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Appendix and Supplemental material not intended for publication-Round 2

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Supplemental material

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Supplemental Material

Table S 1: Estimations results for different estimators

	Stewart (2007)	Replication	Heckman[a]	Het slope model[b]	Bivariate RE probit[c]
dependent variable			*unemployed in t*		
Unemployed at $t-1$	0.435 (0.152)	0.501 (0.156)	0.571 (0.161)	0.618 (0.259)	0.640 (0.154)
Low pay at $t-1$	0.211 (0.106)	0.260 (0.132)	0319 (0.109)	0.269 (0.129)	0.447 (0.153)
λ	0.235 (0.069)	0.352 (0.079)	0.329 (0.078)	0.300 (0.091)	0.284 (0.084)
θ			0.716 (0.213)		
λ_2				0.134 (0.270)	0.463 (0.043)
ρ_α				-0.180 (0.576)	-0.288 (0.143)
Pred. prob $\hat{p}_{\mathrm{hp}_{t-1}}$	0.035	0.036	0.027	0.037	0.036
Pred. prob $\hat{p}_{\mathrm{ue}_{t-1}}$	0.068	0.072	0.066	0.086	0.087
Pred. prob $\hat{p}_{\mathrm{lp}_{t-1}}$	0.049	0.052	0.045	0.054	0.047
χ^2-statistic of test: $\mathrm{ue}_{t-1}=\mathrm{lp}_{t-1}$	1.56[1]	1.58	1.72	1.58	0.97
$[p-\text{value}]$	0.21[1]	0.21	0.19	0.21	0.32
log likelihood	-1977.76[2]	-1350.13	-1707.44	-1351.96	-3667.90
observations	13,016	13,017	16,428	13,017	13,017

Source: BHPS, years 1991-96, own calculations and Stewart (2007). Estimations include additional covariates and year dummies as enlisted in Stewart (2007). hp=high pay, lp=low pay, ue=unemployed. [a] Instruments used for the initial period: father, resp. mother, not working when respondent aged 14, socio-economic group: father's job, resp. mother's job. For estimating used the command **redprob** (Stewart 2006). [b] For initial condition following the suggestion of Wooldridge (2005). Using MSL based on 35 Halton draws. [c] For initial condition following the suggestion of Wooldridge (2005). Using the command **bireprob** (Plum 2016) for estimation. [1] χ^2-statistic and p-value refer to the Heckman Estimator. [2] Also contains the log-likelihood of the initial period.

Model

Heckman Estimator

$$\begin{aligned} y_{1it} &= \mathbf{1}\left(x_{it}'\beta + \gamma_1 y_{1it-1} + \gamma_2 y_{2it-1} + \bar{x}_i'\delta + \alpha_i + u_{it} > 0 \right) \text{ for } t \geq 2 \\ y_{1it} &= \mathbf{1}\left(z'_{i1}\,\pi + \theta\alpha_i + u_{i1} > 0 \right) \text{ for } t = 1 \end{aligned} \tag{S1}$$

Heterogeneous slope model

$$y_{1it} = \mathbf{1}\left(x_{it}'\beta + \gamma_1 y_{1it-1} + \gamma_2 y_{2it-1} + a_1 y_{1i1} + a_2 y_{2i2} + \bar{x}_i'\delta + \alpha_i + \alpha_{2i} y_{1it-1} + u_{it} > 0 \right) \tag{S2}$$

with $V_\alpha = \begin{pmatrix} \sigma^2_{\alpha_1} & \\ \rho_\alpha \sigma_{\alpha_1} \sigma_{\alpha_2} & \sigma^2_{\alpha_2} \end{pmatrix}$. For an application, see also Plum and Ayllón (2015).

Bivariate random-effects probit model

$$\begin{aligned} y_{1it} &= \mathbf{1}\left(x_{1it}'\beta_1 + \gamma_{11} y_{1it-1} + \gamma_{12} y_{2it-1} + a_{11} y_{1i1} + a_{12} y_{2i2} + \bar{x}_i'\delta_1 + \alpha_{1i} + u_{1it} > 0 \right) \\ y_{2it} &= \mathbf{1}\left(x_{2it}'\beta_2 + \gamma_{21} y_{1it-1} + \gamma_{22} y_{2it-1} + a_{21} y_{1i1} + a_{22} y_{2i2} + \bar{x}_i'\delta_2 + \alpha_{2i} + u_{2it} > 0 \right) \text{ if } y_{1it} = 0 \end{aligned} \tag{S3}$$

with $V_\alpha = \begin{pmatrix} \sigma^2_{\alpha_1} & \\ \rho_\alpha \sigma_{\alpha_1} \sigma_{\alpha_2} & \sigma^2_{\alpha_2} \end{pmatrix}$.

Table S 2: Transition matrix of the basic model

	Higher-paid$_t$	Low-paid$_t$	Unemployed$_t$	Total$_{t-1}$
Higher-paid$_{t-1}$	94.64	3.44	1.93	89.38
Low-paid$_{t-1}$	42.61	53.91	3.48	7.95
Unemployed$_{t-1}$	64.08	15.23	20.69	2.67
Total$_t$	89.68	7.77	2.55	

Source: BHPS, years 1991-96, own calculations and Stewart (2007). *N*=13017.

Table S 3: Transition matrix of the repeatedly unemployed model

	Higher-paid$_t$	Low-paid$_t$	Unemployed$_t$	Total$_{t-1}$
Higher-paid$_{t-1}$	94.64	3.44	1.93	88.88
Low-paid$_{t-1}$	42.57	53.96	3.47	7.92
Unemployed$_{t-1}$	53.46	13.37	33.17	3.20
Total$_t$	89.20	7.76	3.05	

Source: BHPS, years 1991-96, own calculations and Stewart (2007). *N*=13087.

References

Plum, A (2016) “bireprob: An estimator for bivariate Random-Effects Probit Models” *STATA Journal* **16**, 96-111.

Plum, A. and S. Ayllón (2015) “Heterogeneity in unemployment state dependence” *Economics Letters* **136**, 85-87.

Stewart, M. (2006) “Heckman estimator of the random effects dynamic probit model” available at: http://www2.warwick.ac.uk/fac/soc/economics/staff/mstewart/stata/