Estimation of Educational Borrowing Constraints using Returns to Schooling

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October 25, 2015

Lang (1993) and Card (1995) suggest

- Often IV estimates of Returns to Schooling are Higher than OLS
- "Discount Rate Bias" is one explanation
- People invest in schooling until marginal return equals interest rate
- If instrument affects people with high personal interest rate, they will also have high returns to schooling
- IV picks up effect for them so it could be high

This argument implicitly suggests that borrowing constraints are important.

We take this argument one step further

In this framework understanding returns and schooling decisions together is important and informative

As we have discussed, a major reason to care about the returns to schooling is because we care about borrowing constraints

We have a model in which people are borrowing constrained in school, but borrow and lend freely afterward

Basic Idea:

Consider two different types of costs

- Direct costs of School: These must be financed while in school
- Foregone Earnings: These do not need to be financed in school

Changing the direct costs of school affects borrowing constrained individuals relatively more than foregone earnings

We use this distinction for identification in three contexts:

- Regression Approach
- Instrumental Variables
- Structural Model

The Model

$$V_s = \sum_{t=0}^{\infty} \delta^t \frac{c_t^\gamma}{\gamma} + T(S),$$

$$S = \arg\max \{V_S \mid S \in \mathcal{S}\}.$$

People face interest rate R while in school

Market interest rate $\frac{1}{\delta}$ afterward

Maximize utility subject to

$$\sum_{t=0}^{S-1} \left(\frac{1}{R}\right)^t c_t + \left(\frac{1}{R}\right)^S \sum_{t=S}^{\infty} \delta^{t-s} c_t \leq I_s,$$

Present Value of Income:

$$I_S = \left(\frac{1}{R}\right)^S \sum_{t=S}^{T} \delta^{t-S} w_{ts} - \sum_{t=0}^{S-1} \left(\frac{1}{R}\right)^t \tau_{t+1}$$

This gives psuedo-indirect utility function

$$V_S = \frac{I_S^{\gamma} \left(\sum_{t=0}^{S-1} R^{\frac{t\gamma}{1-\gamma}} \delta^{\frac{t}{1-\gamma}} + (R\delta)^{\frac{S\gamma}{1-\gamma}} \sum_{t=S}^{\infty} \delta^t\right)^{1-\gamma}}{\gamma} + T(S).$$

Sketch of Result

Consider choice between two options

$$
\begin{aligned}
V_0 &= \frac{W_0^{\gamma}\left(\frac{1}{1-\delta}\right)^{1-\gamma}}{\gamma} \\
V_1 &= \frac{(W_1/R-\tau_1)^{\gamma}\left(1+(R\delta)^{\frac{\gamma}{1-\gamma}}\sum_{t=1}^{\infty}\delta^t\right)^{1-\gamma}}{\gamma}
\end{aligned}
$$

τ_1 represents direct costs

Consider two individuals who are just indifferent between these choices

$$(V_0 = V_1)$$

In addition suppose that the total level of utility and tastes for schooling are identical for the two.

For Non-Borrowing Constrained Student $(\delta = 1/R)$:

$$-\frac{\partial\left(V_1 - V_0\right)}{\partial \tau_1} = \frac{\gamma V_1}{\left(\delta W_1 - \tau_1\right)} = \frac{\gamma V_0}{W_0} = \frac{\partial\left(V_1 - V_0\right)}{\partial W_0}.$$

Marginal Value of \$1.00 is the same during school as out of School

For Borrowing Constrained $(\delta > 1/R)$:

$$-\frac{\partial\left(V_1 - V_0\right)}{\partial \tau_1} = \frac{\gamma V_1}{\left(\frac{1}{R} W_1 - \tau_1\right)} > \frac{\gamma V_0}{W_0} = \frac{\partial\left(V_1 - V_0\right)}{\partial W_0}.$$

Marginal Value of \$1.00 is Higher During School

Data

NLSY

Variables that we use:

- Local Labor Market Variation
- Presence of a college in county

We need to know where they lived at 17, so we use only the younger cohorts

Local Labor Market data comes from Bureau of Economic Analysis

County level measures of income-Services, Agricultural, Wholesale and Retail Trade

Presence of a college: we use Dept. of Education HEGIS and IPEDS, count whether there is either a two or four year college in county

IV Estimates

Idea for IV:

When we instrument using college in a county it should pick up borrowing constrained people

Prediction: IV estimate should be higher using presence of a college as an instrument

Local income at 17 could pick up wealth of county

Want to control for local labor market at time wage is earned

$$\log(w_{it}) = \beta_0 + S_i\beta_1 + \ell_{it}\beta_2 + X_{it}\beta_3 + u_{it},$$

Problem is that moving is endogenous

We instrument for ℓ_{it}, with the value of local income at date t in the county that i lived when the were 17

Table 2
First Stage Regression of
Schooling on Explanatory Variables
(Standard Errors in Parentheses)

Variable	(1)	(2)	(3)	(4)
Coll in County	0.417			0.435
	(0.152)			(0.148)
Loc Inc at 17		-0.023	-0.182	-0.183
		(0.021)	(0.074)	(0.074)
Mean Loc Inc			0.130	0.123
Working Life*			(0.058)	(0.058)

Local Earnings as Instrument

Table 3

	OLS	IV1	IV2
Schooling	0.058	0.083	0.110
	(0.004)	(0.042)	(0.086)

College in County as Instrument

Table 4a

	OLS	IV1	IV2
Schooling	0.062	0.228	0.193
	(0.004)	(0.109)	(0.084)

But this is not directly comparable because we did not control for local income

Might make sense to do this anyway

Control for Current Local Income

Table 4a

	OLS	IV1	IV2
Schooling	0.058	0.057	0.061
	(0.004)	(0.115)	(0.076)

Regression Approach

Model predicts that families that are borrowing constrained should be more sensitive to direct costs of schooling than others

If we knew who was borrowing constrained we could test this directly

We don't know exactly, but we have some idea who is more likely to be borrowing constrained

Table 7

Black×	-0.330
College in County	(0.220)
Hispanic×	-0.635
College in County	(0.390)
Highest Grade Father×	0.071
College in County	(0.030)
Highest Grade Mother×	-0.065
College in County	(0.055)
Family Income×	0.111
College in County	(0.067)
Number of Siblings×	-0.039
College in County	(0.041)

Structural Approach

$$\log(w_{sit}) = \gamma_S + X'_{Wi}\beta_W + X'_{\ell it}\beta_\ell + u_{sit}$$

$$\tau_t = X'_{Ci}\beta_C$$

We solve certainty equivalence problem so we ignore uncertainty coming after schooling decisions

$$I_{si} = \left(\frac{1}{R_i}\right)^S e^{\gamma_S + X'_{Wi}\beta_W} \left(\sum_{t=S}^{\infty} \delta^{t-S} e^{E_S\left(X'_{\ell it}\beta_\ell\right) + E_s(u_{it})}\right) - \sum_{t=0}^{S-1} \left(\frac{1}{R_i}\right)^t X'_{Ci}\beta_C$$

Use log utility

$$
\begin{aligned}
V_{Si} &= \left(\frac{1}{1-\delta}\right)\left(\log\left(I_{Si}\right)+\log\left(1-\delta\right)\right) \\
&\quad + \left[\sum_{t=0}^{S-1}\delta^t t + \left(\frac{\delta^S}{1-\delta}\right)S\right]\log\left(\delta R_i\right) + X_{Ti}^{'}\beta_{TS} + \nu_{Si} \\
&\equiv \alpha_1 \log\left(\left(\frac{1}{R_i}\right)^S e^{X_{Wi}^{'}\beta_W + X_{LSi}^{'}\widetilde{\beta}_{LS} + \theta_{Si}} - \sum_{t=0}^{S-1}\left(\frac{1}{R_i}\right)^t X_{Ci}^{'}\beta_C\right) \\
&\quad + \alpha_{2S} + \alpha_{3S}\log(R_i) + X_{Ti}^{'}\beta_{TS} + \nu_{Si},
\end{aligned}
$$

where $X_{Ti}^{'}\beta_{TS} + \nu_{Si}$ represents non-pecuniary tastes for school level S

Observable Borrowing Constraints

First we let R_i depend on observables

Do it in such a way that left out group is not borrowing constrained

Four schooling choices, dropout, high school graduate, some college, college graduate

Error term is nested logit

Can interpret either as multinomial choice or Dynamic Discrete Choice with uncertainty

Table 9

Tests for the Presence of Borrowing Constraints

Specification	Borr. Rate[b]	Likelihood
A. Base Case:		2547.69
Everyone	1.031	
B. Racial Groups:		2547.34
Whites	1.031	
Blacks	1.000	
Hispanics	1.000	
C. Parents Education:		2547.42
Both College Educated	1.031	
Father 12, Mother 12	1.000	
Father 12, Mother Coll	1.000	
Father Coll, Mother 12	1.033	

D. Family Income:		2546.91
Top Third	1.031	
	(-)	
Middle Third	1.032	
	(0.006)	
Bottom Third	1.038	
	(0.008)	
E. Number of Siblings:		2547.69
Zero	1.031	
	(-)	
Two	1.031	
	(0.003)	
Four	1.031	
	(0.006)	

Unobservable Borrowing Constraints

Next we let R_i be random

Intuition for Identification:

$$\begin{aligned}
V_{0i} &= \alpha_1 \left(X'_{Wi}\beta_W + X'_{\ell 0i}\widetilde{\beta}_{\ell 0} + \theta_{0i} \right) + a_1 \\
&\quad + X'_{Ti}\beta_{T0} + \nu_{T0i} \\
V_{1i} &= \alpha_1 \log(e^{-\log(R_i) + X'_{Wi}\beta_W + X'_{\ell 1i}\widetilde{\beta}_{\ell 1} + \theta_{1i}} - X'_{ci}\beta_c) + a_2 \\
&\quad + a_3 \log(R_i) + X'_{Ti}\beta_{T1} + \nu_{T1i}. \\
\log(w_{it}) &= \beta_0 + S_i\beta_1 + \ell_{it}\beta_2 + X_{it}\beta_3 + u_{it},
\end{aligned}$$

$$V_{1i} - V_{0i} = \alpha_1 \log(e^{X_i\Gamma_1 + \varepsilon_{1i}} - X'_{ci}\beta_c) + X_i\Gamma_2 + \varepsilon_{2i},$$

Three error terms $(\varepsilon_{1i}, \varepsilon_{2i}, u_{it})$.

Three indices $(X_i\Gamma_1, X_i\Gamma_2, X_{ci}\beta_c)$

We want to force Identification in practice to use these ideas rather than functional forms.

In particular:

- R_i takes on two values either borrowing constrained or not
- Flexible about form of ability bias, selection
- Use Iterative procedure

We want some parameters to be estimated from Selection Equation Ψ_1 (Tastes for Schooling)

Others from outcome equation Ψ_2 (wage coefficient, form of selection bias)

1. Fix Ψ_2 and solve for the value of Ψ_1 that maximizes the likelihood of the school choice model.
2. Fix Ψ_1 and solve for the value of Ψ_2 that minimizes the nonlinear least squares,

Table 10

Structural Schooling Model

Distribution of Borrowing Rates (R_i)

Rates	1.030	1.071
Probability	1.00	0.00

Conclusions

We find no evidence that borrowing constraints or “discount rate bias” is important