How incarcerating children affects their labour market outcomes - supplementary material

February 28, 2023

Appendix A Econometric model

We use a multivariate mixed proportional hazard (MMPH) model of transitions between education, custody, employment and NEET. Our approach resembles that of Cockx and Picchio (2013). It assumes transitions occur in continuous time but are interval-censored, as is the case here. Transitions between states are modelled as separate hazard functions. A hazard function is also used to model earnings, following Donald et al. (2000). Doing so has the advantage of flexibility since it avoids the restrictiveness of assuming *a priori* that earnings follows a particular distribution.

A.1 The likelihood function

We follow Van den Berg and Van der Klaauw (2001) and specify the discrete-time process as having an underlying continuous-time mixed proportional hazard (MPH) form. Integrating the continuous-time outcomes over the observation intervals of calendar months, the transition intensity from j to k ($j \neq k$) can be written with a mixed proportional hazard (MPH) form:

$$\theta_{jk}\left(t|\mathbf{x}, a_{lag}, \upsilon_{jk}\right) = h_{jk}(t)\phi_{jk}(\mathbf{x})\psi_{jk}(a_{lag})\upsilon_{jk}. \tag{1}$$

where, $h_{jk}\left(t\right)$ is the baseline transition intensity and a_{lag} is the activity immediately preceding the current spell. Unobserved heterogeneity, υ_{ijk}, is transition-specific. As is common in models of this type, it is assumed fixed and uncorrelated with $\mathbf{x}$. While these are possible strong assumptions, the short time period over which outcomes are observed helps makes the assumption of fixed unobserved heterogeneity less offensive. With regard to the independence assumption, Cockx et al. (2013) show that introducing a functional form restriction on the relationship between υ_{jk} and $\mathbf{x}$ means that the estimated coefficients on $\mathbf{x}$ cannot be separately identified from υ_{jk}. In this formulation, $\mathbf{x}$ act purely as control variables and cannot be interpreted. The other parameters, including the coefficient on a_{lag}, remain identified. Hence, relaxing the assumption of independence between υ_{jk} and $\mathbf{x}$ does not affect the interpretation of the parameter of key interest.

We specify a piecewise constant baseline hazard

$$h_{jk}\left(t\right) = \exp\left(\sum_{b=1}^{b=B_{jk}} \gamma_{jk}^{b} \mathbb{1}\left(\tau_{b-1} \leq t \leq \tau_{b}\right)\right) \tag{2}$$

where B_{jk} is the number of segments, τ_b is the spell duration on completion of segment b, and $\tau_0 = 0$ and where relevant coefficients can be set to zero to tailor to a specific transition intensity. For each transition type, the segments were chosen to ensure a sufficient number of transitions were observed within each one. Due to variation in the numbers experiencing each transition type, this means that the segmentation of the baseline hazard is coarser for some transition types than for others.

The systematic part of the hazard is specified as $\phi_{jk}(\mathbf{x}) = \exp(\mathbf{x})\beta_{jk}$. Here, $\mathbf{x}$ includes both fixed characteristics and time-varying characteristics. The lagged dependencies are specified:

$$\psi_{jk}(a_{lag}) = \exp\left(\sum_{p \neq j} \alpha_{jk}^{p} \mathbb{1}\left(a_{lag} = p\right)\right). \tag{3}$$

Lastly, the specification allows for unobserved heterogeneity, υ_{jk}, where the subscript indicates that this may affect different types of transitions differently. Individual unobserved heterogeneity is assumed fixed across spells of each type.

Earnings at the start of a new job are also conceptualised as a hazard rate (Donald et al., 2000). Analogous to equation 3, the earnings hazard is

$$\theta_w\left(w|\mathbf{x}, a_{lag}, \upsilon_w\right) = h_w(w)\phi_w(\mathbf{x})\psi_w(a_{lag})\upsilon_w. \tag{4}$$

where the baseline hazard, $h_{jk}\left(t\right)$ – in this case, the probability of earning exactly w given earnings of at least w – again takes a piecewise constant form:

$$h_w = \exp\left(\sum_{b=1}^{b=B_w} \zeta_b \mathbb{1}\left(\omega_{b-1} < w \leq \omega_b\right)\right) \tag{5}$$

where ω_b is the maximum earnings level within segment b. The systematic part of the hazard and the influence of previous spell type are also both specified analogously to the transition equations: $\phi_w(\mathbf{x}) = \exp(\mathbf{x})\beta_w$ and $\psi_w(a_{lag}) = \exp\left(\sum_{p\neq j} \alpha_w^p \mathbb{1}\left(a_{lag} = p\right)\right)$.

The contribution to the likelihood function of spell s with origin state j that is not observed to have ended (i.e. a censored spell) after duration d is

$$L_{c,jj}^s = \prod_{r=1}^{d} \exp\left(-\sum_{k\neq j} \theta_{jk}(r)\right). \tag{6}$$

The contribution to the likelihood function of spell s with origin state j that ends with a transition to destination state $k, j \neq k$, at duration d (an uncensored spell) is

$$L_{u,jk}^s = \left[1 - \exp\left(-\sum_{k\neq j} \theta_{jk}(d)\right)\right] \frac{\theta_{jk}(d)}{\sum\limits_{k\neq j} \theta_{jk}(d)} \prod_{r=1}^{d-1} \exp\left(-\sum_{k\neq j} \theta_{jk}(r)\right) \tag{7}$$

as derived in Cockx (1997), equations 22-29. Where that transition is to employment, there is a further contribution to the likelihood from the earnings equation. In this case, failure is in segment R of the earnings distribution

$$L_w^s = \left[1 - \exp\left(-\theta_w(R)\right)\right] \prod_{r=1}^{R-1} \exp\left(-\theta_w(r)\right). \tag{8}$$

The contribution of a spell starting in state j can be written generally as

$$L_j = {L_{c,jj}}^{1-\sum\limits_{k\neq j} y_{jk}} \times \prod_{k\neq j} {L_{u,jk}}^{y_{jk}} \times {L_e}^{y_{jw}} \tag{9}$$

where y_{jk} is a dummy variable taking the value 1 where a spell starting in state j ends with a transition to state k (zero otherwise) and y_{jw} is a dummy variable taking the value 1 where a spell starting in state j ends with a transition to employment, state w.

We follow Heckman and Singer (1984) and discretely approximate the unobserved heterogeneity joint distribution by M mass points, $\upsilon^m, m = 1, 2, \ldots, M$, where $\upsilon^m =$

$\{\upsilon^m_{ec}, \upsilon^m_{ew}, \upsilon^m_{en}, \upsilon^m_{ce}, \upsilon^m_{cw}, \upsilon^m_{cn}, \upsilon^m_{we}, \upsilon^m_{wc}, \upsilon^m_{wn}, \upsilon^m_{ne}, \upsilon^m_{nc}, \upsilon^m_{nw}, \upsilon^m_{w}, \}$. Here, the paired subscripts denote the type of transition by specifying the origin and destination states – e (education), c (custody), w (employment) or n (NEET) – while υ^m_w is the unobserved heterogeneity term in the earnings equation. The probability attached to υ^m is specified as $p^m = \exp(\lambda^m)/(\sum_{g=1}^{M} \exp(\lambda^g)), m = 1, ..., M$, where $\lambda^1 = 0$. The number of mass points, M, is unknown a priori but chosen on the basis of specification tests. Intuitively, we consider that individuals may be in one of M subgroups.

Writing the contribution to the likelihood of a full spell for an individual in subgroup m as L^{ms}_i, the contribution of individual i (conditional on being type m) is the product of all i's spells, S_i:

$$L^m_i = \prod_{s=1}^{S_i} L^{ms}_i. \tag{10}$$

Integrating out the unobserved heterogeneity, the overall contribution of individual i is

$$L_i = \sum_{m=1}^{M} p^m L^m_i \tag{11}$$

Across all individuals, I, the likelihood is

$$L = \prod_{i=1}^{I} L_i = \prod_{i=1}^{I} \sum_{m=1}^{M} p^m L^m_i. \tag{12}$$

Since we want to work with the log-likelihood, we write this out in full as

$$\ln L = \sum_{i=1}^{I} \ln \sum_{m=1}^{M} p^m L^m_i. \tag{13}$$

A.2 Identification

Horny and Picchio (2010) show that, under the MPH assumption, both the unobserved heterogeneity distribution and the structural parameters of the model – including the lagged dependencies – are non-parametrically identified when there are competing risks and multiple realisations of the lagged dependencies. With a single realisation of the lagged dependencies, which is the case for many individuals in the data, identification requires exogenous regressor variation and an auxiliary assumption that the unobserved heterogeneity distribution have a finite mean (Horny and Picchio, 2009). We include among the regressors some strictly exogenous time-varying covariates including local unemployment rate and quarterly dummies. Due to differences between individuals in when they start each spell and the fact that we observe multiple spells of differing durations, there is variation in these covariates across individuals at the same point in their spell. Hence, we contend that the model is identified.

Lastly, we note that most identification results relate to continuous time processes. Gaure et al. (2007) provide extensive Monte Carlo evidence that the parameters of the underlying continuous time model can be recovered using discrete data, so long as the likelihood function reflects the discrete nature of the available data.

Appendix B Full estimation results

Table B1: Full estimation results, convicted males

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
Preceding state:													
- custody	1.732	-0.043	0.392				-2.205	2.686	0.157	-0.434	0.649	-0.368	0.29
	[0.137]	[0.223]	[0.078]				[1.020]	[0.609]	[0.246]	[0.088]	[0.134]	[0.135]	[0.165]
- employment	-0.029	1.179	-0.074	-1.561	1.192	0.243				-0.541	-0.182	0.919	
	[0.436]	[0.100]	[0.073]	[0.721]	[0.748]	[0.316]				[0.069]	[0.263]	[0.051]	
- NEET	0.709	0.257	0.433	-0.852	-0.306	0.508	-0.934	0.118	0.281				0.091
	[0.118]	[0.088]	[0.043]	[0.124]	[0.446]	[0.096]	[0.100]	[0.478]	[0.059]				[0.088]
Age:													
- 13	-0.278		-2.902	1.044		-0.616				2.803	0.5		
	[0.255]		[0.139]	[0.242]		[0.312]				[0.162]	[0.372]		
- 14	-0.174		-2.861	0.898		-0.571				2.82	1.037		
	[0.238]		[0.135]	[0.204]		[0.208]				[0.154]	[0.234]		
- 15	0.031		-2.873	0.702		-0.425			-1.263	2.179	1.206		
	[0.229]		[0.142]	[0.195]		[0.167]			[0.421]	[0.153]	[0.197]		
- 16	0.194	3.585	-0.84	0.154		-0.335	0.77		-1.115	2.166	0.553	0.407	0.661
	[0.146]	[0.220]	[0.113]	[0.139]		[0.099]	[0.185]		[0.108]	[0.132]	[0.108]	[0.105]	[0.105]
- 17		3.68	-0.316				0.506		-0.275	1.79		0.649	0.346
		[0.228]	[0.110]				[0.172]		[0.078]	[0.127]		[0.082]	[0.091]
- 18		3.811	0.079				-0.031		-0.24	0.972		0.57	0.186
		[0.239]	[0.107]				[0.178]		[0.071]	[0.126]		[0.073]	[0.083]
- 19		3.603	0.096				-0.413		-0.04	0.61		0.393	0.012
		[0.265]	[0.117]				[0.205]		[0.072]	[0.133]		[0.075]	[0.088]
White	-0.375	-0.038	0.124	0.161	0.438	0.128	-0.155	1.4	-0.026	-0.049	-0.178	-0.019	-0.112
	[0.117]	[0.090]	[0.046]	[0.116]	[0.545]	[0.111]	[0.117]	[1.033]	[0.065]	[0.052]	[0.138]	[0.067]	[0.085]
English as additional language	0.206	-0.398	-0.315	-0.087	0.273	0.082	-0.146		-0.352	-0.081	0.567	-0.172	0.225
	[0.216]	[0.169]	[0.087]	[0.202]	[0.896]	[0.180]	[0.222]		[0.141]	[0.099]	[0.260]	[0.140]	[0.175]
Free school meals	-0.012	0.095	0.072	0.028	-0.243	0.017	-0.06	0.011	0.05	-0.071	-0.007	0.043	0.028

Table B1: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
	[0.102]	[0.071]	[0.035]	[0.105]	[0.494]	[0.095]	[0.091]	[0.477]	[0.048]	[0.041]	[0.116]	[0.050]	[0.066]
Special educational needs status:													
- School action	-0.033	-0.01	-0.034	0.187	-0.617	-0.088	0.271	0.03	-0.052	-0.026	-0.367	0.095	-0.157
	[0.148]	[0.087]	[0.045]	[0.148]	[0.775]	[0.141]	[0.106]	[0.665]	[0.061]	[0.053]	[0.166]	[0.062]	[0.082]
- School action plus	-0.033	-0.078	-0.059	0.039	-0.121	-0.041	0.081	0.649	0.043	0.096	0.002	0.052	-0.173
	[0.132]	[0.099]	[0.047]	[0.139]	[0.690]	[0.124]	[0.126]	[0.628]	[0.066]	[0.054]	[0.148]	[0.068]	[0.089]
- Statemented	-0.168	-0.126	-0.093	0.263	-1.233	0.194	0.121	-0.025	0.205	0.113	-0.345	-0.08	-0.227
	[0.173]	[0.121]	[0.059]	[0.188]	[0.921]	[0.172]	[0.158]	[0.828]	[0.083]	[0.068]	[0.198]	[0.086]	[0.110]
Special educational needs type:													
- behavioural, emotional, social difficulties	0.181	0.182	0.042	-0.004	0.847	-0.088	0.034	-0.035	-0.08	-0.011	0.164	0.093	0.121
	[0.136]	[0.096]	[0.046]	[0.148]	[0.718]	[0.132]	[0.124]	[0.590]	[0.067]	[0.054]	[0.160]	[0.068]	[0.092]
- moderate learning difficulties	-0.567	-0.217	-0.076	0.366	0.42	0.07	0.151		0.129	0.039	-0.283	-0.075	0.463
	[0.225]	[0.141]	[0.064]	[0.239]	[1.103]	[0.231]	[0.172]		[0.096]	[0.075]	[0.247]	[0.097]	[0.132]
Child in need	0.678	-0.52	0.535										
	[0.460]	[0.855]	[0.183]										
Looked after	0.598	1.473	-0.212										
	[0.227]	[0.703]	[0.099]										
Non-mainstream schooling:													
- pupil referral unit	0.451	-0.084	0.185	-0.059	-0.997	0.191	-0.043	-0.021	0.106	-0.186	0.515	-0.028	-0.002
	[0.100]	[0.076]	[0.036]	[0.106]	[0.516]	[0.094]	[0.096]	[0.506]	[0.050]	[0.043]	[0.116]	[0.051]	[0.067]
- special school	0.465	-0.358	0.113	-0.199	0.001	-0.158	-0.082	0.634	-0.052	-0.162	0.361	-0.112	0.3
	[0.151]	[0.114]	[0.053]	[0.149]	[0.690]	[0.141]	[0.147]	[0.770]	[0.079]	[0.062]	[0.170]	[0.081]	[0.104]

Table B1: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
- alternative provision	0.383	-0.294	-0.091	-0.164	0.614	-0.002	0.038	1.189	-0.009	-0.09	0.242	-0.18	0.041
	[0.103]	[0.086]	[0.039]	[0.112]	[0.476]	[0.100]	[0.113]	[0.495]	[0.058]	[0.047]	[0.124]	[0.059]	[0.077]
Permanent exclusion	0.53	0.141	0.098	-0.087	0.636	-0.164	-0.122	-0.423	0.04	-0.126	0.186	-0.171	-0.021
	[0.133]	[0.112]	[0.053]	[0.126]	[0.478]	[0.119]	[0.152]	[0.699]	[0.074]	[0.061]	[0.155]	[0.078]	[0.096]
Post 16 qualifications:													
- below level 1	-0.206	-0.019	0.008		0.243		-0.039		0.006	0.008	-0.017	0.051	-0.096
	[0.156]	[0.079]	[0.040]		[0.510]		[0.094]		[0.055]	[0.045]	[0.120]	[0.055]	[0.066]
- above level 2	-0.124	0.097	0.015		1.451		-0.365		-0.002	-0.049	-0.292	0.122	-0.201
	[0.216]	[0.099]	[0.051]		[0.468]		[0.121]		[0.059]	[0.058]	[0.182]	[0.059]	[0.075]
Local authority unemployment rate	0.026	-0.076	0.013	0.01	0.14	-0.009	-0.005	-0.041	0.057	0.105	0.145	-0.101	0.01
	[0.045]	[0.025]	[0.012]	[0.042]	[0.113]	[0.031]	[0.031]	[0.142]	[0.019]	[0.013]	[0.035]	[0.019]	[0.023]
Baseline hazard (transitions):													
- month 1							0.74		0.67	1.193		0.938	
							[0.125]		[0.085]	[0.081]		[0.084]	
- month 2							0.717		0.722	1.238		1.063	
							[0.133]		[0.087]	[0.081]		[0.084]	
- month 3							0.563		0.639	0.918		0.736	
							[0.149]		[0.092]	[0.086]		[0.094]	
- months 1-3				0.283		0.074					0.296		
				[0.123]		[0.104]					[0.093]		
- months 4-6				0.613		0.283	0.4		0.351	0.825		0.52	
				[0.125]		[0.109]	[0.128]		[0.085]	[0.075]		[0.078]	
- months 7-12									0.083	0.63		0.318	
									[0.088]	[0.072]		[0.074]	

Table B1: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
Baseline hazard (earnings):													
- decile 2													0.221
													[0.094]
- decile 3													0.402
													[0.095]
- decile 4													0.602
													[0.097]
- decile 5													0.808
													[0.100]
- decile 6													1.166
													[0.102]
- decile 7													1.491
													[0.111]
- decile 8													2.019
													[0.120]
- decile 9													2.634
													[0.132]
Seasonal and monthly dummies:													
- June, age 15		3.299	2.469										
		[0.296]	[0.120]										
- July, age 15		3.403	1.556										
		[0.290]	[0.132]										
- August, age 15		3.789	2.044										
		[0.282]	[0.110]										
- June, age 17		0.237	0.719										
		[0.245]	[0.104]										

Table B1: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
- July, age 17		0.117	0.61										
		[0.240]	[0.101]										
- August, age 17		0.271	0.104										
		[0.257]	[0.106]										
- June		0.236	0.289										
		[0.165]	[0.069]										
- July		0.268	0.648										
		[0.162]	[0.063]										
- August		0.258	1.173										
		[0.170]	[0.055]										
- September				0.523			0.439			0.015			
				[0.143]			[0.155]			[0.063]			
- quarter 1		0.224			0.234		-0.232		-0.078	0.065		-0.042	-0.141
		[0.104]			[0.535]		[0.117]		[0.061]	[0.058]		[0.064]	[0.074]
- quarter 2		0.287			-0.151		-0.443		-0.083	-0.262		0.102	-0.265
		[0.117]			[0.584]		[0.125]		[0.064]	[0.065]		[0.067]	[0.075]
- quarter 3		0.573			0.025		-0.153		0.194	0.53		0.237	-0.193
		[0.124]			[0.554]		[0.128]		[0.057]	[0.057]		[0.061]	[0.068]
Constant	-5.392	-9.577	-2.142	-3.549	-7.059	-2.891	-3.551	-7.799	-2.026	-5.934	-4.129	-5.354	-3.12
	[0.518]	[0.870]	[0.223]	[0.245]	[0.845]	[0.201]	[0.576]	[1.251]	[0.194]	[0.162]	[0.266]	[0.180]	[0.259]
Log of mass points													
- $\ln(\upsilon_2)$	-2.014	0.925	-1.078	0.444	0.354	0.063	0.548		-0.723	0.704	-1.964	1.037	0.007
	[0.205]	[0.474]	[0.091]	[0.194]	[1.001]	[0.274]	[0.524]		[0.141]	[0.126]	[0.374]	[0.177]	[0.251]
- $\ln(\upsilon_3)$	-2.293	1.045	-0.409	0.565	0.916	0.259	0.17		-0.326	0.3	-2.128	0.64	1.231
	[0.209]	[0.482]	[0.084]	[0.192]	[0.828]	[0.224]	[0.526]		[0.134]	[0.100]	[0.218]	[0.170]	[0.236]
Probability of mass points (logistic transform)													

Table B1: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
- λ_2	0.452												
	[0.191]												
- λ_3	1.045												
	[0.163]												
Resulting probabilities													
- p^1	0.185												
- p^2	0.29												
- p^3	0.525												
Log-likelihood	-68,465.94												
N (rounded to nearest 10)	2,980												

Standard errors in brackets.

Table B2: Full estimation results, convicted females

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
Preceding state:											
- custody	1.707	-0.156	0.19			0.752	-0.022	0.033	1.488	0.127	0.618
	[0.273]	[0.391]	[0.135]			[0.760]	[0.734]	[0.131]	[0.294]	[0.309]	[0.311]
- employment	0.183	1.165	-0.055					-0.443	-0.559	0.795	
	[1.035]	[0.137]	[0.103]					[0.098]	[1.032]	[0.116]	
- NEET	0.574	0.338	0.351	-0.988	0.659	-0.696	0.383				-0.011
	[0.207]	[0.125]	[0.065]	[0.267]	[0.209]	[0.139]	[0.092]				[0.119]
Age:											
-13	1.212		-2.335	0.284	-1.207			2.601	1.99		
	[0.637]		[0.172]	[0.472]	[0.461]			[0.199]	[0.643]		
-14	1.481		-2.324	0.31	-0.964			2.657	2.062		
	[0.615]		[0.165]	[0.373]	[0.312]			[0.182]	[0.539]		
-15	0.77		-2.445	0.455	-0.677		-1.16	2.168	1.667		
	[0.618]		[0.177]	[0.357]	[0.280]		[0.729]	[0.179]	[0.527]		
-16	0.76	2.881	-0.676	0.426	-0.446	0.682	-0.873	1.671	0.901	0.986	1.033
	[0.432]	[0.277]	[0.131]	[0.356]	[0.268]	[0.234]	[0.177]	[0.147]	[0.340]	[0.180]	[0.163]
-17		3.113	-0.06			0.458	0.076	1.212		0.916	0.398
		[0.283]	[0.127]			[0.221]	[0.133]	[0.140]		[0.151]	[0.148]
-18		3.003	0.172			0.02	0.049	0.545		0.751	-0.112
		[0.294]	[0.127]			[0.232]	[0.128]	[0.141]		[0.140]	[0.146]
-19		2.671	0.099			0.044	-0.048	0.217		0.369	-0.202
		[0.330]	[0.144]			[0.254]	[0.138]	[0.153]		[0.150]	[0.158]
White	-0.272	-0.079	0.117	0.176	0.196	-0.128	0.248	-0.313	0.165	-0.385	-0.085
	[0.211]	[0.125]	[0.068]	[0.248]	[0.267]	[0.147]	[0.113]	[0.070]	[0.316]	[0.121]	[0.118]
English as additional language	0.33	0.151	-0.088	-0.175	-0.698	0.11	-0.145	-0.114	0.361	-0.073	-0.485
	[0.345]	[0.197]	[0.116]	[0.387]	[0.452]	[0.228]	[0.204]	[0.127]	[0.476]	[0.215]	[0.204]
Free school meals	0.324	-0.163	0.125	-0.075	-0.33	0.206	0.002	0.008	0.203	-0.105	-0.049

Table B2: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
	[0.165]	[0.101]	[0.049]	[0.198]	[0.212]	[0.120]	[0.084]	[0.054]	[0.246]	[0.093]	[0.100]
Special educational needs status:											
- School action	-0.105	-0.069	0.056	0.07	0.037	0.307	0.139	0.143	-0.028	-0.037	0.028
	[0.202]	[0.105]	[0.054]	[0.237]	[0.247]	[0.126]	[0.090]	[0.060]	[0.288]	[0.100]	[0.105]
- School action plus	-0.332	-0.363	-0.011	0.39	0.489	0.188	-0.069	0.096	-0.095	-0.035	0.101
	[0.225]	[0.141]	[0.066]	[0.272]	[0.274]	[0.160]	[0.119]	[0.074]	[0.313]	[0.130]	[0.149]
- Statemented	-0.019	-0.179	0.034	0.346	0.255	0.471	-0.171	0.013	-0.181	-0.195	0.105
	[0.326]	[0.203]	[0.100]	[0.395]	[0.377]	[0.249]	[0.187]	[0.110]	[0.473]	[0.202]	[0.230]
Special educational needs type:											
- behavioural, emotional, social difficulties	-0.172	0.222	0.15	-0.405	-0.471	-0.04	0.058	-0.115	-0.25	-0.034	0.107
	[0.250]	[0.143]	[0.068]	[0.298]	[0.289]	[0.164]	[0.122]	[0.076]	[0.342]	[0.132]	[0.148]
- moderate learning difficulties	-0.364	-0.288	0.336	-0.628	-0.143	-0.22	0.189	-0.088	0.42	-0.344	0.526
	[0.409]	[0.248]	[0.096]	[0.529]	[0.373]	[0.292]	[0.189]	[0.103]	[0.421]	[0.197]	[0.287]
Child in need			-0.153								
			[0.227]								
Looked after	1.705		0.266								
	[0.428]		[0.148]								
Non-mainstream schooling:											
- pupil referral unit	0.352	0.168	0.254	0.059	-0.067	-0.288	0.042	-0.127	-0.24	-0.173	-0.077
	[0.173]	[0.101]	[0.050]	[0.208]	[0.219]	[0.128]	[0.085]	[0.056]	[0.261]	[0.092]	[0.098]
- special school	0.598	-0.568	-0.188	-0.408	0.628	-0.137	0.485	-0.013	0.05	-0.335	-0.071
	[0.329]	[0.251]	[0.109]	[0.392]	[0.370]	[0.302]	[0.200]	[0.121]	[0.531]	[0.228]	[0.209]

Table B2: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
- alternative provision	0.378	-0.311	-0.126	0.12	-0.568	-0.241	0.017	-0.287	0.69	-0.32	0.05
	[0.193]	[0.140]	[0.065]	[0.233]	[0.260]	[0.184]	[0.111]	[0.079]	[0.299]	[0.125]	[0.127]
Permanent exclusion	0.656	0.029	0.136	-0.337	0.268	0.036	0.312	0.142	0.463	-0.006	-0.209
	[0.209]	[0.159]	[0.077]	[0.254]	[0.254]	[0.215]	[0.125]	[0.082]	[0.342]	[0.143]	[0.160]
Post 16 qualifications:											
- below level 1	-0.094	0.075	0.059			-0.195	-0.001	0.087	-0.375	-0.045	-0.18
	[0.372]	[0.113]	[0.058]			[0.132]	[0.092]	[0.065]	[0.363]	[0.099]	[0.101]
- above level 2	-1.63	0.305	-0.021			-0.048	-0.085	0.105	-0.053	0.299	-0.189
	[1.038]	[0.139]	[0.076]			[0.147]	[0.100]	[0.084]	[0.484]	[0.109]	[0.119]
Local authority unemployment rate	-0.017	-0.009	0.022			-0.032	0.016	0.108	0.067	-0.092	-0.07
	[0.118]	[0.037]	[0.019]			[0.044]	[0.033]	[0.020]	[0.099]	[0.035]	[0.038]
Baseline hazard (transitions):											
- month 1						0.815	0.789	0.97		1.167	
						[0.171]	[0.151]	[0.100]		[0.155]	
- month 2						0.96	0.826	0.915		1.224	
						[0.173]	[0.155]	[0.103]		[0.157]	
- month 3						0.754	0.742	0.894		1.073	
						[0.194]	[0.164]	[0.107]		[0.165]	
- months 1-3				-0.871							
				[0.219]							
- months 4-6				-0.266		0.446	0.539	0.663		0.831	
				[0.212]		[0.174]	[0.148]	[0.094]		[0.142]	
- months 7-12							0.387	0.35		0.369	
							[0.149]	[0.090]		[0.140]	

Table B2: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
Baseline hazard (earnings):											
- decile 2											0.252
											[0.155]
- decile 3											0.788
											[0.153]
- decile 4											0.921
											[0.167]
- decile 5											1.224
											[0.176]
- decile 6											1.631
											[0.181]
- decile 7											2.079
											[0.184]
- decile 8											2.426
											[0.191]
- decile 9											3.077
											[0.196]
Seasonal and monthly dummies:											
- June, age 15		2.774	1.996								
		[0.406]	[0.164]								
- July, age 15		3.836	1.128								
		[0.377]	[0.186]								
- August, age 15		3.758	1.691								
		[0.367]	[0.159]								
- June, age 17		-0.152	0.614								
		[0.339]	[0.140]								

Table B2: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
- July, age 17		-0.119	0.689								
		[0.411]	[0.138]								
- August, age 17		0.612	0.309								
		[0.330]	[0.155]								
- June		0.265	0.581								
		[0.207]	[0.088]								
- July		-0.053	0.855								
		[0.249]	[0.083]								
- August		0.178	1.187								
		[0.240]	[0.079]								
- September				0.055		-0.083		0.038			
				[0.307]		[0.211]		[0.080]			
- quarter 1		0.279				-0.251	0.103	0.017		0.047	-0.304
		[0.146]				[0.164]	[0.105]	[0.091]		[0.120]	[0.125]
- quarter 2		0.576				-0.14	0.104	-0.218		0.327	-0.533
		[0.154]				[0.159]	[0.107]	[0.099]		[0.119]	[0.120]
- quarter 3		0.658				0.235	0.289	0.911		0.416	-0.459
		[0.171]				[0.159]	[0.100]	[0.080]		[0.110]	[0.113]
Constant	-9.85	-6.968	-3.489	-2.549	-1.847	-3.298	-3.447	-4.714	-7.596	-4.308	-2.862
	[0.905]	[0.267]	[0.267]	[0.695]	[0.511]	[0.304]	[0.229]	[0.200]	[0.740]	[0.264]	[0.236]
Log of mass points											
- $\ln(\upsilon_2)$	1.831	-1.372	0.981	0.457	-0.362	0.215	0.582	-0.545	1.206	-1.334	0.013
	[0.504]	[0.301]	[0.104]	[0.602]	[0.394]	[0.317]	[0.167]	[0.127]	[0.540]	[0.211]	[0.224]
- $\ln(\upsilon_3)$	0.698	-0.117	0.535	0.149	0.071	-0.254	0.426	-0.089		-0.75	1.756
	[0.690]	[0.255]	[0.124]	[0.967]	[0.565]	[0.213]	[0.130]	[0.212]		[0.216]	[0.195]
Probability of mass points (logistic transform)											

Table B2: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to n$	$w \to e$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
- λ_2	0.359										
	[0.304]										
- λ_3	-0.268										
	[0.408]										
Resulting probabilities											
- p^1	0.313										
- p^2	0.448										
- p^3	0.239										
log-likelihood	-29,249.15										
N (rounded to nearest 10)	1,390										

Standard errors in brackets.

Table B3: Full estimation results, males

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
Preceding state:													
- custody	2.141	0.087	0.805				-1.621	2.267	0.526	-0.938	1.004	-0.070	-0.013
	[0.076]	[0.126]	[0.061]				[0.217]	[0.240]	[0.128]	[0.057]	[0.058]	[0.072]	[0.083]
- employment	0.478	1.922	0.015	-2.447	2.970	0.184				-1.766	-0.210	1.439	
	[0.169]	[0.067]	[0.066]	[0.387]	[0.240]	[0.161]				[0.083]	[0.137]	[0.052]	
- NEET	0.899	0.319	1.526	-1.235	-0.048	0.723	-1.854	0.601	0.992				-0.057
	[0.073]	[0.076]	[0.037]	[0.084]	[0.226]	[0.060]	[0.083]	[0.234]	[0.055]				[0.087]
Age:													
-13	-1.358		-2.614	0.878		-0.825				1.192	-0.561		
	[0.152]		[0.109]	[0.180]		[0.365]				[0.125]	[0.286]		
-14	-0.811		-2.626	0.703		-0.912				1.235	-0.901		
	[0.126]		[0.103]	[0.128]		[0.203]				[0.111]	[0.233]		
-15	-0.379		-2.072	0.565		-0.484			-0.988	0.941	0.171		
	[0.116]		[0.101]	[0.116]		[0.126]			[0.329]	[0.105]	[0.123]		
-15	0.169	2.900	-1.084	0.176		-0.099	0.308		-1.023	0.863	0.328	0.004	0.888
	[0.069]	[0.140]	[0.081]	[0.075]		[0.057]	[0.124]		[0.097]	[0.087]	[0.058]	[0.094]	[0.087]
-17		3.260	-0.749				0.349		-0.518	0.685		0.304	0.380
		[0.141]	[0.080]				[0.114]		[0.070]	[0.084]		[0.071]	[0.072]
-18		3.192	-0.485				0.156		-0.335	0.204		0.314	0.215
		[0.141]	[0.076]				[0.113]		[0.057]	[0.083]		[0.058]	[0.067]
-19		2.754	0.003				0.182		-0.044	0.239		0.120	0.068
		[0.154]	[0.077]				[0.122]		[0.054]	[0.084]		[0.057]	[0.071]
White	-0.033	0.151	0.175	0.115	0.275	0.277	-0.149	0.195	0.025	-0.105	0.031	0.110	-0.220
	[0.063]	[0.064]	[0.039]	[0.074]	[0.224]	[0.066]	[0.074]	[0.194]	[0.053]	[0.043]	[0.068]	[0.053]	[0.059]
English as additional language	0.059	-0.170	-0.183	0.056	-0.157	-0.007	0.022		-0.228	0.072	0.081	-0.126	0.124
	[0.082]	[0.079]	[0.049]	[0.096]	[0.294]	[0.087]	[0.091]		[0.073]	[0.054]	[0.092]	[0.074]	[0.077]

Table B3: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
Free school meals	-0.084	-0.108	-0.019	0.108	-0.224	0.088	-0.056	0.080	0.098	0.030	0.025	-0.004	0.036
	[0.056]	[0.054]	[0.032]	[0.066]	[0.175]	[0.056]	[0.059]	[0.165]	[0.041]	[0.036]	[0.056]	[0.043]	[0.047]
Special educational needs status:													
- School action	0.068	0.247	0.066	0.105	0.331	0.032	-0.016	-0.105	0.091	0.000	0.027	0.182	0.122
	[0.065]	[0.057]	[0.037]	[0.077]	[0.189]	[0.065]	[0.063]	[0.181]	[0.046]	[0.042]	[0.066]	[0.047]	[0.054]
- School action plus	0.013	0.030	0.015	0.012	-0.194	-0.098	0.156	0.059	0.032	-0.028	0.163	0.029	0.050
	[0.080]	[0.082]	[0.048]	[0.092]	[0.285]	[0.079]	[0.089]	[0.227]	[0.064]	[0.054]	[0.078]	[0.065]	[0.073]
- Statemented	-0.091	0.046	-0.026	0.023	-0.811	-0.111	0.482	0.689	0.119	0.037	0.076	-0.064	0.247
	[0.116]	[0.124]	[0.069]	[0.146]	[0.524]	[0.127]	[0.140]	[0.411]	[0.101]	[0.079]	[0.123]	[0.100]	[0.116]
Special educational needs type:													
- behavioural, emotional, social difficulties	0.037	0.075	0.158	-0.020	0.337	0.056	-0.208	-0.226	0.007	0.111	-0.153	0.050	-0.156
	[0.085]	[0.086]	[0.049]	[0.099]	[0.294]	[0.084]	[0.095]	[0.244]	[0.067]	[0.057]	[0.084]	[0.068]	[0.077]
- moderate learning difficulties	-0.174	-0.103	0.023	0.143	0.562	-0.055	-0.366		0.125	0.028	0.001	-0.081	-0.014
	[0.126]	[0.117]	[0.067]	[0.145]	[0.403]	[0.125]	[0.142]		[0.091]	[0.077]	[0.116]	[0.095]	[0.107]
Child in need	0.672	-0.035	0.423										
	[0.071]	[0.062]	[0.037]										
Looked after	0.318	-0.202	0.049										
	[0.068]	[0.081]	[0.040]										
Non-mainstream schooling:													

Table B3: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
- pupil referral unit	0.431	-0.042	0.190	0.001	-0.234	0.037	-0.091	0.388	0.120	-0.197	0.072	-0.135	-0.115
	[0.061]	[0.078]	[0.038]	[0.069]	[0.204]	[0.058]	[0.088]	[0.190]	[0.052]	[0.041]	[0.059]	[0.050]	[0.060]
- special school	0.273	-0.572	0.164	0.079	-0.111	-0.007	-0.253	-0.386	0.087	-0.099	0.150	-0.032	0.019
	[0.109]	[0.137]	[0.066]	[0.135]	[0.497]	[0.115]	[0.158]	[0.438]	[0.101]	[0.075]	[0.115]	[0.098]	[0.118]
- alternative provision	0.139	-0.413	-0.030	-0.070	-0.714	-0.046	-0.226	-0.271	0.177	-0.229	0.065	-0.210	-0.035
	[0.073]	[0.110]	[0.048]	[0.086]	[0.330]	[0.073]	[0.131]	[0.330]	[0.069]	[0.056]	[0.073]	[0.069]	[0.083]
Permanent exclusion	0.320	0.149	0.190	0.032	0.363	-0.076	0.008	-0.422	0.054	0.089	-0.015	0.066	-0.008
	[0.071]	[0.098]	[0.047]	[0.082]	[0.240]	[0.072]	[0.110]	[0.266]	[0.063]	[0.050]	[0.073]	[0.061]	[0.074]
Post 16 qualifications:													
- below level 1	-0.323	0.148	-0.169		0.226		-0.170		-0.009	-0.113	-0.041	0.046	-0.079
	[0.075]	[0.062]	[0.039]		[0.186]		[0.067]		[0.052]	[0.043]	[0.062]	[0.051]	[0.055]
- above level 2	-0.375	0.230	-0.150		0.249		-0.212		-0.055	-0.168	-0.014	0.133	-0.164
	[0.106]	[0.076]	[0.049]		[0.245]		[0.078]		[0.056]	[0.054]	[0.086]	[0.054]	[0.061]
Local authority unemploymenr rate	0.037	-0.053	0.039	0.016	0.193	0.008	0.002	0.094	0.010	0.064	0.062	-0.004	0.018
	[0.022]	[0.020]	[0.012]	[0.024]	[0.049]	[0.018]	[0.022]	[0.050]	[0.018]	[0.013]	[0.018]	[0.017]	[0.019]
Baseline hazard (transitions):													
- month 1							2.201		1.317	2.628		1.868	
							[0.084]		[0.069]	[0.074]		[0.069]	
- month 2							1.335		0.731	1.856		1.146	
							[0.101]		[0.078]	[0.080]		[0.080]	
- month 3							0.880		0.479	1.381		0.768	
							[0.122]		[0.088]	[0.089]		[0.091]	

Table B3: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	$Earn$
- months 1-3				1.275		0.692					0.623		
				[0.089]		[0.068]					[0.055]		
- months 4-6				0.290		0.148	0.561		0.165	1.050		0.430	
				[0.110]		[0.083]	[0.107]		[0.079]	[0.081]		[0.079]	
- months 7-12									0.018	0.843		0.249	
									[0.078]	[0.080]		[0.076]	
Baseline hazard (earnings):													
- decile 2													0.240
													[0.086]
- decile 3													0.418
													[0.086]
- decile 4													0.504
													[0.090]
- decile 5													0.815
													[0.089]
- decile 6													1.037
													[0.092]
- decile 7													1.342
													[0.096]
- decile 8													1.727
													[0.101]
- decile 9													2.359
													[0.110]
Seasonal and monthly dummies:													
- June, age 15		2.975	1.582										

Table B3: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
		[0.190]	[0.095]										
- July, age 15		2.787	0.847										
		[0.203]	[0.106]										
- August, age 15		2.518	0.952										
		[0.233]	[0.097]										
- June, age 17		0.132	0.035										
		[0.164]	[0.110]										
- July, age 17		0.220	-0.138										
		[0.154]	[0.108]										
- August, age 17		0.392	-0.058										
		[0.163]	[0.097]										
- June		0.201	0.405										
		[0.103]	[0.057]										
- July		0.240	0.657										
		[0.104]	[0.052]										
- August		0.106	0.926										
		[0.113]	[0.048]										
- September				0.127			-0.155			0.099			
				[0.100]			[0.093]			[0.052]			
- quarter 1		-0.198			-0.388		-0.114		0.139	-0.096		-0.047	-0.220
		[0.074]			[0.234]		[0.078]		[0.052]	[0.050]		[0.054]	[0.061]
- quarter 2		0.073			-0.587		-0.264		-0.075	-0.237		0.016	-0.388
		[0.072]			[0.239]		[0.083]		[0.058]	[0.056]		[0.058]	[0.065]
- quarter 3		0.315			-0.233		0.241		0.203	0.083		0.078	-0.362
		[0.072]			[0.215]		[0.072]		[0.051]	[0.048]		[0.053]	[0.058]
Constant	-5.179	-7.867	-3.061	-3.809	-5.921	-3.223	-3.066	-5.210	-3.487	-4.794	-3.959	-5.358	-2.763
	[0.156]	[0.144]	[0.108]	[0.157]	[0.383]	[0.128]	[0.171]	[0.410]	[0.125]	[0.113]	[0.134]	[0.109]	[0.151]

Table B3: (continued)

	$e \to c$	$e \to w$	$e \to n$	$c \to e$	$c \to w$	$c \to n$	$w \to e$	$w \to c$	$w \to n$	$n \to e$	$n \to c$	$n \to w$	*Earn*
Log of mass points													
- $\ln(\upsilon_2)$	0.675	1.383	0.538	1.097	1.131	0.445	0.436	0.698	0.678	0.808	0.540	0.857	0.381
	[0.108]	[0.110]	[0.068]	[0.106]	[0.277]	[0.100]	[0.108]	[0.333]	[0.074]	[0.057]	[0.097]	[0.092]	[0.115]
- $\ln(\upsilon_3)$	-0.995	0.903	-0.796	0.698	-0.088	-0.534	-0.490	0.319	0.275	0.306	-0.141	0.544	0.841
	[0.131]	[0.110]	[0.067]	[0.157]	[0.464]	[0.205]	[0.122]	[0.451]	[0.085]	[0.104]	[0.175]	[0.111]	[0.121]
Probability of mass points (logistic transform)													
- λ_2	-1.157												
	[0.121]												
- λ_3	-0.548												
	0.200												
Resulting probabilities													
- p^1	0.528												
- p^2	0.166												
- p^3	0.306												
log-likelihood	-95,276.830												
N	2,980												

Standard errors in brackets.

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