Supplementary Material for Like Father, Like Son: Social Network Externalities and Parent-Child Correlation in Behavior

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1 Fitting the Threshold Model to European Data

We fit the threshold model from Section 4 to data on parent-child education levels in European countries. We use data from the European Community Household Panel (ECHP), that contains information on the level of human capital of representative households in various European member countries. These data allow us to infer the education transition matrices for combinations of parents and children.[1] However, this data does not span more than two consecutive generations and we cannot build an identification strategy based on Proposition **??**.

To eliminate degrees of freedom, we fit a further simplified version of the threshold model such that $p_L = 1 - p_H$ and $p_H \geq 1/2$.

For this exercise, a human capital of 0 indicates that an individual pursued education to a point no further than high school graduation, and 1 indicates that education was pursued beyond high school.[2] Given the threshold model, any (n, τ, p_H) implies steady state probabilities of the four possible parent-child education combinations: 00, 01, 10, 11. So given the observed frequency distribution in the data, we find the parameters (n, τ, p_H) that lead to predictions that most closely match those observed frequencies.

Table 1 shows the calibrated values of p_H and τ for various European countries and for all parent-child gender combinations when $n = 50$.

[1] We are grateful to Simona Comi for providing us with the underlying data corresponding to wave 5 (1998) of the ECHP. Comi (2003) presents an exhaustive analysis of European social mobility patterns with the ECHP database.

[2] Education beyond high school (tertiary education) is measured by Comi as still being in school at 20 years of age. It need not indicate that any higher degrees were earned.

	Father	*Daugh*		*Father*	*Son*		*Mother*	*Daugh*		*Mother*	*Son*	
Country	*Cor*	p_H	τ	*Cor*	p_H	τ	*Cor*	p_H	τ	*Cor*	p_H	τ
Austria	.123	.95	26	.057	.96	26	−.002	.97	30	.016	.96	29
Belgium	.027	.62	27	.174	.68	26	.014	.70	30	.100	.62	26
Denmark	.047	.73	35	.071	.77	34	.004	.75	35	.008	.74	21
Finland	−.128	.82	33	−.036	.85	32	−.061	.82	34	.014	.78	33
France	.119	.61	39	.221	.73	26	.093	.70	35	.176	.63	27
Germany	.107	.79	27	.111	.81	27	.067	.86	27	.045	.85	17
Greece	.003	.81	28	.070	.86	26	.011	.88	33	.001	.83	27
Ireland	.211	.82	26	.189	.84	26	.190	.85	26	.146	.83	26
Italy	.131	.94	26	.141	.95	26	.091	.96	26	.130	.95	26
Luxemburg	.289	.79	26	.083	.78	27	.145	.80	34	.070	.77	33
The Netherlands	.043	.89	31	.082	.87	31	−.021	.93	30	.005	.93	30
Portugal	.098	.94	26	.228	.96	26	.095	.96	26	.187	.94	16
Spain	.111	.81	26	.122	.84	26	.036	.86	32	.053	.82	32
United Kingdom	.045	.52	1	.070	.61	24	.023	.61	27	.095	.58	26

TABLE 1. ECHP intergenerational correlation in education vs. estimated investment probability in the threshold model.[3]

The full collection of observed matrices, together with the estimated ones, the estimated p_H's and τ's and an estimation error ε are all presented below in Tables 2 through 5.[4] We also estimate the model for $n = 25$ and find almost no differences in the fits (see Tables 2 to 5 below). To get a feeling for these numbers, we first present and discuss a couple of examples in Table 1b.

TABLE 1B. FATHER/DAUGHTER.

data			estimated threshold model		
AU	0	1		0	1
0	.903	.033	0	.900	.048
1	.054	.008	1	.048	.005
			p_H=96,τ=26,ε=.017		
BE	0	1		0	1
0	.357	.295	0	.356	.237
1	.181	.167	1	.237	.170
			p_H=.62,τ=27,ε=.080		

[3] For each parent-child gender combination (father/daughter, father/son, mother/daughter, mother/son), the first column, *Cor*, reports the intergenerational correlation in education levels for the education transition matrices from wage 5 (1998) of the ECHP. We distinguish two education levels: (*i*) nor more than high school graduation, and (*ii*) past high school education. The second column, p_H, reports the estimated value for the investment probability in the threshold investment model when $n = 50$. The corresponding estimated values for τ and the error ε are reported in the appendix, together with estimations for p_H, τ, ε when $n = 25$. Data and estimations are reported for fourteen countries.

[4] Given a value of n (here, $n = 25, 50$), our algorithm searches through a grid of admissible values for τ and p_H. The size of the grid is chosen in increments of .01 for p_H. The error ε is the Euclidean distance between the estimated and actual four-vectors.

The first column reports the education transition matrices for father/daughter from wave 5 (1998) of the ECHP, from Comi. 0 stands for nor more than high school graduation; 1 stands for past high school education. AU=Austria, BE=Belgium, The corresponding parameters p_H, τ for the estimated threshold investment model are reported below the matrices. The error ε is equal to the Euclidean distance between the estimated and the actual distributions.

It is important to stress that the implied parameters of the model give us more information than the intergenerational correlations. The parameters of the model give all the investment probabilities. Instead, the intergenerational correlation coincides with the variance of these investment probabilities.

For instance, Denmark and the United Kingdom exhibit very similar father-daughter correlations (.045 and .047) and similar father-son correlations. Yet, the calibrated values of p_H and τ differ drastically between both countries, in both the case of daughter and son behavior: p_H is .52 for daughters and .61 for sons for the U.K. versus .73 and .77 for Denmark.[5] Although similar in terms of correlation levels, the threshold model would suggest, instead, that the influence of the social setting on education decisions (as measured through p_H) is much higher in Denmark than in the U.K. This is not captured through the correlation, but is inferred by the model and is implicitly is identified by the average investment rates.[6]

[5]The estimated value of $\tau = 1$ in the daughter case for the U.K. is essentially irrelevant as a p_H close to 1 /2 implies that the investment is essentially independent of the state, and that is why the threshold is not tied down. The comparison of father-son for the two countries leads to a situation where the τ is tied down for the U.K..

[6]When data that spans at least three successive generations is available, as pointed out in Proposition **??**, and a proper identification strategy can be implemented. Again, the calibration exercise is meant here to be only an illustrative exercise rather than a proper test of the model.

TABLE 2. FATHER/DAUGHTER.

data			estimation			threshold model		
AU	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.903	.033	0	.902	.048	0	.900	.048
1	.054	.008	1	.048	.003	1	.048	.005
			p_H=.95,τ=14,ε=.017			p_H=96,τ=26,ε=.017		
BE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.357	.295	0	.357	.237	0	.356	.237
1	.181	.167	1	.237	.168	1	.237	.170
			p_H=.63,τ=14,ε=.080			p_H=.62,τ=27,ε=080		
DK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.534	.061	0	.533	.197	0	.533	.197
1	.350	.054	1	.197	.073	1	.197	.073
			p_H=.73,τ=21,ε=.205			p_H=.73,τ=35,ε=.205		
FI	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.672	.053	0	.664	.151	0	.664	.151
1	.274	.002	1	.151	.034	1	.151	.034
			p_H=.82,τ=20,ε=.161			p_H=.82,τ=33,ε=.161		
FR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.366	.416	0	.368	.239	0	.366	.239
1	.071	.148	1	.239	.155	1	.239	.156
			p_H=.61,τ=16,ε=.244			p_H=61,τ=39,ε=.244		
GE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.624	.063	0	.622	.163	0	.621	.166
1	.261	.052	1	.163	.052	1	.166	.047
			p_H=.80,τ=14,ε=.140			p_H=.79,τ=27,ε=.141		
GR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.646	.192	0	.648	.157	0	.648	.157
1	.124	.038	1	.157	.038	1	.157	.038
			p_H=.81,τ=15,ε=.048			p_H=.81,τ=28,ε=.048		

The first column reports the education transition matrices for father/daughter from wage 5 (1998) of the ECHP, from Comi. 0 stands for nor more than high school graduation; 1 stands for past high school education. Data is reported for seven countries: AU=Austria, BE=Belgium, DK=Denmark, FI=Finland, FR=France, GE=Germany, GR=Greece. Columns 2 and 3 report the estimated values for the education transition matrices for $n = 25, 50$. The corresponding parameters p_H, τ for the estimated threshold investment model are reported below the matrices. The error ε is equal to the Euclidean distance between the estimated and the actual distributions.

Table 2 (Father/Daughter) (Contd.)

data			estimation			threshold model		
IR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.645	.220	0	.648	.154	0	.643	.148
1	.063	.072	1	.154	.044	1	.148	.062
			p_H=.81,τ=14,ε=.116			p_H=.82,τ=26,ε=.112		
IT	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.876	.056	0	.874	.061	0	.880	.056
1	.055	.013	1	.061	.005	1	.056	.007
			p_H=.94,τ=14,ε.012			p_H=94,τ=26,ε=.007		
LX	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.580	.268	0	.577	.141	0	.576	.169
1	.045	.107	1	.141	.141	1	.169	.086
			p_H=.83,τ=13,ε=.163			p_H=.79,τ=26,ε=.160		
NL	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.791	.015	0	.792	.098	0	.792	.098
1	.188	.007	1	.098	.012	1	.098	.012
			p_H=.89,τ=18,ε=.122			p_H=.89,τ=31,ε=.122		
PO	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.865	.081	0	.865	.065	0	.870	.061
1	.043	.011	1	.065	.005	1	.061	.008
			p_H=.93,τ=14,ε=.028			p_H=.94,τ=26,ε=.028		
SP	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.623	.216	0	.622	.163	0	.624	.154
1	.098	.063	1	.163	.052	1	.154	.068
			p_H=.80,τ=14,ε=.085			p_H=.81,τ=26,ε=.084		
UK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.246	.223	0	.230	.250	0	.230	.250
1	.254	.278	1	.250	.270	1	.250	.270
			p_H=.52,τ=25,ε=.032			p_H=.52,τ=1,ε=.032		

ECHP data and estimations are reported for the following seven countries: IR=Ireland, IT=Italy, LX=Luxemburg, NL=The Netherlands, PO=Portugal, SP=Spain, UK=The United Kingdom.

Table 3 (Father/Son)

data			estimation			threshold model		
AU	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.919	.018	0	.922	.038	0	.920	.038
1	.060	.003	1	.038	.002	1	.038	.003
			$p_H=.96, \tau=14, \varepsilon=.030$			$p_H=.96, \tau=26, \varepsilon=.030$		
BE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.405	.227	0	.407	.200	0	.397	.218
1	.170	.198	1	.200	.194	1	.218	.167
			$p_H=.73, \tau=13, \varepsilon=.040$			$p_H=.68, \tau=26, \varepsilon=.058$		
DK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.587	.027	0	.585	.180	0	.585	.180
1	.356	.030	1	.180	.055	1	.180	.055
			$p_H=.77, \tau=21, \varepsilon=.234$			$p_H=.77, \tau=34, \varepsilon=.234$		
FI	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.724	.032	0	.723	.128	0	.723	.128
1	.237	.006	1	.128	.023	1	.128	.023
			$p_H=.85, \tau=19, \varepsilon=.146$			$p_H=.85, \tau=32, \varepsilon=.146$		
FR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.481	.332	0	.477	.207	0	.478	.197
1	.058	.129	1	.207	.108	1	.197	.128
			$p_H=.71, \tau=14, \varepsilon=.196$			$p_H=.73, \tau=26, \varepsilon=.194$		
GE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.653	.053	0	.657	.151	0	.654	.154
1	.251	.043	1	.151	.041	1	.154	.038
			$p_H=.82, \tau=14, \varepsilon=.140$			$p_H=.81, \tau=27, \varepsilon=.140$		
GR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.726	.131	0	.728	.124	0	.721	.120
1	.111	.033	1	.124	.024	1	.120	.038
			$p_H=.86, \tau=14, \varepsilon=.017$			$p_H=.86, \tau=26, \varepsilon=.016$		

The first column reports the education transition matrices for father/son from wage 5 (1998) of the ECHP, from Comi. Data and estimations are reported for seven countries: AU=Austria, BE=Belgium, DK=Denmark, FI=Finland, FR=France, GE=Germany, GR=Greece.

Table 3 (Father/Son) (Contd.)

data			estimation			threshold model		
IR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.686	.196	0	.692	.138	0	.682	.134
1	.062	.056	1	.138	.032	1	.134	.049
			p_H=.84,τ=14,ε=.099			p_H=.84,τ=26,ε=.96		
IT	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.886	.047	0	.893	.052	0	.890	.052
1	.055	.012	1	.052	.003	1	.052	.006
			p_H=.95,τ=14,ε=.013			p_H=.95,τ=26,ε=.009		
LX	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.601	.266	0	.605	.169	0	.605	.172
1	.077	.056	1	.169	.057	1	.172	.052
			p_H=.79,τ=14,ε=.134			p_H=.78,τ=27,ε=.134		
NL	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.757	.011	0	.757	.113	0	.757	.113
1	.222	.010	1	.113	.017	1	.113	.017
			p_H=.87,τ=18,ε=.149			p_H=.87,τ=31,ε=.149		
PO	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.919	.038	0	.922	.038	0	.920	.038
1	.031	.012	1	.038	.002	1	.038	.003
			p_H=.96,τ=14,ε=.013			p_H=.96,τ=26,ε=.012		
SP	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.683	.156	0	.683	.141	0	.682	.134
1	.109	.051	1	.141	.035	1	.134	.049
			p_H=.83,τ=14,ε=.039			p_H=.84,τ=26,ε=.034		
UK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.226	.237	0	.217	.235	0	.210	.241
1	.224	.312	1	.235	.314	1	.241	.309
			p_H=.65,τ=12,ε=.014			p_H=.61,τ=24,ε=.023		

ECHP data and estimations are reported for the following seven countries: IR=Ireland, IT=Italy, LX=Luxemburg, NL=The Netherlands, PO=Portugal, SP=Spain, UK=The United Kingdom.

TABLE 4 (MOTHER/DAUGHTER)

data			estimation			threshold model		
AU	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.992	.037	0	.992	.038	0	.992	.038
1	.039	.001	1	.038	.002	1	.038	.002
			p_H=.96,τ=17,ε=.001			p_H=.96,τ=30,ε=.001		
BE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.374	.314	0	.374	.238	0	.374	.238
1	.165	.147	1	.238	.151	1	.238	.151
			p_H=.62,τ=16,ε=.106			p_H=.62,τ=30,ε=.106		
DK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.538	.068	0	.540	.195	0	.540	.195
1	.350	.045	1	.195	.070	1	.195	.070
			p_H=.74,τ=20,ε=.202			p_H=.74,τ=35,ε=.202		
FI	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.606	.043	0	.600	.175	0	.600	.175
1	.338	.013	1	.175	.050	1	.175	.050
			p_H=.78,τ=21,ε=.213			p_H=.78,τ=34,ε=.213		
FR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.381	.455	0	.391	.235	0	.390	.234
1	.055	.110	1	.235	.141	1	.234	.141
			p_H=.63,τ=17,ε=.287			p_H=.63,τ=35,ε=.287		
GE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.714	.079	0	.710	.131	0	.713	.131
1	.176	.031	1	.131	.028	1	.131	.025
			p_H=.85,τ=14,ε=.069			p_H=.85,τ=27,ε=.069		
GR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.693	.202	0	.689	.141	0	.689	.141
1	.080	.025	1	.141	.029	1	.141	.029
			p_H=.83,τ=20,ε=.087			p_H=.83,τ=33,ε=.087		

The first column reports the education transition matrices for mother/daughter from wage 5 (1998) of the ECHP, from Comi. Data and estimations are reported for seven countries: AU=Austria, BE=Belgium, DK=Denmark, FI=Finland, FR=France, GE=Germany, GR=Greece.

Table 4 (Mother/Daughter) (Contd.)

data			estimation			threshold model		
IR	0	1	$n=25$	0	1	$n=50$	0	1
0	.663	.235	0	.666	.148	0	.662	.141
1	.046	.056	1	.148	.039	1	.141	.055
			p_H=.82,τ=14,ε=.135			p_H=.83,τ=26,ε=.134		
IT	0	1	$n=25$	0	1	$n=50$	0	1
0	.891	.061	0	.893	.052	0	.890	.052
1	.040	.008	1	.052	.003	1	.052	.006
			p_H=.95,τ=14,ε=.016			p_H=.95,τ=26,ε=.015		
LX	0	1	$n=25$	0	1	$n=25$	0	1
0	.596	.330	0	.593	.177	0	.593	.177
1	.028	.046	1	.177	.053	1	.177	.053
			p_H=.77,τ=20,ε=.214			p_H=.77,τ=34,ε=.214		
NL	0	1	$n=25$	0	1	$n=25$	0	1
0	.856	.021	0	.856	.069	0	.856	.069
1	.126	.002	1	.069	.006	1	.069	.006
			p_H=.93,τ=18,ε=.072			p_H=.93,τ=30,ε=.072		
PO	0	1	$n=25$	0	1	$n=50$	0	1
0	.866	.082	0	.865	.065	0	.870	.061
1	.041	.011	1	.065	.005	1	.061	.008
			p_H=.93,τ=14,ε=.030			p_H=.94,τ=26,ε=.030		
SP	0	1	$n=25$	0	1	$n=25$	0	1
0	.666	.254	0	.664	.151	0	.664	.151
1	.056	.028	1	.151	.034	1	.151	.034
			p_H=.82,τ=19,ε=.140			p_H=.82,τ=32,ε=.140		
UK	0	1	$n=25$	0	1	$n=50$	0	1
0	.302	.302	0	.301	.248	0	.302	.247
1	.189	.208	1	.248	.203	1	.247	.205
			p_H=.55,τ=17,ε=.080			p_H=.58,τ=27,ε=.080		

ECHP data and estimations are reported for the following seven countries: IR=Ireland, IT=Italy, LX=Luxemburg, NL=The Netherlands, PO=Portugal, SP=Spain, UK=The United Kingdom.

Table 5 (Mother/Son)

data			estimation			threshold model		
AU	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.944	.019	0	.940	.029	0	.940	.029
1	.036	.001	1	.029	.001	1	.029	.001
			p_H=.97,τ=19,ε=.013			p_H=.97,τ=29,ε=.013		
BE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.427	.282	0	.422	.222	0	.428	.210
1	.143	.147	1	.222	.135	1	.210	.152
			p_H=.68,τ=14,ε=.100			p_H=.70,τ=26,ε=.099		
DK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.560	.035	0	.563	.188	0	.563	.188
1	.379	.026	1	.188	.063	1	.188	.063
			p_H=.75,τ=21,ε=.248			p_H=.75,τ=21,ε=.248		
FI	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.677	.024	0	.672	.148	0	.672	.148
1	.287	.012	1	.148	.032	1	.148	.032
			p_H=.82,τ=19,ε=.188			p_H=.82,τ=33,ε=.188		
FR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.474	.356	0	.477	.207	0	.469	.212
1	.057	.112	1	.207	.108	1	.212	.107
			p_H=.71,τ=14,ε=.212			p_H=.70,τ=27,ε=.212		
GE	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.732	.073	0	.731	.124	0	.730	.124
1	.171	.024	1	.124	.021	1	.124	.022
			p_H=.86,τ=15,ε=.070			p_H=.86,τ=17,ε=.070		
GR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.771	.151	0	.772	.106	0	.774	.106
1	.065	.013	1	.106	.016	1	.106	.015
			p_H=.88,τ=14,ε=.061			p_H=.88,τ=27,ε=.061		

The first column reports the education transition matrices for mother/son from wage 5 (1998) of the ECHP, from Comi. Data and estimations are reported for seven countries: AU=Austria, BE=Belgium, DK=Denmark, FI=Finland, FR=France, GE=Germany, GR=Greece.

Table 5 (Mother/Son) (Contd.)

data			estimation			threshold model		
IR	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.697	.214	0	.701	.134	0	.692	.131
1	.049	.041	1	.134	.030	1	.131	.046
			p_H=.84,τ=14,ε=.117			p_H=.85,τ=26,ε=.117		
IT	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.906	.051	0	.912	.043	0	.910	.043
1	.034	.009	1	.043	.002	1	.043	.004
			p_H=.96,τ=14,ε=.015			p_H=.096,τ=26,ε=.013		
LX	0	1	$n = 25$	0	1	$n = 25$	0	1
0	.642	.292	0	.640	.160	0	.640	.160
1	.036	.029	1	.160	.040	1	.160	.040
			p_H=.80,τ=20,ε=.181			p_H=.80,τ=33,ε=.181		
NL	0	1	$n = 25$	0	1	$n = 25$	0	1
0	.858	.019	0	.856	.069	0	.856	.069
1	.120	.003	1	.069	.006	1	.069	.006
			p_H=.93,τ=17,ε=.072			p_H=.93,τ=30,ε=.072		
PO	0	1	$n = 25$	0	1	$n = 25$	0	1
0	.912	.038	0	.912	.043	0	.912	.043
1	.039	.011	1	.043	.002	1	.043	.004
			p_H=.96,τ=14,ε=.011			p_H=.96,τ=16,ε=.010		
SP	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.734	.188	0	.737	.120	0	.731	.124
1	.056	.022	1	.120	.023	1	.124	.021
			p_H=.86,τ=14,ε=.094			p_H=.86,τ=32,ε=.094		
UK	0	1	$n = 25$	0	1	$n = 50$	0	1
0	.305	.328	0	.306	.237	0	.304	.242
1	.142	.226	1	.237	.219	1	.242	.213
			p_H=.64,τ=13,ε=.133			p_H=.61,τ=26,ε=.134		

ECHP data and estimations are reported for the following seven countries: IR=Ireland, IT=Italy, LX=Luxemburg, NL=The Netherlands, PO=Portugal, SP=Spain, UK=The United Kingdom.