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TRENDS IN THE TRANSITORY VARIANCE OF EARNINGS IN THE UNITED STATES*

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We decompose the rise in cross-sectional variance of male annual earnings in the United States from 1969 to 1996 into permanent and transitory components. We find that the variance of permanent earnings began rising in the the late 1970s and has continued to rise in the 1980s. The variance of transitory earnings also rose in the 1980s but declined in the 1990s. There are lags in the earnings process which require a structural model to pinpoint the exact calendar times at which the changes in trends occurred.

The rise in earnings inequality in many industrialised countries, most notably the United States and the United Kingdom, has been one of the more important developments in the labour markets of these countries in the last several decades. There is a wealth of explanations for this phenomenon and not all explanations work equally well in all countries (Katz and Autor, 1999). As we noted in prior work (Gottschalk and Moffitt, 1994; Moffitt and Gottschalk, 1995), the explanations that have been adduced for this trend all presume that it has risen from an increase in the dispersion of permanent earnings, such as an increase in the price of skill; yet it could also have arisen from an increase in the variance of transitory earnings. An increase in transitory earnings variance should have rather different explanations, such as an increase in labour market instability, more competitive markets which generate fluctuating fortunes of firms, a rise in the temporary workforce, or some other phenomenon. We presented evidence in our earlier work that the transitory variance of male earnings had indeed risen in the United States up to 1987 and could explain about 50% of the total rise in cross-sectional earnings variance (see Blundell and Preston (1998) for UK evidence on increasing transitory earnings variance).

In this paper we extend our analysis to 1996 and generalise the analysis in other ways as well. The growth of cross-sectional earnings inequality slowed in the United States in the late 1980s and early 1990s and it is unclear whether this was a result of a slowing of the growth of the permanent or transitory variance. In addition, our prior work examined only white males and only examined within-group transitory variance (ie, of regression residuals); in this paper we examine all males and compute transitory variances for overall annual earnings. In addition, we utilise a relatively simple graphical device to illustrate the trend in transitory earnings which turns out to show the same trends as more sophisticated econometric models of earnings dynamics.

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1. The Michigan PSID

We use the Michigan Panel Study on Income Dynamics (PSID), a longitudinal survey that has followed a sample of households from the civilian non-institutional population of the United States since 1968. Approximately 5,000 households were interviewed in the initial year of the survey and have been interviewed annually through 1997, the last interview year we include.[1] Children of original 1968 households have been kept in the sample when they leave to form new households, as have adults who leave, thereby keeping the sample representative of the population except for new immigrants. Earnings are reported for the year prior to interview, so our data cover annual earnings in years 1967–96; we delete the first two years because earnings were bracketed, leaving us with years 1969–96. Earnings are converted to real 1992 dollars. We analyse only males to avoid the complications generated by trends in the probability of working that would arise for females. We restrict our sample to heads of household because the PSID earnings measure we use is only available for heads. The sample we use includes male heads 20–59 who had positive hours of work and earnings in the year prior to interview and who were not in school at the date of interview. In order to maximise the sample size, we include every annual observation for each individual for which these restrictions are met; thus individuals sometimes drop out and reappear in the sample over time, leading to an unbalanced panel. The analysis sample has 2,988 men with about 12 years of data per person, for a total of approximately 35,856 person-year observations.

2. A Simple Method for Computing Transitory Variances

The standard permanent–transitory model is:

$$y_{ia} = \mu_i + v_{ia} \tag{1}$$

where y_{ia} is log earnings for individual i at age a, μ_i is a time-invariant individual component with variance σ_μ^2, and v_{ia} is a transitory component with variance σ_v^2. Assuming the two components are uncorrelated, the cross-sectional variance of log earnings is the sum of the two:

$$V = \mathrm{Var}(y_{ia}) = \sigma_\mu^2 + \sigma_v^2. \tag{2}$$

A simple method of estimating the transitory variance can be seen by noting that the permanent variance is equal to the covariance of log earnings between a pair of ages sufficiently far apart that the transitory errors are uncorrelated:

$$C = \mathrm{Cov}(y_{ia}, y'_{ia}) = \sigma_\mu^2 \quad \text{if} \quad \mathrm{Cov}(v'_{ia}\, v'_{ia}) = 0. \tag{3}$$

Since sample counterparts of V and C are easily computed from the data, an estimate of the transitory variance can be computed as $T = V - \mathrm{C}$.

Fig. 1 shows the trends in V, C, and T using a five-year gap between earnings observations as a preliminary guess of a sufficiently long gap that transitory errors are uncorrelated. These data indicate that cross-sectional variance rose strongly in

[1] We exclude the 'SEO' sample and hence do not use survey weights.

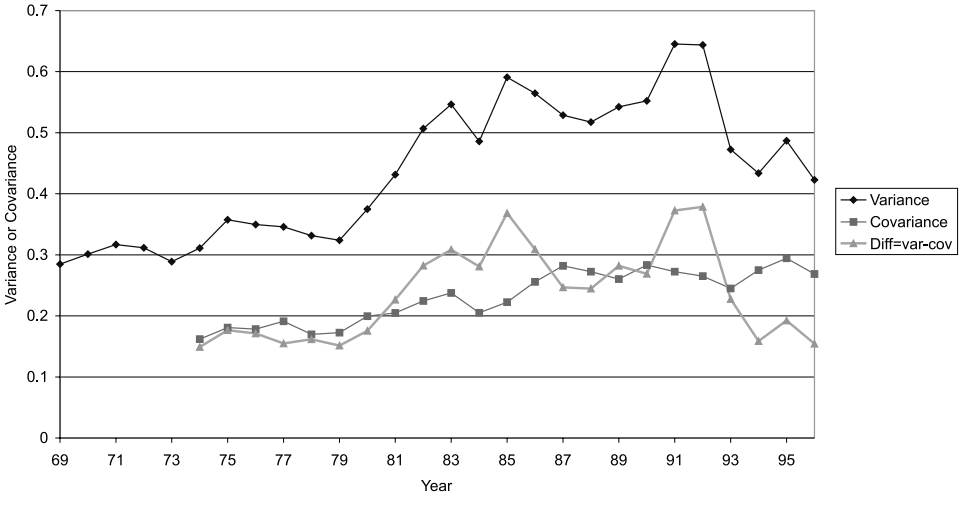

Fig. 1. *Permanent and Transitory Variances of Male Log Earnings,* 1969–1996

the late 1970s and 1980s, but was essentially level, albeit with considerable fluctuation, in the first half of the 1990s. The earnings covariance rose steadily over the whole period, indicating a secular increase in the permanent variance. The difference between the two, which is the transitory variance, rose dramatically in the 1980s, levelled off in the late 1980s, and fell after 1991.

Thus our findings from these extended data show that the transitory variance did indeed rise strongly in the 1980s. In fact, from 1974 to 1991 (our earlier work only went up to 1987), the transitory variance accounts for about 70% of the overall cross-sectional variance increase. However, the rapid reduction in the transitory variance after 1991 is new and unexpected. It may reflect the business cycle, for the US economy has exhibited strong and steady growth in the 1990s. Such a countercyclical effect in the transitory earnings variance is apparent in Fig. 1, for the early 1980s and late 1980s were both high unemployment years. The early 1990s have also been low unemployment years. But the transitory variance also seems to have been at a higher average level throughout the 1980s, which would not be explained by cyclical factors. Whether the recent decline in transitory variance is a cyclical phenomenon or a trend must await more data from the latter half of the 1990s.

3. A Formal Model of Earnings Dynamics

The five-year earnings assumption is relatively arbitrary and does not utilise most of the data. More important, it does not serve to isolate specific year shocks which could affect earnings. A formal error components model of earnings dynamics is needed for that purpose.

There is a large body of econometric literature on earnings dynamics (see Atkinson *et al.* (1992) for a review of the early literature). That literature shows that transitory errors are indeed serially correlated and also that permanent compo-

nents tend to change as well, either by a random walk or from a random growth rate which differs across individuals. However, the literature also shows that the autocovariance structure of earnings can be captured by a relatively small parameterised model composed of a low-order ARMA process on the transitory error and a growth process on the permanent component.

Our major difference with this literature is that we wish to examine the existence of structural shifts by calendar time in this earnings structure. To that end, we utilise a relatively simple model of earnings dynamics over the life cycle and then estimate which of the parameters of that model are shifting with calendar time (since the overall variances and covariances are changing, at least some of the parameters must have changed, by definition). The separation of age effects from year effects is critical to our model. All components will be indexed by both age and year.

After much experimentation, we have settled on a life-cycle model of earnings dynamics with an ARMA(1,1) transitory error and a permanent component that follows a random walk. We allow all the parameters of this model to shift with calendar time. Our model is as follows:

$$y_{iat} = \alpha_t \mu_{iat} + v_{iat} \tag{4}$$

$$\mu_{iat} = \mu_{i,a-1,t-1} + \omega_{iat} \tag{5}$$

$$v_{iat} = \rho_t v_{i,a-1,t-1} + \xi_{iat} + \theta_t \xi_{i,a-1,t-1}. \tag{6}$$

Log earnings for individual i at age a in year t (y_{iat}) are composed of a permanent component (μ_{iat}) and a transitory component (v_{iat}). The permanent component begins at some value μ_{i1} in the first period of working life and then evolves according to the random walk specified in (5), where ω_{iat} are white-noise shocks to permanent earnings. The transitory component evolves by an ARMA(1,1) process, where ρ_t is the autocorrelation parameter, θ_t is the moving-average parameter, and the ξ_{iat} are white-noise transitory shocks. Permanent and transitory components can be distinguished because the latter are mean-reverting and the former are not.

There are five time-varying parameters in the model – α_t, ρ_t, θ_t, and the variances of ω_{iat} and ξ_{iat}. The first is a coefficient on the permanent component which can be interpreted as the price of skill, assuming that the permanent component measures skill. That price is allowed to shift with time as the forces of supply and demand for skill evolve. The other four are parameters of the transitory process and have less economic interpretation.[2] We estimate the model with minimum distance, following the suggestion of Chamberlain (1984) to use the elements of the empirical covariance matrix as observations in a nonlinear least squares estimation which fits the parameters of the assumed model to those elements. Robust standard errors are obtained.

Our initial estimations explored specifications in which the five parameters were allowed to be a function of a polynomial in calendar year. Repeated exploration of these models revealed, in our preliminary analysis, that the bulk of the structural

[2] The coefficient α_t is normalised to 1 at $t = 0$ (1969 in our data). A sixth parameter is the $a = 1$ variance of the permanent component. We initially held it fixed but later allowed it to vary with calendar time and found that it did not.

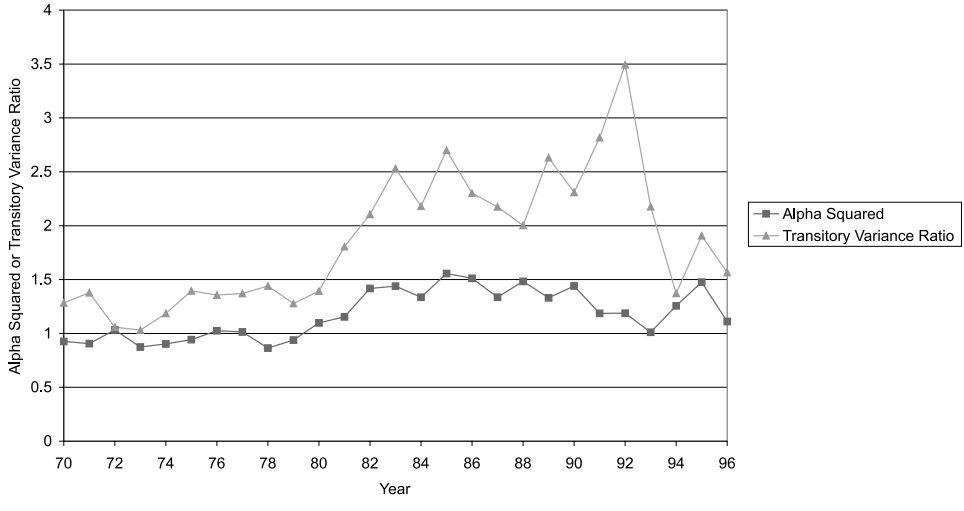

Fig. 2. *Trends in Alpha Squared and the Variance of Transitory Shocks*

shift is occurring in two parameters: α_t and the variance of ξ_{iat}. These parameters are readily interpretable as permanent and transitory variance components. The first is the coefficient on the permanent component, as already noted, and the latter is the forcing variable in the transitory earnings process, the white-noise shocks which arrive each period and which affect future earnings through the MA and AR serial correlation structure. The random walk, MA, and AR structures themselves do not appear to have much calendar time shifts.

Working from this result we then allow the parameters α_t and the variance ξ_{iat} to vary completely by year by estimating the model above with separate values of these parameters for each value of t. The other parameters are held fixed. Fig. 2 shows a plot of the estimated square of α_t (this puts it onto a variance scale) and the variance of ξ_{iat}. The ratio of the value of the latter in each year to its initial 1969 value is plotted; α_t is already normalised to 1 in 1969.

The results in the figure tell approximately the same story as in Fig. 1, with a rising then falling variance of transitory shocks and a rising permanent variance. This is a sign that the five-year covariance lag used for the simple estimation of the permanent variance is roughly accurate. A shorter lag would have given a more distorted picture of the growth of permanent variances because short lags would be contaminated by the increasing transitory variance, which spills over into subsequent periods through the ARMA process and increases short-term covariances. A longer lag would have given a less realistic pattern of the trend in α_t, however, because the coefficient on the variance of μ in a covariance of two earnings observations is $\alpha_t\alpha_{t-L}$, where L is the length of the lag. If α_t is trending, a higher L implies that this coefficient is a more distorted estimate of the current α_t; a five-year gap is somewhat distorted but not too much if α_t is moving slowly.

However, the timing of change in Fig. 2 differs slightly from that in Fig. 1 for the same reasons. Thus, for example, the parameter governing the variance of trans-

itory shocks in Fig. 2 appears to have risen somewhat in the late 1980s, compared to a more stationary profile of the transitory variance in Fig. 1 in this period. The difference may be that the shocks in Fig. 2 are damped by the ARMA process, which smooths them out because shocks have persistent effects on later earnings.

Likewise, the permanent shocks in Fig. 2 do not rise as steadily as the covariances in Fig. 1. The Fig. 1 covariances rise in the late 1970s, then rise again in the mid 1980s, then rise once more in the early 1990s. The sudden rise in the late 1970s occurs because the permanent variance shocks in Fig. 2 started rising earlier than this; the former rise with a lag because they represent the combined influence of α_t and α_{t-5}. The sudden rise of the covariance in 1985 is a lagged reaction to the sharp rise in permanent variance shocks in the early 1980s. In the early 1990s, the covariances were rising because of a jump-up in the permanent variance shocks in the late 1980s.

4. Conclusions

The increase in the transitory variance of earnings is one of the more puzzling aspects of the changes in labour markets in the United States and United Kingdom over the last several years. In earlier work we found it to be stronger for workers with low wage levels but present to some degree for more educated workers as well. Preliminary indications, yet to be confirmed, are that the more recent changes in transitory variance are equally pervasive throughout the workforce. The sudden decline of transitory variance documented in this paper adds to the puzzle.

Although no explanation is provided here, it is demonstrated that a search for such an explanation should make use of a structural model of earnings dynamics rather than a simple examination of raw permanent and transitory variances. Because of lags in the earnings process, the occurrence of shocks at one point in time does not appear until later in the actual earnings variances. A proper accounting for the timing of calendar-time events which might have generated the changes should use the timing of occurrence of the underlying structural shocks.

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