Swedish Institute for Social Research (SOFI)

Stockholm University

WORKING PAPER 3/2012

ON THE VARIABILITY OF INCOME WITHIN AND ACROSS GENERATIONS

by

Markus Jäntti and Lena Lindahl

On the variability of income within and across generations[1]

Markus Jäntti[2] Lena Lindahl[3]

January 27, 2012

[1]Financial support from the Swedish Council for Working Life and Social Research (FAS) is gratefully acknowledged.

[2]Corresponding author. Swedish Institute for Social Research (SOFI), Stockholm University, email markus.jantti@sofi.su.se.

[3]Swedish Institute for Social Research (SOFI), Stockholm University

Abstract

We examine the association of income variability both within and across generations based on a heterogeneous growth model of permanent and transitory income in Sweden. Non-parametric regressions reveal that income variability is strongly associated with long-run levels of income, especially for low- and high-income earners, and that it is also strongly associated across generations.

JEL Classification: D31, D63, J62, C14
Keywords: Intergenerational mobility, income variability

1 Introduction

The extent to which a person's economic position depends on that of his parents is of great scientific and public interest (Solon, 1999). Economic theory predicts such associations (see e.g. Becker and Tomes, 1986) and judgments on social justice may depend on their strength.

The prototypical approach in empirical research on intergenerational associations of economic status is to regress a measure of "permanent" or long-run income of offspring on that of their parents. The analyses rest on two basic premises. First, long-run income, measured as a multi-year average, is the most relevant measure of economic well-being. Second, deviations of annual from long-run income are treated as classical errors – assumed to be uncorrelated with long-run income and have a constant variance.

We question both these premises. Long-run income is most welfare relevant only if individuals have access to well-functioning capital markets and can distinguish between transitory and permanent shocks to income, which is not very realistic. The assumption that short-run deviations are classical has been falsified (see Haider and Solon, 2006). The close to exclusive focus on long-run economic status is therefore unwarranted and obscures other transmission mechanisms. If shocks are correlated, transmission across generations is more extensive than previously believed.

We show that a model with heterogeneous income profiles generates implications very different from those based on classical errors: the deviations of an individual's income from a multi-year average depend on his income level, annual deviations from multi-year average income are correlated across generations, and the association of parent-child income increases with the age of both. We demonstrate the presence of these implications in data for Swedish fathers and their children.

2 A model for intergenerational income variability

Research on the so-called generalized-errors-in-variables (GEIV) model shows that earnings measured at young ages are a downward-biased and at later ages an upward-biased measure of lifetime earnings (Böhlmark and Lindquist, 2006; Haider and Solon, 2006). In the US and Sweden, deviations from a multi-year average around age 40 are approximately classical. Using averages around that age allows for the analysis of intergenerational association of long-run income.

However, Nybom and Stuhler (2011) use nearly complete actual lifetime incomes for both Swedish fathers and sons, and find large biases in the intergenerational elasticity estimates. Their results imply the GEIV model is too simple and point to the presence of heterogeneous income profiles.

This leads us to the following model. We allow for individually varying intercepts and slopes (abstracting from a population-wide age profile):

$$\begin{aligned} y_{ijt} &= \alpha_{ij} + \beta_{ij} t + v_{ijt} \\ v_{ijt} &= \phi v_{ij,t-1} + u_{ijt} + \theta u_{ij,t-1} \\ u &\sim N(0, \sigma_u^2) \quad j = O, P. \end{aligned} \tag{1}$$

Short-run deviations from the income profile are autocorrelated (here, an ARMA[1,1] process). Both the intercepts and the growth rates may be correlated across generations, as captured by the following bivariate regression:

$$\begin{aligned} \alpha_{iO} &= \gamma \alpha_{iP} + \varepsilon_i \\ \beta_{iO} &= \delta \beta_{iP} + \nu_i; \quad \alpha, \beta \perp \varepsilon, \nu. \end{aligned} \tag{2}$$

We assume that the parent's earnings intercept and growth rate have zero mean, positive variances $(\sigma^2_{\alpha_P}, \sigma^2_{\beta_P})$ and may be correlated (ρ_P):

$$\begin{bmatrix} \alpha_P \\ \beta_P \end{bmatrix} \sim F\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{\alpha_P} & \cdot \\ \rho_P \sigma_{\alpha_P} \sigma_{\beta_P} & \sigma^2_{\beta_P} \end{bmatrix} \right) \tag{3}$$

Given the population regression 2, the child's intercept and growth rate are

$$\begin{bmatrix} \alpha_O \\ \beta_O \end{bmatrix} \sim F\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \gamma^2 \sigma^2_{\alpha_P} + \sigma^2_{\varepsilon} & \cdot \\ \gamma \delta \rho_P \sigma_{\alpha_P} \sigma_{\beta_P} & \delta^2 \sigma^2_{\beta_P} + \sigma^2_{\nu} \end{bmatrix} \right). \tag{4}$$

Consider what happens when one relies on an over-time average of annual incomes but the income process does have a random growth rate. Let $\overline{y_{ij}} = 1/T \sum_1^T y_{ijt}$ be the average across ages 1 to T for generation j and let $e_{ijt} = y_{ijt} - \overline{y_{ij}}$ be the deviation of annual from that over-time-average income. If annual income follows the process in equation 1, then we have

$$
\begin{aligned}
e_{ijt} &= y_{ijt} - \overline{y_{ij}} \\
&= \alpha_{ij} + \beta_{ij}t + v_{ijt} - \frac{1}{T}\sum_{1}^{T}(\alpha_{ij} + \beta_{ij}t + v_{ijt}) \\
&= (\alpha_{ij} - \frac{1}{T}T\alpha_{ij} + \beta_{ij}t - \frac{1}{T}\beta_{ij}\frac{T(T+1)}{2} + v_{ijt} - \frac{1}{T}\sum_{1}^{T}v_{ijt} \\
&= \beta_{ij}\left(t - \frac{(T+1)}{2}\right) + v_{ijt} - \frac{1}{T}\sum_{1}^{T}v_{ijt} \\
&= \beta_{ij}\tilde{t} + \widetilde{v}_{ijt}.
\end{aligned}
\tag{5}
$$

The last line of equation 5 suggests several ways in which the deviation of annual from over-time-average income will display "non-classical" behavior:

1. the deviations are strongly correlated across time, driven by three factors: the (possible) time-series structure of the errors v_t in equation 1, the time-average that is part of $\tilde{v}$, and the fact that the random growth rate β is present in every deviation;

2. the variance of the deviations depends on lifetime income. In particular, the variance for both the lowest and the highest income earners is larger than for those close to the average;

3. the variance of the deviations increases across time as the variance of the random growth rates is multiplied by age squared;

4. the deviations are correlated across generations if, as we posit in equation 2, the growth rates are intergenerationally correlated;

5. the intergenerational correlation in such deviations increases across age.

In our analysis, we explore these implications. Next we briefly describe our data.

3 Data

We use data from two administrative registers, put together by Statistics Sweden: the Multi-generational register, from which we draw a 35 percent random sample of the Swedish population, including their biological parents, and the income register, from which we use total market income *(Swed. sammanräknad nettoinkomst)*, originating from tax assessments.

We include sons and daughters born 1950-1957 with fathers born 1925-1937, and have restricted the age difference between fathers and offspring to 20 years or more. Income data are available for the years 1960-2007, so using these cohorts provides us with long-run average income and its variability in ages 30-50 in both generations, including up to 21 years of income. We impose a lower limit of SEK 100 (in 2007 prices) to include an income observation.[1] Our analysis is based on residuals from a regression of annual ln income on gender, year and birth cohort dummies as well as their full interactions. An individual's long-run average income is measured by taking the mean of all available income observations, and income variability by the standard deviation of annual incomes.

4 Analysis

Intragenerational association of over-time average income and its variability

Figure 1 plots a non-parametric smooth of the within-individual standard deviation against long-run income, estimated using local likelihood regression.[2]. Panel A shows the plot for fathers and sons. The vertical lines index different percentiles of the marginal distribution of average income for offspring (dashes) and fathers (solid lines).

The graphs demonstrate, as expected in Section 2, that the profile of annual income variability depends on long-run income and is U-shaped. The magnitude of the differences in income variability are quite substantial. For instance, at median long-run income, the estimated standard deviation for sons is around 0.15. This increases to about 0.21 at the 25th percentile and 0.6 at the 10th. The profile of income variability also increases upward in the distribution of long-run income, although not as steeply – the standard deviation is asymmetric with respect to median income.

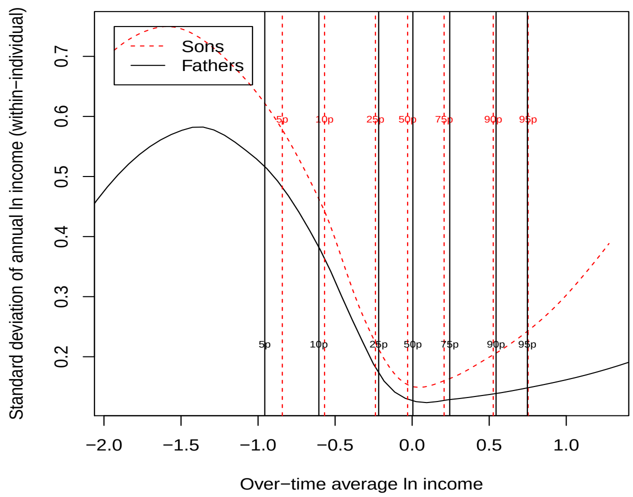
The same strongly U-shaped pattern of variability is evident for daughters (Panel B). Variability around the median is higher than for sons, and reaches its

[1] This lower limit is commonly imposed when using these data, see, e.g., Björklund, Jäntti, and Lindquist (2009).

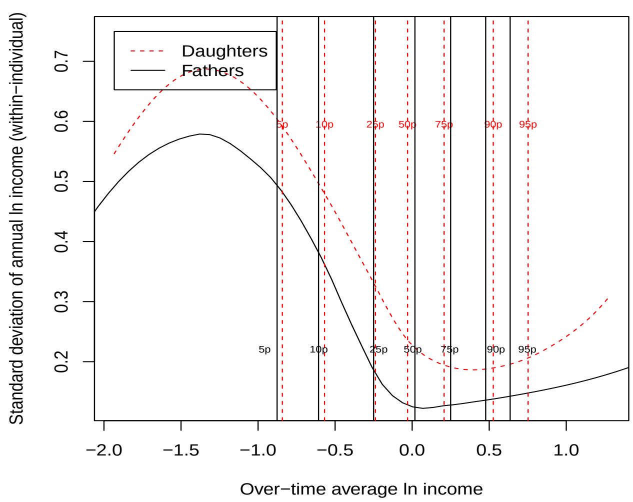
[2] We use a gamma family to ensure the standard deviations are positive, see Loader (1999).

Figure 1 The variation (std) of annual ln income across over-time mean of ln income

A. Sons and fathers



B. Daughters and fathers



Note: Incomes are measured as the residual of a regression of annual ln income on gender, cohort and year dummies fully interacted. The x-axes limits exclude the lowest and the highest half percent of fathers. The plot shows the smoothed estimate of the within-individual standard deviation of annual income from average income.

minimum further up in the distribution of long-run income. Variability in the right and left tails of the distribution is, by contrast, lower.

Finally, the variability of annual income has increased across generations. The standard deviation of annual income for sons as a function of their long-run income is uniformly higher than that for fathers. The broad shape of the association is similar for the two generations.

Intergenerational associations in income variability

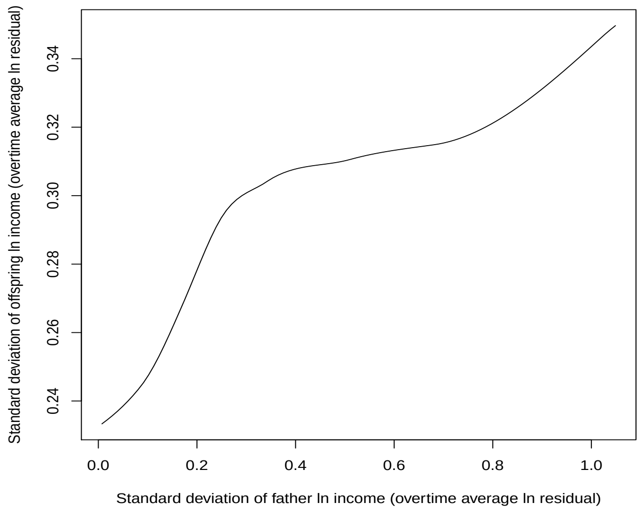
Figure 1 shows that income variability is strongly associated with long-run income within generations. While lower than in the United States, there is substantial intergenerational persistence in long-run incomes in Sweden (Björklund and Jäntti, 2009). Since long-run income is intergenerationally correlated, income variability may also be so. We examine the evidence for the intergenerational association of income variability in Figure 2, where Panel A graphs the estimated profile in sons variability, conditional on that of fathers, and Panel B that for daughters and fathers.[3]

The fitted offspring standard deviations suggest offspring variability increases with parental variability. The shape of the variability profile for sons is similar, but much steeper, than that for daughters, and in both cases non-linear. Whether or not the fitted values are considered to express very strong dependence of offspring variability on parental variability is a matter of judgement. For sons, moving from the very left of fathers' variability distribution to the very right is associated with roughly one tenth in the expected standard deviation of annual incomes.

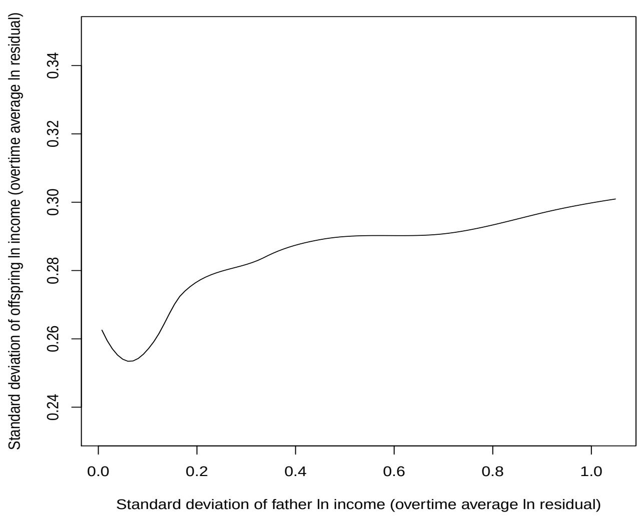
[3]We use, again, a gamma link function to force the fitted variances to be positive and use a local likelihood smoother to explore the association (Loader, 1999).

Figure 2 Intergenerational associations of income variability – non-parametric estimates

A. Men



B. Women



Note: The plot shows the smoothed estimate of the within-offspring standard deviation of annual deviations from overtime-average income against within-father standard deviation of annual deviations from overtime-average income.

Lastly, we fit offspring's income variability on both parental overtime average income and parental variability (see Figure 3). The results suggest a complex pattern of dependence of offspring income variability on parental income levels and variability. High parental income is associated with high offspring variability, even more so when parental income variability increases. By contrast, offspring of low-income fathers are not particularly at risk of having very high variability, even when parental income variability increases. However, comparing offspring of low-income to average-income fathers, the former do have substantially higher own income variability – as seen when moving from the middle of father's income level to the left, holding father's variability constant. But that offspring income variability increases only marginally as parental income variability increases – moving now along the left edge of father's income level but increasing his income variability, son's variability does not increase almost at all.

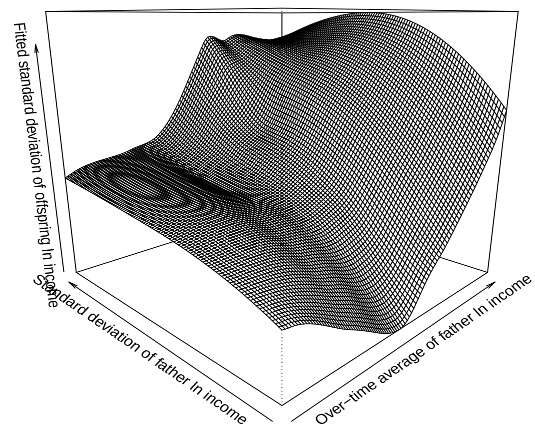
5 Concluding remarks

Our paper contributes to the study of the intergenerational transmission of economic advantage. Most research on the transmission qof economic advantage are based on models that rely on the idea of a "permanent income" that does not vary with age. We demonstrate that in a random growth rate model, annual deviations from long-run average income display a number of properties that are absent in those models. The variability of income deviations increases with age and depends on income levels. Furthermore, if growth rates are intergenerationally correlated, then so are also income variabilities.

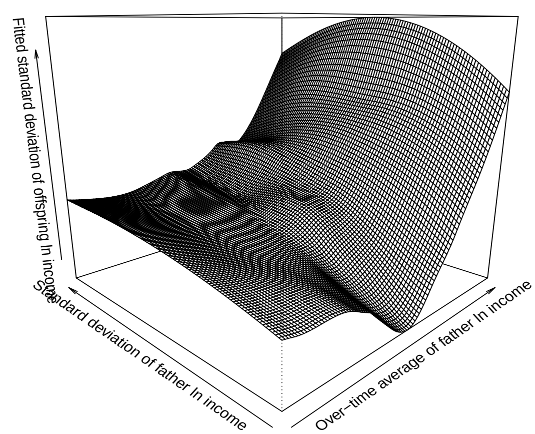
Our evidence confirms many of the expected patterns. Income variability does vary strongly across levels of mean income, being particularly high for low-income and slightly less so for high-income earners. Moreover, income variability is strongly related across generations. Fitting offspring income variability on both parental income levels and the variability of parental income across time, however, suggests that son's of low-income fathers, while subject to higher than average income variability, are to some extent protected from also being susceptible to large income variability.

Figure 3 Intergenerational associations of income variability – non-parametric estimates on both parental overtime average income and variability

A. Men



B. Women



Note: The plot shows the smoothed estimate of the within-offspring standard deviation of annual deviations from overtime-average income against both father's overtime average income and within-father standard deviation of annual deviations from overtime-average income.

References

Becker, Gary S and Nigel Tomes (1986). "Human Capital and the Rise and Fall of Families". In: *Journal of Labor Economics* 4, S1–S39.

Björklund, Anders and Markus Jäntti (2009). "Intergenerational income mobility and the role of family background". In: *Oxford Handbook of Economic Inequality*. Ed. by Wiemer Salverda, Brian Nolan, and Timothy M Smeeding. Oxford: Oxford University Press. Chap. 20, pp. 491–521.

Björklund, Anders, Markus Jäntti, and Matthew J Lindquist (2009). "Family Background and Income during the Rise of the Welfare State: Brother Correlations in Income for Swedish Men Born 1932-1968". In: *Journal of Public Economics* 93.5–6. doi:10.1016/j.jpubeco.2009.02.006, pp. 671–680.

Böhlmark, Anders and Matthew J Lindquist (2006). "Life-Cycle Variations in the Association between Current and Lifetime Income: Replication and Extension for Sweden". In: *Journal of Labor Economics* 24.4, pp. 879–896.

Haider, Steven and Gary Solon (2006). "Life-Cycle Variation in the Association between Current and Lifetime Earnings". In: *American Economic Review* 96.4, pp. 1308–1320.

Loader, Clive (1999). *Local Regression and Likelihood*. Statistics and Computing. New York: Springer-Verlag.

Nybom, Martin and Jan Stuhler (2011). *Heterogeneous Income Profiles and Life-Cycle Bias in Intergenerational Mobility Estimation*. Discussion Paper 5697. `http://ftp.iza.org/dp5697.pdf`. Bonn: IZA.

Solon, Gary (1999). "Intergenerational mobility in the labor market". In: *Handbook of Labor Economics*. Ed. by Orley Ashenfelter and David Card. Vol. 3. New York: Elsevier Science B.V., pp. 1761–1800.