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Another problem in the estimation of intergenerational income mobility

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ABSTRACT

The current econometric model of intergenerational income mobility is premised on a simplified notion of permanent income. Analytical results and empirical evidence suggest that estimates are not robust to failure of this assumption.

The intergenerational elasticity (IGE) of child to parent income provides a summary statistic of income mobility, where low (high) elasticities reflect high (low) mobility. The literature has moved on from past estimation issues, involving biases from measurement error and unrepresentative samples, to comparing mobility estimates (geographically and intertemporally) and decomposing estimates into possibly causal components (see for instance Solon, 2002; Bowles and Gintis, 2002). Below we outline new estimation concerns relating to the assumption that a proxy for permanent income is the appropriate variable for estimating income mobility.

1. The standard model

The primary statistical model in the IGE literature is one in which children's permanent income is a function of parents' permanent income and some noise, while *annual* income is a function of their respective permanent incomes and other, transitory, factors. Early estimates of the IGE used single years of income, but subsequent work found that multi-year averages yielded higher estimates. This suggested that single-year estimates may suffer attenuation bias due to their proxying for permanent income.[1]

$$y_{0is} = y_{0i} + w_{0is} + v_{0is} \tag{1}$$

$$y_{1it} = y_{1i} + w_{1it} + v_{1it} \tag{2}$$

$$y_{1i} = \rho y_{0i} + \varepsilon \tag{3}$$

Parental income in year s and children's income in year t are represented by y_{0is} and y_{1it} respectively. Following Mazumder (2003) these are expressed as functions of permanent (y_{0i} and y_{1i}), transitory (w_{0is} and w_{1it}) and white noise components (v_{0is} and v_{1it}) respectively. The latter two components in parental income create the basic measurement error problem. A more complicated case, is when there is serial correlation:

$$w_{0is} = \delta w_{0is-1} + \xi_{0is} \tag{4}$$

This can be shown to yield the following result:

$$plim\ \hat{\rho} = \rho\lambda_T \tag{5}$$

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[1] See Solon (1992) and Zimmerman (1992). This possibility seems to have been first suggested by Bowles (1972).

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Where

$$\lambda_T = \frac{\sigma^2_{Y_0}}{\sigma^2_{Y_0} + (1/T)\alpha\sigma^2_{W_0} + (1/T)\sigma^2_{V_0}}$$

And α in the denominator is:

$$\alpha = \left\{1 + 2\delta\left(\frac{T - \delta T - 1 + \delta^T}{T(1-\delta)^2}\right)\right\}$$

Parameters σ_{W_0}, σ_{V_0} and σ_{Y_0} represent variances of the transitory, white noise and permanent components respectively.

The effect of serial correlation is represented by α ($\alpha = 1$ if no serial correlation) and λ_T is the attenuation factor ($0 < \lambda_T < 1$). Increasing T decreases the attenuation bias, but the effect is mitigated by correlation between transitory components. Consequently, Mazumder (2005) has argued that averages over longer periods than previously used give an IGE in the United States around 0.6, rather than earlier estimates of 0.4.

Transitory components here are mere nuisance terms—obscuring the intergenerational relation in incomes. The next section examines the implications of children's income being a function of the transitory *and* permanent components of their parents' income.

2. An alternative model

Though the literature is agnostic about structural issues, the simplified notion of permanent income as a lifetime average implicitly excludes a class of structural models.[2] For instance, models incorporating differential contribution to the IGE of parental income in early childhood, or the effect of parental credit constraints on children's later income, are excluded by this assumption. More fundamentally, IGE estimates themselves may fluctuate due to unobserved heterogeneity if these assumptions fail.

The modification we propose is given in Eq. (6). The second term allows children's permanent income (y_{1i}) to be a function of deviations from parents' permanent income (z_{0iq}).

$$y_{1i} = \rho y_{0i} + \sum_q \beta_q z_{0iq} + \varepsilon \tag{6}$$

Where $z_{0iq} = y_{0iq} - y_{0i} = \left(w_{0iq} + v_{0iq}\right)$
and $q \in Q, s \in S, Q \subset S$

Years of 'childhood' and parental income are indexed by q and s respectively. The actual range of q, with q^L and q^H the first and last years, is an empirical question.[3] The coefficient (β) is allowed to vary, so transitory income may have different impacts depending on the stage of childhood.

What is the appropriate IGE under this model? Since average lifetime income is the same in every year, one approach is to add ρ for *each* year along with the betas:

$$\rho^* = \left(\frac{\rho T' + \sum\beta_q}{T'}\right) = \rho + \frac{\sum\beta_q}{T'}$$

When $\beta_q = 0$, $\forall q$, the model reduces to the standard one.

2.1. Estimation of IGE using one year of parental income

Prior to recognition of the measurement error problem, IGEs were estimated using single years of parental income. Below we characterise the probability limits (plims) on such estimates, under the null that our alternative model is true.

2.1.1. Income earned outside childhood

A critical issue is whether parental income was earned within, or outside of, childhood. If the year of income is taken from a period (k) outside childhood, we have:

$$plim\hat{B}^* = \frac{\rho\sigma^2_{Y_0} + \sigma^2_{W_0}\sum_q \beta_q \delta^{|q-k|}}{\sigma^2_{Y_0} + \sigma^2_{W_0} + \sigma^2_{V_0}} \tag{7}$$

The denominator is as in Eq. (5) but $\alpha = 1$ because $T = 1$. The new numerator term represents the sum of the coefficients on transitory income for each year of childhood, each weighted by a value ($\delta^{|q-k|}$) that is a function of the correlation in the transitory component w_0 (i.e. δ), and proximity of that year to the one used in estimation ($|q-k|$). This assumes $\delta \neq 0$; with no serial correlation, using a non-childhood year picks up *none* of the impact of transitory income.[4] In this model higher autocorrelation can play a *positive* role in this respect.[5]

2.1.2. Income earned inside childhood

Assuming we have access to childhood income, using any such year in our regression produces an estimate with the following plim (derivations of this and subsequent results are provided in the appendix of Muller (2008)).

$$plim\hat{B}^* = \frac{\rho\sigma^2_{Y_0} + \sigma^2_{W_0}\sum_q \beta_q \delta^{|q-k^*|} + \beta_{k^*}\sigma^2_{V_0}}{\sigma^2_{Y_0} + \sigma^2_{W_0} + \sigma^2_{V_0}} \tag{8}$$

The white noise term (v_0) *for the year used* is now part of the calculated coefficient. Note that k^* is, by definition, closer on average to other childhood income than k in Eq. (7), and in general we may expect the second term in Eq. (8) to be larger than the equivalent term in Eq. (7). This may not be true in special cases where k is just outside childhood and closer to years of high importance than k^*. The relative magnitudes of the various components of income are also important. Mazumder (2003) suggests the following values (based on other studies of longitudinal income data):

$$\frac{\sigma^2_{W_0}}{\sigma^2_{Y_{0t}}} = 0.3, \frac{\sigma^2_{V_0}}{\sigma^2_{Y_{0t}}} = 0.2 \text{ and } \frac{\sigma^2_{Y_0}}{\sigma^2_{Y_{0t}}} = 0.5$$

The difference between Eqs. (7) and (8) gives a testable prediction: IGE estimates based on within-childhood income should be *higher* than those using non-childhood income. And the methodological implications are clear: *single-year estimation* should use income earned during childhood, or as close to childhood as possible (subject to life-cycle effects being accounted for).

2.2. Using multi-year averages of parental income

The current preferred method for calculating IGEs averages parental income over as many years as feasible. Below we characterise

[2] In fact, Friedman explicitly advocated against this (see Friedman, 1957, 23).

[3] I.e. Our definition of childhood here is tautological; it is that period in which parental income can causally impact child income. For some purposes one may even wish to extend this to consider parental bequests.

[4] Note however that even if δ is, for instance, 0.5, if the year in question is more than ten years away from childhood $\delta^{|q-k|} \cong 0$. We make use of this fact in Section 3.

[5] Though taking averages gives an additional attenuation effect due to the serial correlation—represented by α—as it did in the standard model; see Section 2.2, Eq. (9).