Estimating Marginal Returns to Education

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This paper estimates marginal returns to college for individuals induced to enroll in college by different marginal policy changes. The recent instrumental variables literature seeks to estimate this parameter, but in general it does so only under strong assumptions that are tested and found wanting. We show how to utilize economic theory and local instrumental variables estimators to estimate the effect of marginal policy changes. Our empirical analysis shows that returns are higher for individuals with values of unobservables that make them more likely to attend college. We contrast our estimates with IV estimates of the return to schooling.

TABLE 2—DEFINITIONS OF THE VARIABLES USED IN THE EMPIRICAL ANALYSIS

Variable	Definition
Y	Log wage in 1991 (average of all nonmissing wages between 1989 and 1993)
$S = 1$	If ever enrolled in college by 1991; zero otherwise
$\mathbf{X}$	AFQT,[a] mother's education, number of siblings, average log earnings 1979–2000 in county of residence at 17, average unemployment 1979–2000 in state of residence at 17, urban residence at 14, cohort dummies, years of experience in 1991, average local log earnings in 1991, local unemployment in 1991
$\mathbf{Z}\backslash\mathbf{X}^{b}$	Presence of a college at age 14 (Card 1995; Stephen V. Cameron and Christopher Taber 2004), local earnings at 17 (Cameron and Heckman 1998; Cameron and Taber 2004), local unemployment at 17 (Cameron and Heckman 1998), local tuition in public four-year colleges at 17 (Thomas J. Kane and Cecilia E. Rouse 1995)

TABLE 3—COLLEGE DECISION MODEL: AVERAGE MARGINAL DERIVATIVES

	Average derivative
Controls (**X**)	
Corrected AFQT	0.2826
	(0.0114)***
Mother's years of schooling	0.0441
	(0.0059)***
Number of siblings	−0.0233
	(0.0068)***
Urban residence at 14	0.0340
	(0.0274)
"Permanent" local log earnings at 17	0.1820
	(0.0941)**
"Permanent" state unemployment rate at 17	0.0058
	(0.0165)
Instruments (**Z**)	
Presence of a college at 14	0.0529
	(0.0273)**
Local log earnings at 17	−0.2687
	(0.1008)***
Local unemployment rate at 17 (in percent)	0.0149
	(0.0100)
Tuition in 4 year public colleges at 17 (in \$100)	−0.0027
	(0.0017)*
Test for joint significance of instruments: *p*-value	0.0001

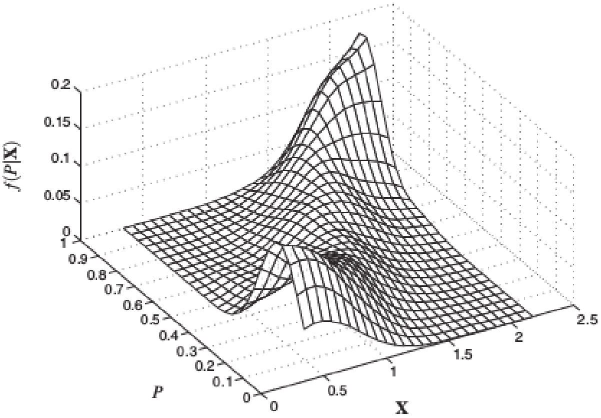


FIGURE 2. SUPPORT OF P CONDITIONAL ON $\mathbf{X}$

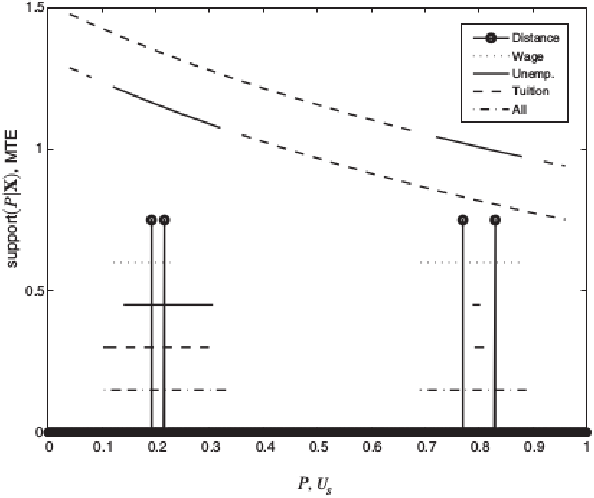
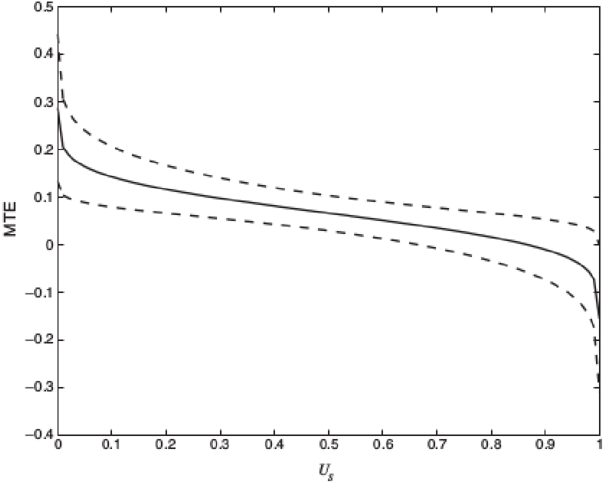


FIGURE 7. SUPPORT OF P FOR FIXED $\mathbf{X}$



MTE
U_S
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

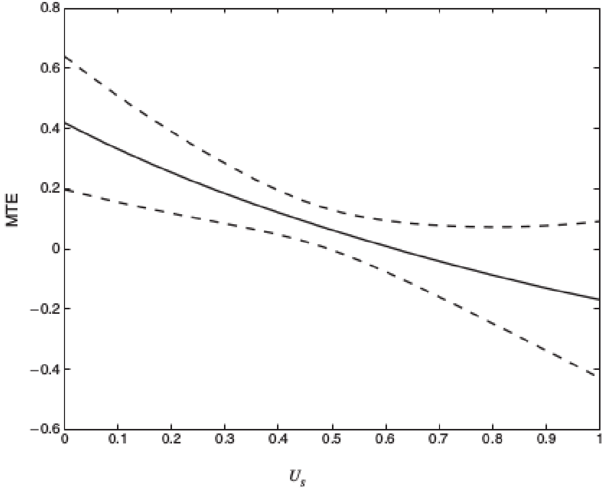


FIGURE 4. $E(Y_1 - Y_0 | \mathbf{X}, U_S)$ WITH 90 PERCENT CONFIDENCE INTERVAL—
LOCALLY QUADRATIC REGRESSION ESTIMATES

TABLE 4— TEST OF LINEARITY OF $E(Y|\mathbf{X}, P = p)$ USING POLYNOMIALS IN P; AND TEST OF EQUALITY OF LATES OVER DIFFERENT INTERVALS (H_0: $LATE^j\,(U_S^{L_j}, U_S^{H_j}) - LATE^{j+1}\,(U_S^{L_{j+1}}, U_S^{H_{j+1}}) = 0$)

Panel A. Test of linearity of $E(Y|\mathbf{X}, P = p)$ using models with different orders of polynomials in P[a]

Degree of polynomial for model	2	3	4	5
p-value of joint test of nonlinear terms	0.035	0.049	0.086	0.122
Adjusted critical value		0.057		
Outcome of test		Reject		

Panel B. Test of equality of LATEs (H_0: $LATE^j\,(U_S^{L_j}, U_S^{H_j}) - LATE^{j+1}\,(U_S^{L_{j+1}}, U_S^{H_{j+1}}) = 0$)[b]

Ranges of U_S for $LATE^j$	(0,0.04)	(0.08,0.12)	(0.16,0.20)	(0.24,0.28)	(0.32,0.36)	(0.40,0.44)
Ranges of U_S for $LATE^{j+1}$	(0.08,0.12)	(0.16,0.20)	(0.24,0.28)	(0.32,0.36)	(0.40,0.44)	(0.48,0.52)
Difference in LATEs	0.0689	0.0629	0.0577	0.0531	0.0492	0.0459
p-value	0.0240	0.0280	0.0280	0.0320	0.0320	0.0520
Ranges of U_S for $LATE^j$	(0.48,0.52)	(0.56,0.60)	(0.64,0.68)	(0.72,0.76)	(0.80,0.84)	(0.88,0.92)
Ranges of U_S for $LATE^{j+1}$	(0.56,0.60)	(0.64,0.68)	(0.72,0.76)	(0.80,0.84)	(0.88,0.92)	(0.96,1)
Difference in LATEs	0.0431	0.0408	0.0385	0.0364	0.0339	0.0311
p-value	0.0520	0.0760	0.0960	0.1320	0.1800	0.2400
Joint p-value				0.0520		

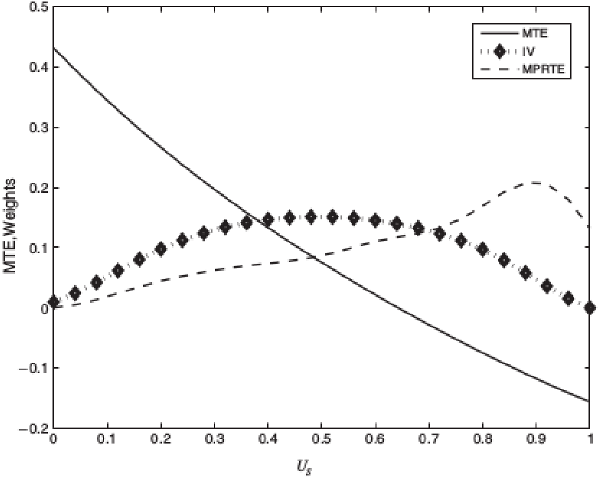


Figure 6. Weights for IV and MPRTE

Table 5—Returns to a Year of College

Model		Normal	Semiparametric
$ATE = E(\beta)$		0.0670 (0.0378)	Not identified
$TT = E(\beta \mid S = 1)$		0.1433 (0.0346)	Not identified
$TUT = E(\beta \mid S = 0)$		−0.0066 (0.0707)	Not identified
MPRTE			
Policy perturbation	Metric		
$Z_\alpha^k = Z^k + \alpha$	$\lvert \mathbf{Z}\gamma - V \rvert < e$	0.0662 (0.0373)	0.0802 (0.0424)
$P_\alpha = P + \alpha$	$\lvert P - U \rvert < e$	0.0637 (0.0379)	0.0865 (0.0455)
$P_\alpha = (1 + \alpha)P$	$\lvert \frac{P}{U} - 1 \rvert < e$	0.0363 (0.0569)	0.0148 (0.0589)
Linear IV (Using $P(\mathbf{Z})$ as the instrument)		0.0951 (0.0386)	
OLS		0.0836 (0.0068)	

Appendix

References

Carneiro, P., Heckman, J. J., & Vytlacil, E. J. (2011). Estimating marginal returns to education. *American Economic Review*, *101*(6), 2754–2781.