Online Appendix of "Measuring the Effects of Welfare Time Limits"
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1 Details on Robustness Analysis

Tables A5 and A6 provide additional evidence for the effects of the time limit and the non-time-limit component of FTP under a variety of model specifications. In Table A5, the main objective of the exercise is to control for work experience. As treatment group individuals may accumulate a higher level of work experience than control group individuals, this may potentially affect the model estimates in a complicated way. Since work-related variables are endogenous, additional instruments are constructed in a similar spirit to moments conditions in equation (12) (see main text) using individual-level employment data. The model and the corresponding instrument matrix are defined formally in the next section on GMM estimator. Columns 1 and 2 report the estimates for the baseline and disadvantaged samples, respectively. In both columns, the baseline model is expanded to include work experience (ω_{it}), as well as contemporaneous and three lagged indicators of employment status (x_{it}, $x_{i,t-1}$, $x_{i,t-2}$, $x_{i,t-3}$) as additional regressors.

After controlling for work-related variables, both the stock coefficient β_S and the time horizon coefficient β_A remain similar in size. The treatment group coefficient β_E also remains similar. The estimates reveal interesting relationships between welfare use and labor market outcomes, which are different between baseline and disadvantaged individuals. First, consider baseline individuals (Column 1). All else being equal, welfare use is lower by 0.6 percentage points when an individual accumulates an extra month of work experience. In addition, all else being equal, an individual is 9.9 percentage points less likely to participate in welfare if she works. Both results are consistent with the benefit structure of the welfare program, which provides partial or no payments to workers who have earnings beyond the level designated by the earnings disregard. Next, consider disadvantaged individuals (Column 2). Unlike baseline individuals, neither work experience nor employment status have a significant effect on welfare use. This suggests that the link between welfare use and labor market outcomes is weak among disadvantaged individuals; attachment to the labor market does not induce them to leave welfare.

Table A6 presents model estimates for the baseline sample under several alterative specifications. The results for the disadvantaged sample are qualitatively similar and are therefore not reported. Column 1 extends the baseline model by allowing for the stock effect to be a piecewise linear function of the remaining stock S_{it} (e.g., Ribar, Edelhoch and Liu 2008). Under this specification, if the individual has more than six remaining months of welfare eligibility, the marginal effect of the stock on welfare participation is β_S. Otherwise, the marginal effect is $\beta_S + \beta_{S1}$, where β_{S1} captures the piecewise linear effect. An extra instrument is required to estimate β_{S1}; the model and its corresponding instrument matrix are defined formally in the next section on GMM estimator. The results are qualitatively similar to the baseline model. The estimate for β_S is 0.003 with a standard error of 0.004, and the estimate for β_{S1} is 0.041 with a standard error of 0.024. The time horizon coefficient and treatment group coefficient are 0.002 and 0.018, respectively, which are similar to the estimates from the baseline model.

Columns 2 and 3 explore the sensitivity of the model estimates to lagged dependent variables. The specification of lagged dependent variables may affect the estimate for the stock effect in a complicated way. In Column 2, the model is assumed to exhibit first-order state dependence only, and higher-order lags of the dependent variable are excluded from the set of regressors. The stock coefficient β_S becomes slightly larger at 0.008. The coefficient for the first-order autoregressive lag (α_1) also becomes larger at 0.728, as it picks up the effects from the omitted second-order lag, which was statistically significant in the baseline model. Both the Sargan-Hansen test and the Arellano-Bond test reject the null hypothesis at the 1 percent level, implying that the model is misspecified. Column 3 considers another end of the spectrum by including six autoregressive lags in the model. Only the first- and second-order autoregressive lags are statistically significant, and the coefficients on the higher-order lags are close to zero. The stock coefficient β_S becomes slightly larger at 0.007, and is statistically significant at the 10 percent level.

The last two columns of the table examine whether the estimation results are sensitive to the instruments used. In the baseline model, there are 12 lagged dependent variables involved in instrument construction (i.e., $y_{i,t-2}$, ..., $y_{i,t-1-\bar{m}}$ where $\bar{m} = 12$). Column 4 uses six lagged dependent variables for instrument construction (i.e., $\bar{m} = 6$), and Column 5 uses 18 lagged dependent variables for instrument construction (i.e., $\bar{m} = 18$). In both cases, the estimation results are very similar to the baseline model.

Table A7 provides further evidence for state dependence in welfare use. In this exercise, only the control group is used for the estimation of the model in equation (10) (see main text), and the FTP-related parameters (β_0, β_S, β_A, and β_E) are set to zero. The analysis then becomes analogous to the existing literature on dynamic panel data models, which focuses on disentangling state dependence from unobserved heterogeneity using existing patterns of behavior in panel data. Columns 1 and 2 report the key estimates for the baseline and disadvantaged control group samples, respectively. The state dependence coefficients are very similar in magnitude to the corresponding estimates in the baseline model. Therefore, the results suggest that individuals exhibit similar state dependence in welfare use even in the absence of time limits.

This issue is further investigated by formally allowing state dependence to differ between control and treatment groups. Three terms are added to equation (10) (see main text): $\gamma_k E_i y_{i,t-k}$ where $k = 1, 2, 3$. If the treatment changes dynamics beyond the stock effect β_S, the coefficients on γ_k should be significantly different from zero.[1] [2] The empirical results indicate that the coefficients on γ_k are negative but not statistically significant (see Table A8). Given how the moment conditions are constructed, interactive state dependence considerably reduces the amount of exogenous variations that can be used to identify β_S. However, when more instruments are used, the stock effect is statistically significant at the 10 percent level, while the interactive state dependence coefficients remain not significantly

[1]One possible explanation for why γ_k can be nonzero is that the non-time limit component may directly affect state dependence in the treatment group, not just the coefficient β_E. The model assumes that the error process is identical between control and treatment group individuals. Therefore, γ_k has no direct behavioral interpretation beyond reflecting potential complicated time-limit dynamics that are not picked up by β_S (or some other effects not picked up by β_E).

[2]For example, consider substituting out S_{it} in equation (10) (see main text) using its definition $\bar{S}_i - \sum_{r=0}^{t-1} y_{ir}$. Then, the kth-order state dependence in the control group is α_k. After substituting out S_{it}, the k-th order state dependence in the treatment group will be smaller at $\alpha_k - \beta_S$. However, because we explicitly control for S_{it} and estimate β_S, the "net" state dependence in the treatment group remains to be α_k (implying that γ_k should not be significantly different from zero).

different from zero.

2 Further Details of the GMM Estimator

Controlling for Work Experience. We discuss an extension of the baseline model that controls for work experience and other work-related variables. The model is:

$$y_{it} = \lambda_0 + \sum_{k=1}^{K_1} \alpha_k y_{i,t-k} + \sum_{k=0}^{K_2} \gamma_k x_{i,t-k} + \gamma_w \omega_{it} + \beta_0 E_i \mathbf{1}\{S_{it} < H_{it}\} + \beta_S E_i \mathbf{1}\{S_{it} < H_{it}\}(S_{it} - \bar{S}_i) + \beta_A E_i \mathbf{1}\{S_{it} < H_{it}\}(A_{it} - \bar{A}_i) + \beta_E E_i + \lambda_A A_{it} + \boldsymbol{X_{it}\lambda} + \mu_i + \epsilon_{it}, \tag{1}$$

where x_{it} is a employment status indicator for individual i at month t (=1 if she works, =0 otherwise), and $\omega_{it} = \sum_{k=0}^{t-1} x_{ik}$ is her cumulative months of work since random assignment.[3] In general, we should expect that there is a negative relationship between welfare participation and work-related variables, that is, the expected signs of γ_k and γ_w are negative. Similar to equation (11) (see main text), assuming $S_{it} \neq H_{it} - 1$ and taking first-order difference the above model becomes

$$\begin{aligned} \Delta y_{it} = & \sum_{k=1}^{K_1} \alpha_k \Delta y_{i,t-k} + \sum_{k=0}^{K_2} \gamma_k \Delta x_{i,t-k} + \gamma_w x_{i,t-1} - \beta_S E_i \mathbf{1}\{S_{i,t-1} < H_{i,t-1}\} y_{i,t-1} \\ & + \beta_A E_i \mathbf{1}\{S_{i,t-1} < H_{i,t-1}\} \Delta A_{it} + \lambda_A \Delta A_{it} + \Delta \boldsymbol{X_{it}\lambda} + \Delta\epsilon_{it}, \end{aligned} \tag{2}$$

where $\Delta x_{it} = x_{it} - x_{i,t-1}$. To address the endogeneity of work-related variables $x_{i,t-k}$ and ω_{it}, the following population moments are used:

$$E(x_{i,t-2-m} \Delta\epsilon_{it}) = 0 \qquad m = 0, ..., t-2. \tag{3}$$

[3]The data on work-related variables comes from (calendar) quarterly administrative records on employment in the FTP public use file. The data is converted to a monthly level for analysis.

Then, similar to equation (21) (see main text), the corresponding instrument submatrix is defined as

$$Z_{iw} = \begin{bmatrix} x_{i2} & x_{i1} & x_{i0} & 0 & ... & 0 \\ x_{i3} & x_{i2} & x_{i1} & x_{i0} & ... & 0 \\ \vdots & \vdots & \vdots & \vdots & & \vdots \\ x_{i,T-2} & x_{i,T-3} & x_{i,T-4} & x_{i,T-5} & ... & x_{i,T-1-\bar{m}} \end{bmatrix}_{(T-3)\times\bar{m}} . \tag{4}$$

The full instrument matrix for individual i is

$$Z_i = \left[\begin{array}{ccc|c} Z_{iy} & E_i\mathbf{1}\{\bar{S}_i < H_{i0}\}Z_{iy} & Z_{iw} & 0 \\ \hline 0 & 0 & 0 & Z_{ix} \end{array}\right], \tag{5}$$

where the number of columns in Z_i is $3\bar{m} + K_x + 3$, and the number of overidentifying restrictions is $3\bar{m} + K_x + 3 - [(K_1 + 1) + (K_2 + 2) + (K_x + 3)] = 3\bar{m} - K_1 - K_2 - 3$.

Piecewise Linear Effects. We discuss an extension of the baseline model that allows for piecewise linear stock effects. The model is:

$$y_{it} = \lambda_0 + \sum_{k=1}^{K} \alpha_k y_{i,t-k} + \beta_0 E_i \mathbf{1}\{S_{it} < H_{it}\} + \beta_S E_i \mathbf{1}\{S_{it} < H_{it}\}(S_{it} - \bar{S}_i) +$$
$$\beta_{S1} E_i \mathbf{1}\{S_{it} < H_{it}\} \min\{S_{it} - \bar{s}, 0\} + \beta_A E_i \mathbf{1}\{S_{it} < H_{it}\}(A_{it} - \bar{A}_i) + \beta_E E_i + \lambda_A A_{it} + \boldsymbol{X_{it}\lambda} + \mu_i + \epsilon_{it}. \tag{6}$$

If S_{it} is larger than $\bar{s}$, the marginal effect of S_{it} will be β_S, otherwise the marginal effect will be $\beta_S + \beta_{S1}$. The model is estimated using an expanded instrument matrix:

$$Z_i = \left[\begin{array}{ccc|c} Z_{iy} & E_i\mathbf{1}\{\bar{S}_i < H_{i0}\}Z_{iy} & E_i\mathbf{1}\{\bar{S}_i < H_{i0}\}\sum_{j=1}^{\bar{m}} Z_{iys}[*j] & 0 \\ \hline 0 & 0 & 0 & Z_{ix} \end{array}\right]. \tag{7}$$

The extra elements are described as follows. Let matrix Z_{iys} be the entrywise product of Z_{iy} and Z_{is} (i.e., $Z_{iys} \equiv Z_{iy} \circ Z_{is}$), where Z_{is} is a matrix with the following indicator functions as entries:

$$Z_{is} = \begin{bmatrix} \mathbf{1}(S_{i2} < \bar{s}) & \mathbf{1}(S_{i1} < \bar{s}) & \mathbf{1}(S_{i0} < \bar{s}) & 0 & ... & 0 \\ \mathbf{1}(S_{i3} < \bar{s}) & \mathbf{1}(S_{i2} < \bar{s}) & \mathbf{1}(S_{i1} < \bar{s}) & \mathbf{1}(S_{i0} < \bar{s}) & ... & 0 \\ \vdots & \vdots & \vdots & \vdots & & \vdots \\ \mathbf{1}(S_{i,T-2} < \bar{s}) & \mathbf{1}(S_{i,T-3} < \bar{s}) & \mathbf{1}(S_{i,T-4} < \bar{s}) & \mathbf{1}(S_{i,T-5} < \bar{s}) & ... & \mathbf{1}(S_{i,T-1-\bar{m}} < \bar{s}) \end{bmatrix}_{(T-3)*\bar{m}} . \quad (8)$$

The term $\sum_{j=1}^{\bar{m}} Z_{iys}[*j]$ is a *vector* that is constructed by summing up all columns in Z_{iys}. In particular, for individual i, the vector will be nonzero if her stock S_{it} is smaller than $\bar{s}$ in at least one time period in the sample. Since the vector represents the extra instrument that is needed for estimating β_{S1}, the number of overidentifying restrictions remains unchanged.

APPENDIX TABLE A5

CONTROLLING FOR WORK-RELATED VARIABLES USING GMM, KEY ESTIMATES[a]

Variable (parameter in parentheses)	Baseline Sample (1)	Disadvantaged Sample (2)
y_{t-1} (α_1)	0.635 ***	0.574 ***
	(0.020)	(0.026)
y_{t-2} (α_2)	0.106 ***	0.164 ***
	(0.012)	(0.017)
y_{t-3} (α_3)	-0.002	-0.023 *
	(0.009)	(0.012)
FTP dummy×I{S<H} (β_0)	0.015	-0.026
	(0.026)	(0.032)
FTP dummy×I{S<H}×(A-Ā) (β_A)	0.001	0.004
	(0.002)	(0.003)
FTP dummy×I{S<H}×(S-Sbar) (β_S)	0.006 **	0.003 *
	(0.003)	(0.002)
FTP dummy (β_E)	0.023	0.102 ***
	(0.022)	(0.038)
Work experience (γ_w)	-0.006 **	0.001
	(0.003)	(0.005)
$Work_t$ (γ_0)	-0.099 **	-0.047
	(0.040)	(0.041)
$Work_{t-1}$ (γ_1)	-0.056 **	0.026
	(0.028)	(0.026)
$Work_{t-2}$ (γ_2)	0.030 ***	0.007
	(0.011)	(0.013)
$Work_{t-3}$ (γ_3)	-0.013	-0.001
	(0.012)	(0.014)
R-squared	0.75	0.73
Sargan-Hansen test for over-identifying restrictions[b]	28.67 (df=27)	30.02 (df=27)
Arellano-Bond test for serial correlation[c]	-0.23	-0.13

a The baseline sample consists of 1445 individuals, and the disadvantaged sample consists of 1130 individuals. Both samples contain 20 months of data (up to month 23 following random assignment). Details of model specification and estimation are given in the Appendix. Other regressors include age, race, years of schooling, number of children, age of the youngest child, a dummy variable that equals one if the youngest child is under age 3, the interaction between the dummy variable above with the FTP dummy, a dummy variable that equals one if the youngest child is over age 18, calendar year indicators, and calendar month indicators. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

d The reported statistic follows a chi-square distribution with degree of freedom (df) given in parentheses.

e The reported statistic (Arellano and Bond (1991)) follows an asymptotic standard normal distribution.

APPENDIX TABLE A6

ALTERNATIVE SPECIFICATIONS OF THE THEORY-BASED MODEL (BASELINE SAMPLE)[a]

Variable (parameter in parentheses)	Piecewise Linear Stock Effect[b] (1)	Fewer Lags of Y (2)	More Lags of Y[c] (3)	Fewer Instru-ments[c] (4)	More Instru-ments[c] (5)	Keane-Runkle Estimator (6)
y_{t-1} (α_1)	0.658 ***	0.728 ***	0.753 ***	0.658 ***	0.668 ***	0.605 ***
	(0.018)	(0.015)	(0.026)	(0.019)	(0.017)	(0.039)
y_{t-2} (α_2)	0.117 ***		0.103 ***	0.112 ***	0.120 ***	0.102 ***
	(0.012)		(0.016)	(0.013)	(0.012)	(0.013)
y_{t-3} (α_3)			0.006	0.002	0.010	0.003
			(0.013)	(0.010)	(0.009)	(0.012)
y_{t-4} (α_4)			0.002			
			(0.013)			
y_{t-5} (α_5)			0.007			
			(0.012)			
y_{t-6} (α_6)			-0.001			
			(0.012)			
FTP dummy×I{S<H} (β_0)	0.000	0.009	0.026	0.009	0.004	0.032
	(0.023)	(0.028)	(0.027)	(0.023)	(0.021)	(0.043)
FTP dummy×I{S<H}× (A-16) (β_A)	0.002	0.001	0.000	0.001	0.001	0.002
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
FTP dummy×I{S<H}× (S-24) (β_S)	0.003	0.008 ***	0.007 *	0.007 **	0.005 **	0.011 **
	(0.004)	(0.002)	(0.004)	(0.003)	(0.002)	(0.005)
FTP dummy×I{S<H}× min{S-6,0} (β_{S1})	0.041 *					
	(0.024)					
FTP dummy (β_E)	0.018	0.029	0.010	0.026	0.020	0.031
	(0.018)	(0.023)	(0.019)	(0.018)	(0.017)	(0.032)
R-squared	0.74	0.72	0.74	0.74	0.74	0.72
Sargan-Hansen test for over-	25.48	89.12 ***	22.24	10.14	37.52	23.17
	(df=20)	(df=22)	(df=23)	(df=8)	(df=32)	(df=20)
Arellano-Bond test for serial correlation[e]	-0.03	6.37 ***	-0.41	0.28	0.18	-

a The sample consists of 1445 individuals and 20 months of data (up to month 23 following random assignment). Other regressors include age, race, years of schooling, number of children, age of the youngest child, a dummy variable that equals one if the youngest child is under age 3, the interaction between the dummy variable above with the FTP dummy, a dummy variable that equals one if the youngest child is over age 18, calendar year indicators, and calendar month indicators. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b Details of model specification and estimation are given in the Appendix.

c Fifteen, six, and eighteen lagged dependent variables are involved in instrument construction, respectively.

d The reported statistic follows a chi-square distribution with degree of freedom (df) given in parentheses.

e The reported statistic (Arellano and Bond (1991)) follows an asymptotic standard normal distribution.

APPENDIX TABLE A7

USING THE CONTROL GROUP SAMPLE ONLY, KEY ESTIMATES[a]

Variable (parameter in parentheses)	Baseline Sample Control Group (1)		Disadvantaged Sample Control Group (2)	
y_{t-1} (α_1)	0.634	***	0.555	***
	(0.028)		(0.039)	
y_{t-2} (α_2)	0.102	***	0.163	***
	(0.018)		(0.024)	
y_{t-3} (α_3)	0.001		-0.055	***
	(0.013)		(0.017)	
R-squared	0.75		0.72	
Sargan-Hansen test for over-identifying restrictions[b]	17.84 (df=21)		21.70 (df=21)	
Arellano-Bond test for serial correlation[c]	1.53		-0.44	

a The baseline control group sample consists of 737 individuals, and the disadvantaged control group sample consists of 554 individuals. Both samples contain 20 months of data (up to month 23 following random assignment). Other regressors include age, race, years of schooling, number of children, age of the youngest child, a dummy variable that equals one if the youngest child is under age 3, a dummy variable that equals one if the youngest child is over age 18, calendar year indicators, and calendar month indicators. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b The reported statistic follows a chi-square distribution with degree of freedom (df) given in parentheses.

c The reported statistic (Arellano and Bond (1991)) follows an asymptotic standard normal distribution.

APPENDIX TABLE A8

ADDITIONAL DYNAMIC SPECIFICATIONS (BASELINE SAMPLE)[a]

	Linear Stock Effect		Piecewise Linear Stock Effect	
Variable (parameter in parentheses)	(1)	(2)	(3)	(4)
y_{t-1} (α_1)	0.664 ***	0.674 ***	0.666 ***	0.674 ***
	(0.026)	(0.025)	(0.026)	(0.025)
y_{t-2} (α_2)	0.120 ***	0.127 ***	0.121 ***	0.127 ***
	(0.017)	(0.017)	(0.017)	(0.017)
y_{t-3} (α_3)	0.012	0.017	0.012	0.017
	(0.013)	(0.013)	(0.013)	(0.013)
FTP dummy×y_{t-1}	-0.093	-0.120	-0.094	-0.121
	(0.105)	(0.097)	(0.104)	(0.094)
FTP dummy×y_{t-2}	-0.024	-0.036	-0.023	-0.035
	(0.032)	(0.031)	(0.032)	(0.031)
FTP dummy×y_{t-3}	-0.017	-0.022	-0.018	-0.021
	(0.020)	(0.020)	(0.020)	(0.020)
FTP dummy×I{S<H} (β_0)	0.099	0.116	0.091	0.113
	(0.087)	(0.079)	(0.087)	(0.078)
FTP dummy×I{S<H}× (A-16) (β_A)	0.001	0.000	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
FTP dummy×I{S<H}× (S-24) (β_S)	0.017	0.020 *	0.014	0.017
	(0.012)	(0.011)	(0.012)	(0.011)
FTP dummy×I{S<H}× min{S-6,0} (β_{S1})			0.037	0.029 *
			(0.024)	(0.017)
FTP dummy (β_E)	0.050	0.060	0.047	0.056
	(0.046)	(0.042)	(0.046)	(0.041)
Sargan-Hansen test for over-identifying restrictions[b]	25.84 *	36.65	25.94 *	34.98
	(df=17)	(df=29)	(df=17)	(df=29)
Arellano-Bond test for serial correlation[c]	0.10	0.19	-0.05	0.18
Lag length of instruments used[d]	12	18	12	18

a The sample consists of 1445 individuals and 20 months of data (up to month 23 following random assignment). Other regressors include age, race, years of schooling, number of children, age of the youngest child, a dummy variable that equals one if the youngest child is under age 3, the interaction between the dummy variable above with the FTP dummy, a dummy variable that equals one if the youngest child is over age 18, calendar year indicators, and calendar month indicators. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b The reported statistic follows a chi-square distribution with degree of freedom (df) given in parentheses.

c The reported statistic (Arellano and Bond (1991)) follows an asymptotic standard normal distribution.

d Number of lagged dependent variables involved in instrument construction.