"The cyclicality of skill acquisition: evidence from panel data"

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Web Appendix

This appendix complements the paper "The cyclicality of skill acquisition: evidence from panel data". In the first section, we discuss the cyclicality of time devoted to educational activities using data from the American Time Use Surveys (ATUS). In the second section, we provide additional robustness checks to the statistical analysis presented in the paper.

1 Individual level regressions using data from ATUS

This section discusses the cyclicality of time devoted to educational activities, as reported in the American Time Use Surveys (ATUS). The evidence presented here complements that of the paper, where the incidence of schooling and training is measured using data from the National Longitudinal Survey of Youth 1979 (NLSY 79).

We obtained the data from the ATUS summary activity file; which can be downloaded from the Bureau of Labor statistics website http://www.bls.gov. In producing some of the statistics presented in the paper and in this appendix, sampling weights need to be employed. The weights are clearly explained in the user's guide and can be downloaded together with the summary activity file [1]. The Stata routines used to conduct the analysis are available upon request.

The ATUS surveys are annual, cross-sectional surveys conducted yearly since 2003 (the last survey available at the time we write this appendix was that of 2009). They contain detailed information on the time allocations of individual survey respondents for the day of

[1] http://www.bls.gov/tus/atususersguide.pdf

the interview. The surveys contain a time-use category called "time devoted to educational activities". This category includes several sub-categories that record time spent attending classes, conducting research and homework, fulfilling administrative processes, and other similar activities. We added up the time spent on all of these subcategories in order to construct our main dependent variable of *Time in school*, expressed in minutes per day.

The ATUS files also contain measures of demographic and educational characteristics which we use as control variables. We utilize the ATUS variable "telfs" to classify individuals as employed or unemployed, and to identify those who are out of the labor force. Similarly, we create the dummy variable *College* which equals 1 if the individual has a college degree and zero otherwise. We also construct dummy variables for *Race* (1=white, 0=otherwise); *Gender* (1=male, 0=female); *Income*; and the number of children under 18 that live in the household (*Children*). Finally, we collect information on the monthly unemployment rate from the Bureau of Labor and Statistics (the highest frequency available), and label this variable *Unemployment*. We restrict the sample to individuals in the labor force and in between the ages of 19 and 49, to make it comparable with that in the paper.

Table 1 shows the descriptive statistics of these variables. The sample contains 53,227 observations. In average, 34% of respondents have a college degree, 82% are white, 44% are male, and 80% of the sample is employed. In this data, the correlation between *Time in school* and *Unemployment* is .008 (p=.06), suggesting countercyclical time investments in schooling.

We investigate the cyclicality of time devoted to educational activities by conducting estimations similar to those found in table 5 of the paper. The results are obtained first using OLS, then using the Tobit approach. In all regressions, the dependent variable is *Time in school*. A set of month dummies are included as controls.

The results of OLS estimations are presented in table 2. In column 1 the model is estimated without controlling for employment status. Hours in schooling are countercyclical in this case, but the statistical significance is marginal. In column 2, *Employed* and its

interaction with the unemployment rate are added. Schooling again appears countercyclical, although the response is smaller for employed individuals than for the unemployed, echoing the results in the paper with regards to training. In columns 3 and 4 we divide the sample between unskilled and skilled individuals. For the unskilled, the results are similar to those in column 2, but for college graduates, in column 4, schooling time is acyclical. This result mirrors that found for schooling incidence and reported in the paper

The results are qualitatively similar in table 3, where we use the Tobit model. The importance of controlling for employment status becomes apparent when comparing columns 1 and 2. Time in school appears acyclical in column 1, but as is apparent in column 2, this is due to the canceling out of the responses of employed and unemployed individuals.

Overall, the evidence reported here is in line with that obtained using schooling incidence and reported in the paper. One interesting difference is the distinct responses of time devoted to schooling to unemployment for employed and unemployed individuals. In the paper, this difference is present in the response of training, but not schooling incidence, to changes in the unemployment rate.

2 Robustness checks

In this section we return to the analysis of the NLSY79 data, and present the results of two sets of robustness checks for the main results in the paper. In particular, we reproduce the results in tables 4 and 5 of the paper using, first, an alternative measure of unemployment, and second, an alternative statistical model.

The first set of robustness checks reproduces tables 4 and 5 in the paper substituting the unemployment rate for the ratio of non employed individuals (unemployed plus out of the labor force), over the population aged 17 to 65. This measure is robust to movements in and out of the labor force. Such movements might reduce the cyclical variation in the unemployment rate, in which case our results would exaggerate the effects of unemployment

on skill acquisition.

Table 4 shows the results for training incidence. The results are quite similar to those in table 4 of the paper with two exceptions of note. First, training appears procyclical in the unconditional Logit estimates of column 1. Second, training for the unemployed appears always acyclical here, but is generally countercyclical in the main results. In turn, table 5 reports results for schooling. The results are again very similar to those in the paper. A significant difference is that, in table 5, the effects are larger for unemployed than for employed individuals.

The second set of robustness checks addresses the case where the conditional independence assumption does not hold. Kwak and Wooldridge (2009) provide simulation-based evidence that the FE Logit model is inconsistent when the errors are not conditionally independent, including the case of serial correlation. We reproduce the results of tables 4 and 5 of the paper using a version of correlated random effects (CRE) Probit, where we allow for a general correlation structure in the errors. The CRE model is robust to violations in the conditional independence assumption, at the cost of specifying a functional form for the relationship between individual invariant effect and the covariates. In our case, we use a linear function of the individual means of the variables *Not working*, *College*, *Gender*, and the three terms of the cubic polynomial in age. Our version of the CRE model uses a sandwich type estimator for the variances, which is somewhat less efficient than the standard CRE approach. We use this estimator because we faced difficulties in making the standard CRE maximum likelihood procedure converge.

Table 6 shows the results for training. We find that the estimates retain the same signs as those in table 4 in the paper, but the standard errors increase, so that significance disappears in a few cases. As in the main results, training is countercyclical for the unemployed in both the unconditional estimates of marginal effects (column 1), and the FE estimates (column 2). The estimates of cyclicality for in the case of firm financed training (column 3) become marginally insignificant. Significance also disappears in column 6, when the sample

is restricted to college graduates. Although the signs of the estimates are similar to those in table 4 of the paper, it is worth noting that the CRE estimates are consistently smaller.

In turn, table 7 shows the results for schooling. Here, the results are almost identical to those in table 5 of the paper. As in the case of training, the estimates are generally smaller than in the FE estimates.

Table 1: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Time in school	12.388	67.736	0	1090	53227
Unemployment	5.853	1.465	4.4	10.1	53239
College	0.342	0.474	0	1	53227
Race	0.823	0.382	0	1	53227
Gender	0.439	0.496	0	1	53227
Children	1.316	1.196	0	11	53227
Employed	0.801	0.399	0	1	53227

Table 2: Hours in schooling activities, linear regression

	Pooled	Pooled2	Unskilled	Skilled
	(1)	(2)	(3)	(4)
Unemployment	.39	2.91	3.33	1.12
	(.20)*	(.65)***	(.74)***	(1.44)
College	3.07	2.37		
	(.62)***	(.56)***		
Race	-3.97	-2.61	-1.33	-4.85
	(.76)***	(.70)***	(.88)	(1.16)***
Gender	-3.45	-3.25	-4.49	-1.10
	(.58)***	(.53)***	(.68)***	(.86)
Employed		7.06	7.40	-1.89
		(4.33)	(4.94)	(9.59)
Employed×		-2.53	-2.52	-1.37
Unemployment rate		(.68)***	(.78)***	(1.47)
Observations	53227	45234	29033	16201

Dependent variable: *Time in school*
Vars. not shown: age, age sq, age cb, month dummies
Standard errors in parentheses
*** significant at 1%,** significant at 5%,* significant at 10%
Source: ATUS

Table 3: Hours in schooling activities, Tobit

	Pooled	Pooled2	Unskilled	Skilled
	(1)	(2)	(3)	(4)
Unemployment	.92	29.80	32.12	12.16
	(3.22)	(9.27)***	(10.02)***	(22.71)
College	57.25	52.38		
	(10.50)***	(10.92)***		
Race	-80.90	-69.03	-53.31	-98.65
	(11.44)***	(12.01)***	(14.57)***	(21.14)***
Gender	-99.34	-94.49	-108.47	-68.10
	(9.92)***	(10.19)***	(12.49)***	(17.69)***
Employed		83.93	64.77	-7.79
		(64.68)	(70.71)	(155.56)
Employed×		-30.43	-24.93	-25.86
Unemployment rate		(9.91)***	(10.89)**	(23.53)
Observations	53227	45234	29033	16201

Dependent variable: *Time in school*
Vars. not shown: age, age sq, age cb, month dummies
Standard errors in parentheses
*** significant at 1%,** significant at 5%,* significant at 10%
Source: ATUS

Table 4: Training incidence

	Pooled	Pooled-FE	Firm-FE	Self-FE	Unsk-FE	Skilled-FE
	(1)	(2)	(3)	(4)	(5)	(6)
Non employment rate	-1.89 (.66)***	-.13 (.75)	-2.42 (.86)***	6.12 (1.88)***	1.05 (.91)	-3.00 (1.36)**
Not working	-.52 (.48)	.41 (.52)	.07 (.79)	-.28 (1.18)	.84 (.58)	-1.68 (1.34)
Not working× Non employment rate	-.02 (1.66)	-1.37 (1.78)	-.03 (2.70)	.70 (4.02)	-2.90 (1.97)	5.97 (4.54)
College	.59 (.01)***					
Observations	519925	327600	260721	81871	243946	79865
Marginal effect of non employment						
Employed	-.12	-.01	-.21	.36	.09	-.34
	[.00]	[.85]	[.00]	[.21]	[.36]	[.00]
Non employed	-.07	-.11	-.14	.37	-.14	.26
	[.17]	[.35]	[.32]	[.25]	[.28]	[.54]
Aggregate	-.11	-.03	-.2	.36	.05	-.29
	[.00]	[.65]	[.00]	[.18]	[.53]	[.00]

Dependent variable: *Training* (cols. 1,2,5,6), *Firm financed* (col. 3), *Self financed* (col. 4)
Vars. not shown: age, age sq, age cb, recall, quarter dummies
Standard errors in parentheses; p-values in square brackets
*** significant at 1%,** significant at 5%,* significant at 10%
Source: BLS (nonemp); NLSY79 (all other variables).

Table 5: Schooling incidence

	Pooled	Pooled-FE	Pooled-FE2	Unsk-FE	Skilled-FE
	(1)	(2)	(3)	(4)	(5)
Non employment rate	.82 (.77)	4.86 (.85)***	2.43 (.93)***	4.81 (1.21)***	.004 (1.67)
Not working	-2.72 (.49)***		-4.09 (.55)***	-2.13 (.65)***	-.75 (1.31)
Not working× Non employment rate	8.89 (1.67)***		13.76 (1.89)***	7.11 (2.23)***	2.51 (4.47)
College	.76 (.01)***				
Observations	519925	190293	174247	119607	50068
Marginal effect of unemployment					
Employed	.04		.21	.39	.0004
	[.4]		[.1]	[.06]	[1]
Non employed	1.08e-15		.94	.66	.19
	[.00]		[.00]	[.01]	[.6]
Aggregate	.03	.61	.35	.45	.02
	[.39]	[.00]	[.02]	[.03]	[.91]

Dependent variable: *School*.
Vars. not shown: age, age sq, age cb, recall, quarter dummies
Standard errors in parentheses; p-values in square brackets
*** significant at 1%,** significant at 5%,* significant at 10%
Source: BLS (nonemp); NLSY79 (all other variables).

Table 6: Training incidence. Correlated random effects

	Pooled	Pooled-CRE	Firm-CRE	Self-CRE	Unsk-CRE	Skilled-CRE
	(1)	(2)	(3)	(4)	(5)	(6)
Unemployment rate	-.001	-.005	-.01	.02	-.0002	-.02
	(.004)	(.006)	(.007)	(.01)	(.007)	(.01)
Not working	-.44	-.16	-.06	-.15	-.14	-.15
	(.05)***	(.07)**	(.09)	(.13)	(.08)*	(.18)
Not working×	.03	.03	.01	.02	.02	.03
Unemployment rate	(.008)***	(.01)**	(.02)	(.02)	(.01)*	(.03)
College	.29					
	(.006)***					
Observations	519925	519925	519907	519905	416961	102964
Marginal effect of unemployment						
Employed	-.0001	-.0006	-.001	.0005	-.00003	-.003
	[.78]	[.41]	[.1]	[.15]	[.97]	[.2]
Unemployed	.003	.002	.00009	.0008	.002	.002
	[.00]	[.06]	[.83]	[.08]	[.08]	[.6]
Aggregate	.0004	-.0002	-.0009	.0005	.0004	-.002
	[.31]	[.81]	[.12]	[.08]	[.62]	[.26]

Dependent variable: *Training* (cols. 1,2,5,6), *Firm financed* (col. 3), *Self financed* (col. 4)
Vars. not shown: age, age sq, age cb, recall, quarter dummies, and individual averages of Not working, College, Gender, and age to age cubed
Standard errors in parentheses; p-values in square brackets
*** significant at 1%,** significant at 5%,* significant at 10%
Source: BLS (nonemp); NLSY79 (all other variables).

Table 7: Schooling incidence. Correlated random effects

	Pooled	Pooled-CRE	Pooled-CRE2	Unsk-CRE	Skilled-CRE
	(1)	(2)	(3)	(4)	(5)
Unemployment rate	.02	.02	.02	.03	.0003
	(.004)***	(.007)**	(.008)**	(.01)***	(.02)
Not working	-.03		.006	-.04	.01
	(.05)		(.09)	(.10)	(.19)
Not working×	-.005		-.005	.004	-.002
Unemployment rate	(.008)		(.02)	(.02)	(.03)
College	.36				
	(.007)***				
Observations	519925	556690	519925	416961	102964
Marginal effect of unemployment					
Employed	.002		.002	.002	.00004
	[.00]		[.01]	[.00]	[.99]
Unemployed	.001		.001	.002	-.0002
	[.02]		[.32]	[.05]	[.96]
Aggregate	.002	.002	.002	.002	.00001
	[.00]	[.01]	[.01]	[.00]	[1]

Dependent variable: *School*.
Vars. not shown: age, age sq, age cb, recall, quarter dummies, and individual averages of Not working, College, Gender, and age to age cubed
Standard errors in parentheses; p-values in square brackets
*** significant at 1%,** significant at 5%,* significant at 10%
Source: BLS (nonemp); NLSY79 (all other variables).