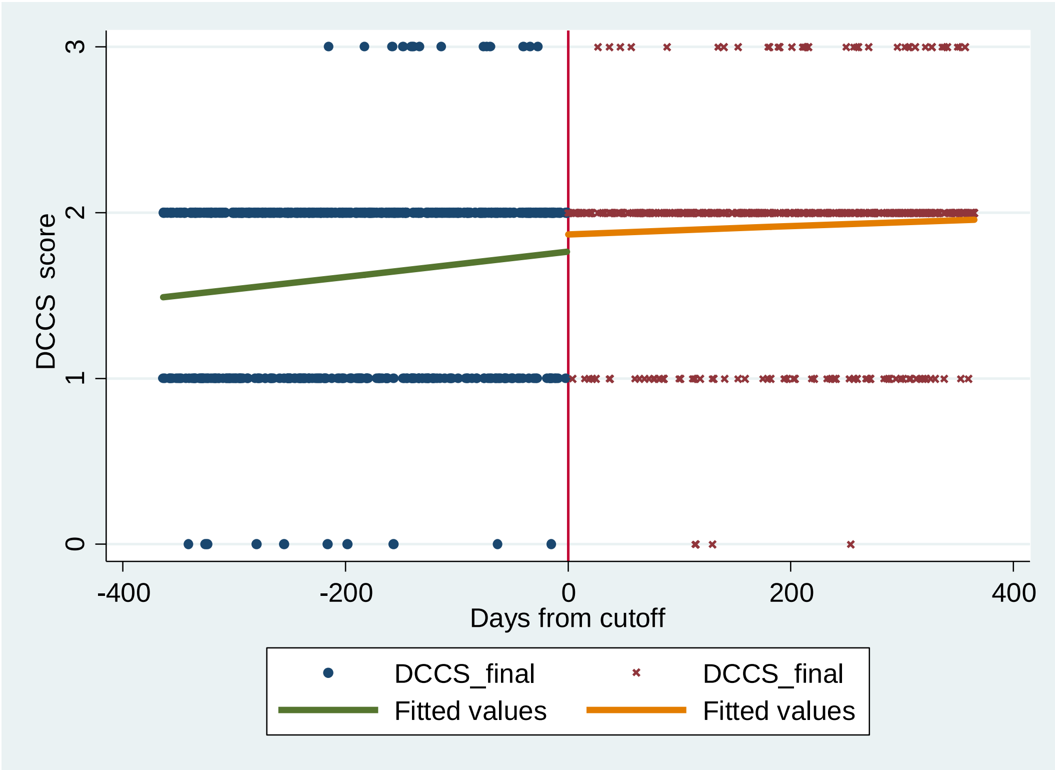


Figure 1_5. Linear fit for scatter plot of PT score of full sample (12 month)

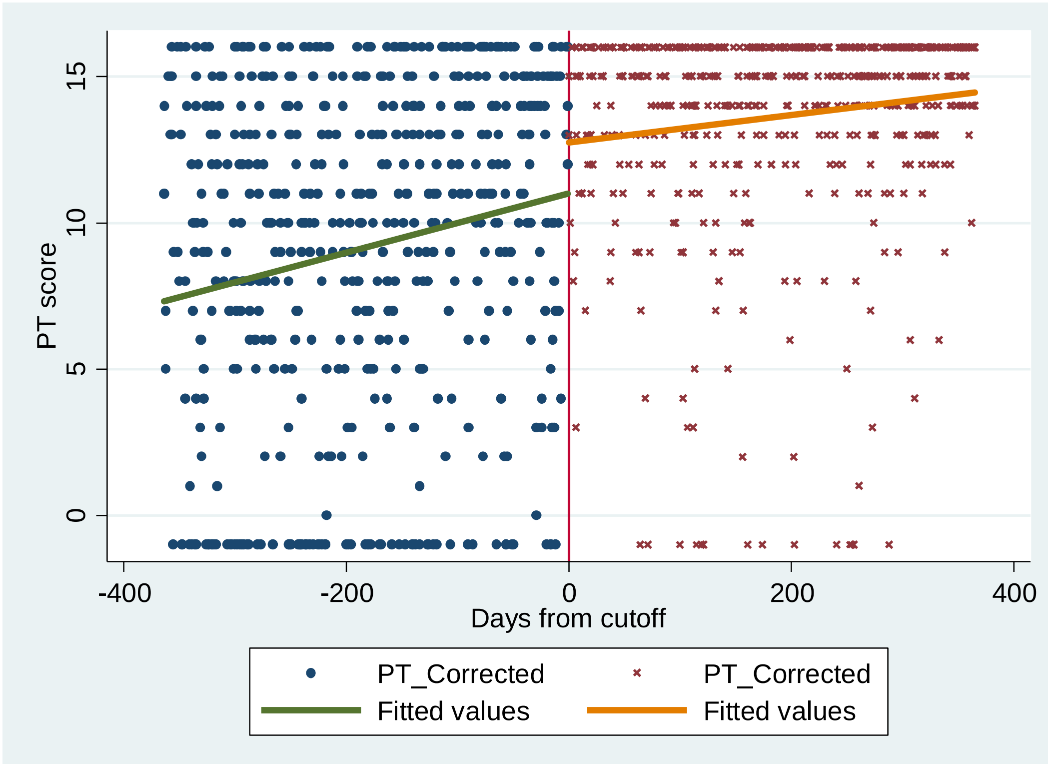
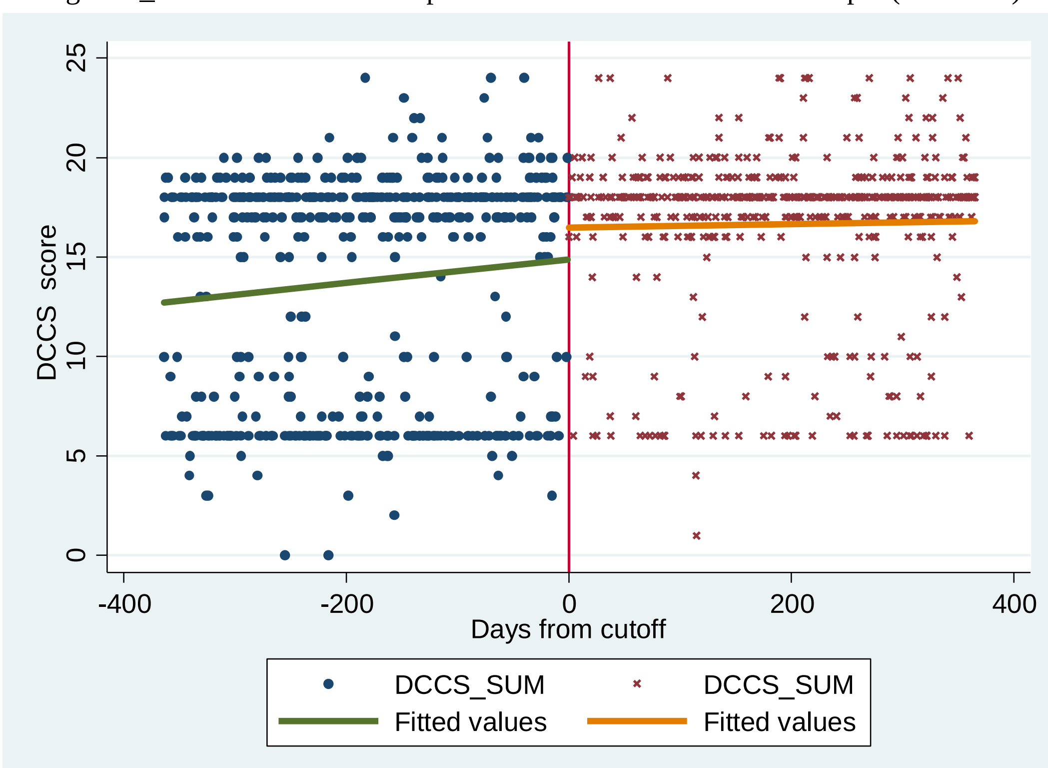


Figure 1_6. Linear fit for scatter plot of new DCCS score of full sample (12 month)



Part II: Partial Sample-Low Income

Table 2-1. WV RDD ITT Analysis Result

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	6.30*	0.44	-1.56	-2.90
		(2.91)	(4.09)	(4.62)	(3.94)
TOPEL	Linear	12.95***	11.69***	11.62***	14.66***a
		(1.29)	(1.83)	(2.25)	(3.00)
WJ-AP	Linear	2.57***	1.85*	1.80	1.32
		(0.63)	(0.80)	(0.98)	(0.84)
DCCS	Linear	0.18	0.15	0.14	0.10
		(0.08)	(0.10)	(0.12)	(0.12)
DCCS New	Linear	1.77*	1.71	1.19	0.47
		(0.83)	(1.04)	(1.27)	(1.25)
PT	Linear	1.30	1.02	0.89	0.71
		(0.67)	(0.83)	(1.02)	(0.95)

Robust standard errors in parentheses

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Quadratic functional form is identified in TOPEL six month adjusted estimates.

Table 2-2. WV RDD IV Analysis Result

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	6.78*	0.50	-1.87	-3.42
		(3.11)	(4.62)	(5.58)	(4.69)
TOPEL	Linear	13.94***	13.22***	13.91***	19.07***a
		(1.35)	(1.95)	(2.49)	(3.69)
WJ-AP	Linear	2.77***	2.10*	2.15	1.56
		(0.66)	(0.88)	(1.14)	(0.96)
DCCS	Linear	0.17	0.16	0.17	0.12
		(0.09)	(0.11)	(0.14)	(0.14)
DCCS New	Linear	1.91*	1.94	1.43	0.56
		(0.88)	(1.15)	(1.50)	(1.46)
PT	Linear	1.40	1.16	1.06	0.83
		(0.72)	(0.93)	(1.23)	(1.12)

Robust standard errors in parentheses

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Quadratic functional form is identified in TOPEL six month IV adjusted estimates.

Table 2-3. Effect Size of Estimates

		PPVT		TOPEL		WJ-AP		DCCS		DCCS New		PT	
		Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size
12 month	ITT	6.30*	0.27*	12.95***	1.46***	2.57***	0.57***	0.18	0.31	1.77*	0.30*	1.30	0.22
	IV	6.78*	0.29*	13.94***	1.58***	2.77***	0.62***	0.17	0.29	1.91*	0.33*	1.40	0.24
6 month	ITT	-2.90	-0.13	14.66***[a]	1.66***[a]	1.32	0.29	0.10	0.17	0.47	0.08	0.71	0.12
	IV	-3.42	-0.15	19.07***[a]	2.16***[a]	1.56	0.35	0.12	0.21	0.56	0.10	0.83	0.14

Robust standard errors in parentheses

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Quadratic functional form is identified in TOPEL six month ITT and IV adjusted estimates.

Part III: Partial Sample-Female Only

Table 1-1. WV RDD ITT Analysis

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	5.937* (2.95)	5.767 (3.79)	6.387 (4.30)	-5.051[b] (6.32)
TOPEL	Linear	8.791*** (1.26)	7.508*** (1.51)	7.666*** (1.63)	12.214*** [a] (2.68)
WJ-AP	Linear	2.004** (0.63)	2.252* (0.78)	2.235* (0.93)	1.939* (0.89)
DCCS	Linear	0.103 (0.07)	0.051 (0.08)	0.024 (0.10)	0.138 (0.10)
DCCS New	Linear	1.369* (0.68)	1.013 (0.84)	0.539 (1.05)	1.353 [b] (2.33)
PT	Linear	1.432* (0.72)	2.343** (0.86)	2.391* (0.94)	3.600 [b] (2.03)

Robust standard errors in parentheses
* $p < .05$, ** $p < .01$, *** $p < .001$ [a] Quadratic functional forms are identified in TOPEL six month, PPVT and DCCS three month ITT adjusted estimates.
[b] Cubic functional forms are identified in PPVT, DCCS New and PT six month ITT adjusted estimates and WJ-AP three month ITT adjusted estimates.

Table 1-2. WV RDD IV Analysis Result

	Empirically Identified Functional Form (1)	Linear (2)	Quadratic (3)	Cubic (4)	Truncated at 6 months (5)
PPVT	Linear	6.222* (3.08)	6.210 (4.03)	7.174 (4.69)	-5.869 [b] (7.55)
TOPEL	Linear	9.213*** (1.36)	8.085*** (1.68)	8.611*** (1.94)	13.892*** [a] (3.23)
WJ-AP	Linear	2.100** (0.65)	2.425** (0.82)	2.511* (1.00)	2.117* (0.96)
DCCS	Linear	0.108 (0.07)	0.055 (0.09)	0.027 (0.11)	0.151 (0.11)
DCCS New	Linear	1.434* (0.71)	1.090 (0.88)	0.605 (1.15)	1.573 [b] (2.61)
PT	Linear	1.501* (0.75)	2.523** (0.90)	2.685** (1.01)	2.563* (1.04)

Robust standard errors in parentheses
* $p < .05$, ** $p < .01$, *** $p < .001$ [a] Quadratic functional forms are identified in TOPEL six month, PPVT and DCCS three month IV adjusted estimates.
[b] Cubic functional forms are identified in PPVT and DCCS New six month IV adjusted estimates and WJ-AP three month IV adjusted estimates.

Table 1-3. Effect Size of Estimates

		PPVT		TOPEL		WJ-AP		DCCS		DCCS New		PT	
		Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size	Effect	Effect Size
12 month	ITT	5.94*	0.27*	8.79***	0.89***	2.00**	0.44**	0.10	0.18	1.37*	0.24*	1.43*	0.24*
	IV	6.22*	0.28*	9.21***	0.93***	2.10**	0.46**	0.11	0.19	1.43*	0.25*	1.50*	0.26*
6 month	ITT	-5.05*b	-0.26*b	12.21***a	1.25***a	1.94*	0.46*	0.14	0.25	1.35b	0.25b	3.60b	0.69b
	IV	-5.87b	-0.30b	13.89***a	1.43***a	2.12*	0.50*	0.15	0.27	1.57b	0.29b	2.56*	0.49*

Robust standard errors in parentheses

* $p < .05$, ** $p < .01$, *** $p < .001$.

[a] Quadratic functional forms are identified in both ITT and IV adjusted estimates for TOPEL six month, PPVT and DCCS three month.

[b] Cubic functional forms are identified in both ITT and IV adjusted estimates for PPVT and DCCS New six month and WJ-AP three month. Cubic functional form is also identified in PT six month ITT adjusted estimates.