

# Recent Trends in Household Income Dynamics for the United States, Germany and Great Britain

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## Abstract

This paper studies household income inequality in the United States, Germany and Great Britain using the latest Cross-national Equivalence File from 1979 to 2004. I estimate an error components model to examine the changes in permanent variation and transitory variation in household income and compare between three countries. Despite the differences in overall inequality among three countries, permanent variance converges since the late 1990's. Transitory variance accounts for more than half of the total variance in all three countries. Comparison of transitory variance at household level and individual level also suggest some evidence of household insurance.

*JEL Codes:* D31, D63.

*Keywords:* Household Income, Permanent Inequality, Income Volatility, Cross-national Comparison

## 1 Introduction

Rising income inequality has been one of the most important features in many industrial countries over the last couple of decades (Gottschalk and Smeeding, 1997). Such increase in cross-sectional income inequality could arise either from increase of permanent dispersion of average income (“the rich gets richer”, “the poor gets poorer”) or

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larger transitory fluctuation from year to year (income volatility). It is important to distinguish between permanent variation and transitory variance to understand the causes of growing overall income inequality. Rising permanent income dispersion can usually be attributable to skill-biased technological change or increased trade with developing countries, while increased income volatility are more related to the instability of labor market. Gottschalk and Moffitt (1994) launched the recent literature on income volatility. They found that transitory variation accounts for about one third to one half of the total inequality of male earnings and such income volatility also increased over time.

The inequality and volatility of male earnings has been well studied in the U.S. (Haider 2001, Moffitt and Gottschalk 2008) as well as in other industrial countries: Daly and Valletta (2008), Burkhauser et al. (1997), Dickens (1996). Household income inequality is less well studied than male earnings inequality. This is a more complicated question because it involves income sources and decisions of more than just one person. The causes of permanent household income dispersion may also be associated with marital sorting but the causes of transitory income volatility, on the other hand, are subject to changes in family structure and joint decision (labor supply, saving, etc.) of individual members of the household.

Dynan et al. (2008) summarizes existing studies on household income dynamics. Some of these studies use repeated cross-section data such as Current Population Survey (CPS) to study income volatility (Hertz 2006, Bollinger and Ziliak 2007). With such data the variances and covariances of differences in income can not be observed, and the model could not allow for serial correlation in transitory shocks. Others use various descriptive approaches on panel data, such as changes over time in the cross-sectional distribution of income changes (Dynan et. al. 2008), coefficient of variation (Bania and Leete 2007) or some simple decomposition method that is

consistent with formal income dynamics model only under a particular maintained assumption (Hacker 2006). In this paper I apply Moffitt and Gottschalk (2008) latest method to estimate a formal error components model of life cycle income dynamics with calendar time shifts for household income using panel data. Estimation of such model identifies how permanent and transitory variance evolves over time and over life cycle.

This paper also makes cross-national comparison of household income dynamics between the United States, Germany and Great Britain. Given their similarity in income level and economic development but differences in educational and wage-setting institutions as well as family structure, such comparison provides important benchmarks of how income inequality and volatility in the U.S. differs from or is similar to other industrial countries. The cross-national study could also provide policy guidance on how different social policies cope with income instability. Due to lack of comparable data, cross-national comparison of income inequality is rarely studied. Gottschalk and Smeeding (1997) uses Luxembourg Income Study (LIS) to examine cross-sectional inequality in earnings and family income up to early 1990's. LIS contains comparable income measures from repeated cross-sectional data such as CPS in the U.S.. I use the latest Cross-national Equivalence File (CNEF) from 1979 to 2004 which consists of comparable income measures from longitudinal dataset in the U.S. (Panel Study of Income Dynamics), Germany (German Socio-Economic Panel) and the U.K. (British Household Panel Study). From this file I can examine how much of the overall inequality in household income is due to permanent variation and how much is due to transitory variation, and how these trends differs in each country.

Estimation results suggest that despite the differences in over-all inequality among three countries, permanent variance converges since the late 1990's. Transitory variance accounts for more than half of the total variance in household income, about

56 – 78% in the U.S., 67 – 85% in West Germany and 51 – 68% in the U.K.. I further compare transitory variance at household level with that at individual level, which suggest some evidence of household smoothing, especially in the United States.

Section 2 lay out the income dynamics model and estimation method. Section 3 describes the data set and main income variables and sample I use. Estimation results are presented in Section 4 and a brief summary concludes in Section 5.

## 2 Model Specification of Household Income Dynamics

In this section I specify an error components model of household income dynamics. Existing literature on the formula of such models have suggested that permanent component is not fixed over the life cycle, which can be captured by a random walk or random growth process, while transitory component is serially correlated and can be approximated by a low-order ARMA process. I specify a model similar to Moffitt and Gottschalk (2008) which contains all above features:

$$\begin{aligned}
 y_{iat} &= \alpha_t \mu_{ia} + v_{iat} \\
 \mu_{ia} &= \mu_{i,a-1} + \omega_{ia} \\
 v_{iat} &= \rho v_{i,a-1,t-1} + \xi_{iat} + \theta \xi_{i,a-1,t-1}
 \end{aligned} \tag{1}$$

where  $y_{iat}$  is log household income or its residual for household  $i$  at head's age  $a$  in calendar year  $t$ . It is composed of a permanent component  $\mu_{ia}$  with loading factor  $\alpha_t$ , and a transitory component  $v_{iat}$ . Transitory component is mean-reverting while permanent component is not. Assume  $E(\omega_{ia}) = E(\xi_{iat}) = 0$  and these errors are orthogonal to each other.  $\alpha_t$  captures aggregate changes such as changes in returns

to skill. Permanent effect  $\mu_{ia}$  is age-varying with a random but permanent shock  $\omega_{ia}$ . The transitory component  $v_{iat}$  evolves according to an ARMA(1,1) process with correlation  $\rho$  and smooth rate  $\theta$ . Shocks  $\omega_{ia}$  are i.i.d. with variance  $\sigma_\omega^2$  but the variance of  $\xi_{it}$  is allowed to shift with calendar time such that variance equals to  $\beta_t \sigma_\xi^2$ .<sup>1</sup>

I estimate the model using minimum distance estimation developed in Chamberlain (1984). The parameters are estimated by minimizing the sum of squared deviations between observed elements in variance-covariance matrix and predicted elements implied in above theoretical model, with an identity weighting matrix. Normalizations and initial conditions can be found in Appendix. Given estimated parameters, permanent variance of log household income can be computed by  $\alpha_i^2 var(\mu_{ia})$  and transitory variance is given by  $var(v_{iat})$ .

### 3 Data

This paper uses the latest Cross National Equivalent File (CNEF) which consists of equivalently defined income variables from the Panel Study of Income Dynamics (PSID) 1979-2002, the German Socio-Economic Panel (GSOEP) 1983-2004, and the British Household Panel Survey (BHPS) 1990-2000, prepared by the Department of Policy Analysis and Management at Cornell University.<sup>2</sup> All three datasets are longitudinal files so that I observe income changes over time for the same household. CNEF is qualified for comparative studies between different countries because it constructs

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<sup>1</sup>This model is the same as specification in Moffitt and Gottschalk (2008) except their permanent component also allows for a random growth factor in addition to random walk. The variance of random growth is very small (0.000038) in their estimation.

<sup>2</sup>All years are referred to the income year. PSID only conduct biennial interview after 1996, with data available at 1998, 2000, 2002.

income as well as other variables that are comparable across nations.<sup>3</sup>

The main income variable used in this paper is post-tax and transfer annual household income. This variable is the sum of total household income from labor earnings of all household members, asset flows, private retirement income, private transfers, public transfers, and social security pensions minus total household taxes.<sup>4</sup> The total household income is divided by equivalence scale which is adjusted based on household size to account for economies of scale of household members compared to single individuals.<sup>5</sup> Some sections also look at permanent and transitory variance in household earnings, male or female individual earnings for married families. Household labor earnings represents the combined labor income of the head, partner and other family members.

I only include West Germany sample in GSOEP because data for East Germany (former German Democratic Republic) before 1990 is not available. I follow household heads aged between 20 and 59 with positive household income. Household income is adjusted for inflation using consumer price index in each country and set 1996 as base year. I include every observation for each household that meet these restrictions, hence households might drop out and reappear in the sample over time. I also trim the top and bottom 1 percent outliers of household income within year-age group (20-29, 30-39, 40-49, 50-59) cell to reduce noise, which is a standard procedure in income inequality literature. The sample includes 5,239 households with a total of 115,022 household-year observations in the U.S.; 4,248 households with 88,312 observations in

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<sup>3</sup>The codebook of CNEF provides a description of how these variables are created, the algorithm used to create each variable from the original panel data, and it also provides a reliability code which tells the degree of cross-national comparability with "1" represents completely comparable.

<sup>4</sup>Total household taxes includes income taxes of the head, partner and other family members, as well as payroll taxes of the head and partner. The PSID data do not provide information on payroll taxes. They are calculated by bracketing labor income and applying the average payroll tax rate for that bracket as reported by the Social Security Bulletin, Annual Statistical Supplement, 1990, p.33.

<sup>5</sup>I use general official U.S. Equivalence Weight that is computed based on household size. This equivalence scale is available in CNEF data.

West Germany; and 3,672 households with 37,571 observations in the U.K.. Summary statistics are presented at Table 1.

A variance-autocovariance matrix is formed based on residuals from regressions of log earnings on household head's education, age, age square, a dummy for whether he is married and number of children, separate regression for each year. This first stage regression controls for the changes in the mean household income, thus the analysis in the next section examines the effect of within group variances. I calculate the covariance between income at age  $a$  and  $a'$  between year  $t$  and year  $t'$ , indexed with year, age and lag length.

## 4 Empirical Results

### 4.1 Estimated Permanent and Transitory Variances in Household Income

I estimate income dynamics model in equation (1) and compute permanent variance and transitory variance by year and by age group. Estimated parameters in each country are shown in Table 2.<sup>6</sup> Transitory shocks in household income are serially correlated at a rate of 0.77 in the U.S., 0.76 in West Germany and 0.70 in the U.K.. Random walk is very small in all three countries.

Figure 1 plots actual cross-sectional variance in log household income and the predicted variance across four age groups in three countries. The predicted values from model estimation match empirical variance in the data very well. The United States has the highest overall inequality among all three countries, and West Germany has the lowest inequality for the past two decades. Household income inequality in the

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<sup>6</sup>This draft has not yet obtained robust standard errors.

U.S. increased since the 1980's, declined in the late 1990's and then rise up again in the 2000's. This is consistent with other studies such as Gottschalk and Smeeding (1997) Figure 4 and Nichols and Zimmerman (2008). In West Germany, income inequality gradually increases over time, with the largest jump around the reunification in 1990. In the U.K. household income inequality does not change much in the 1990's.

Figure 2 plots the average permanent variance and transitory variance across four age groups by year. The top figure compares evolution of permanent variance among three countries. Despite large difference among countries in the 80's, the permanent variance converges since the late 90's. In addition, permanent dispersion in household income reduced since mid 90's in all three countries.

The bottom figure in Figure 2 shows the evolution of household income transitory variance. Unlike permanent variance, transitory variance does not have a clear convergence pattern in these three industrial countries. Transitory variance goes up in the long run but subject to cyclical changes in the U.S. and West Germany. In the U.K. it goes up more smoothly.

To examine how much of the overall inequality is attributed to income volatility rather than permanent dispersion, Figure 4-6 presents same results but for the U.S., West Germany and the U.K. separately. Series of transitory variance is always on the top of series of permanent variance, which suggests that transitory variance accounts for at least half of the overall inequality, about 56 to 78 percent in the U.S., 67 to 85 percent in West Germany and 51 to 68 percent in the U.K.. For the same period of 1990-2000, transitory variance accounts for 70 percent of total variation in the U.S., 73 percent in the West Germany and 58 percent in the U.K.. This is different from findings in Moffitt and Gottschalk (2008) using U.S. male wage earnings data, where they find only 30 to 65 percent of the total variance is attributable to transitory variance. Another finding is that trends in transitory variance are mostly

coincide with trends in overall inequality, when comparing with Figure 1. This is a pattern that other studies find consistently for the U.S.. Moffitt and Gottschalk (2008) plot transitory variance against unemployment rate, they find that transitory variance changes are largely cyclical, thus it is more difficult to sort out the trend in the transitory variance, especially when there is a cycle at the end of the period. Same interpretation can be applied here, that trends in transitory variance are largely cyclical.

## **4.2 Compare Household Earnings and Individual Earnings Volatility for Married Families**

As household income is the sum of all household members' individual income and it could involve joint decision made by multiple agents, in this section I look at whether income dynamic at household level differs from that at individual level. I focus on transitory variance only, and compare earnings instead of income, as some of household income such as some household property income or public transfers is not assignable to any specific member. I further restrict the sample to married families to abstract from the effect of marriage or divorce decision on income volatility.

Figure 6 compares husbands' earnings volatility, wives' earnings volatility with their combined earnings volatility in the U.S.. Figure 7 presents results in the West Germany and Figure 8 presents results in the U.K.. Female earnings volatility are much higher than either male or household earnings volatility, which is fully-expected given female wage is usually more volatile than male, and married women as secondary workers are more likely to change participation status (full-time, part-time) or labor supply.<sup>7</sup> In all three countries married women's earning volatility has increased over

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<sup>7</sup>Note that since the estimation is based on log earnings, the sample excludes those who have zero earnings.

time and their increase is much more than married men's income volatility. But again, this could be complicated by labor force participation.

Household earnings volatility in the U.S. are always lower than either male or female earnings volatility, while this is not true for the other two countries. In West Germany and the U.K., household earnings volatility is higher than male earnings volatility, although still much lower than female earnings volatility or the average of the volatility for male and female. This suggests an individual might try to adjust his or her earnings to buffer changes in a partner's earnings so that labor income is more stable at household level, especially in the U.S. This household insurance interpretation could be reinforced by another interesting finding: trends of husbands and wives earnings volatility are moving in the opposite direction, while in West Germany or the U.K. this is not the case. The increase of married men's income volatility always comes with decrease in married women's income volatility. Although there are several possible explanations, household insurance certainly a plausible explanation to these facts.

## 5 Conclusion

In this paper I examine recent trends of household income dynamics in the U.S., West Germany and the U.K. using the latest CNEF data from 1979 to 2004. I estimate a formal error components model as in Moffitt and Gottschalk (2008) to study how permanent variance and transitory variance changes over time. Permanent inequality converges among three countries in the late 1990's, while transitory variance displays a more cyclical pattern. Household income volatility accounts for more than half of the overall inequality. Comparison of income volatility at household level against individual level for married families also suggest evidence of household smoothing,

especially in the United States. These findings deserves further investigation with formal economic models on household behavior.

# Appendix

## A Notation, Initial conditions and Normalizations for Equation (1)

I normalize the initial loading factors into 1, and some additional initial conditions and notation for equation (1) are defined as follows:

$$(1)\alpha_1 = 1$$

$$(2)\beta_1 = 1$$

$$(3)Var(\mu_{i1}) = \sigma_{\mu 1}^2$$

$$(4)Var(\omega_{iat}) = \sigma_{\omega}^2$$

$$(5)\text{Define } a_1 \text{ as household head's age in initial year, let age 20 equals to } a = 1 \quad (2)$$

if  $a_1 \leq 1$  (non-left-censored), then assume:

$$v_{i1t} = \rho v_{i,0,t-1} + \xi_{it}, \quad Var(v_{i1t}) = \sigma_{v1}^2 + \sigma_{\xi t}^2$$

if  $a_1 > 1$  (left-censored), then assume:

$$Var(v_{i,a_1,1}) = \sum_{p=1}^P \gamma_0 + \sigma_{\xi 1}^2$$

The parameters need to be estimated are:  $\alpha_t, \beta_t, \sigma_{\xi 1}^2, \rho, \theta, \sigma_{\mu 1}^2, \sigma_{\omega}^2, \sigma_{v1}^2$  and  $\gamma_0$ .

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Table 1: Descriptive Statistics

	Mean	Std Dev	Min	Max
	U.S.			
Log household income	9.795	0.785	-1.046	15.03
Age of head	40.0	10.38	20	59
Married	0.55	0.50	0	1
Number of children	0.91	1.14	0	9
Family size	2.71	1.48	1	14
	West Germany			
Log household income	9.647	0.638	0.628	2.81
Age of head	41.0	10.65	20	59
Married	0.54	0.50	0	1
Number of children	0.61	0.92	0	10
Family size	2.51	1.34	1	17
	U.K.			
Log household income	9.256	0.693	-0.804	2.39
Age of head	41.0	10.39	20	59
Married	0.68	0.47	0	1
Number of children	1.12	1.53	0	16
Family size	2.82	1.36	1	11

Note: Log household income is divided by equivalence of scale;  
Means taken before trimming and over all household-year observations

Table 2: Estimates of Error Components Model of Log Household Income

year	U.S.		West Germany		U.K.	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
1979	1.000	1.000	-	-	-	-
1980	1.066	1.038	-	-	-	-
1981	1.144	1.200	-	-	-	-
1982	1.248	1.296	-	-	-	-
1983	1.310	1.273	1.000	1.000	-	-
1984	1.415	1.249	1.027	0.893	-	-
1985	1.501	1.237	1.005	0.738	-	-
1986	1.482	1.235	1.095	0.640	-	-
1987	1.550	1.208	1.210	0.612	-	-
1988	1.594	1.216	1.198	0.483	-	-
1989	1.629	1.364	1.223	0.631	-	-
1990	1.645	1.190	1.369	0.570	1.000	1.000
1991	1.713	1.352	1.505	0.522	1.190	0.958
1992	1.622	1.777	1.534	0.757	1.145	1.085
1993	1.577	2.410	1.535	0.732	1.244	0.921
1994	1.556	2.132	1.660	0.770	1.249	0.951
1995	1.509	1.820	1.513	0.721	1.194	0.892
1996	1.328	1.982	1.463	0.734	1.164	0.914
1997	-	-	1.668	0.816	1.145	1.013
1998	1.443	1.918	1.539	0.807	1.065	1.111
1999	-	-	1.404	1.023	1.007	1.164
2000	1.426	1.715	1.398	0.767	1.020	1.360
2001	-	-	1.634	0.816	-	-
2002	1.410	2.492	1.638	0.812	-	-
2003	-	-	1.781	0.806	-	-
2004	-	-	1.539	0.767	-	-
$\sigma_{\xi 1}^2$	0.102		0.152		0.116	
$\sigma_{\mu 1}^2$	0.041		0.021		0.094	
$\rho$	0.769		0.757		0.697	
$\theta$	-0.438		-0.375		-0.349	
$\sigma_{\omega}^2 * 100$	0.014		0.023		-0.070	
$\gamma_0$	0.038		-0.055		0.034	

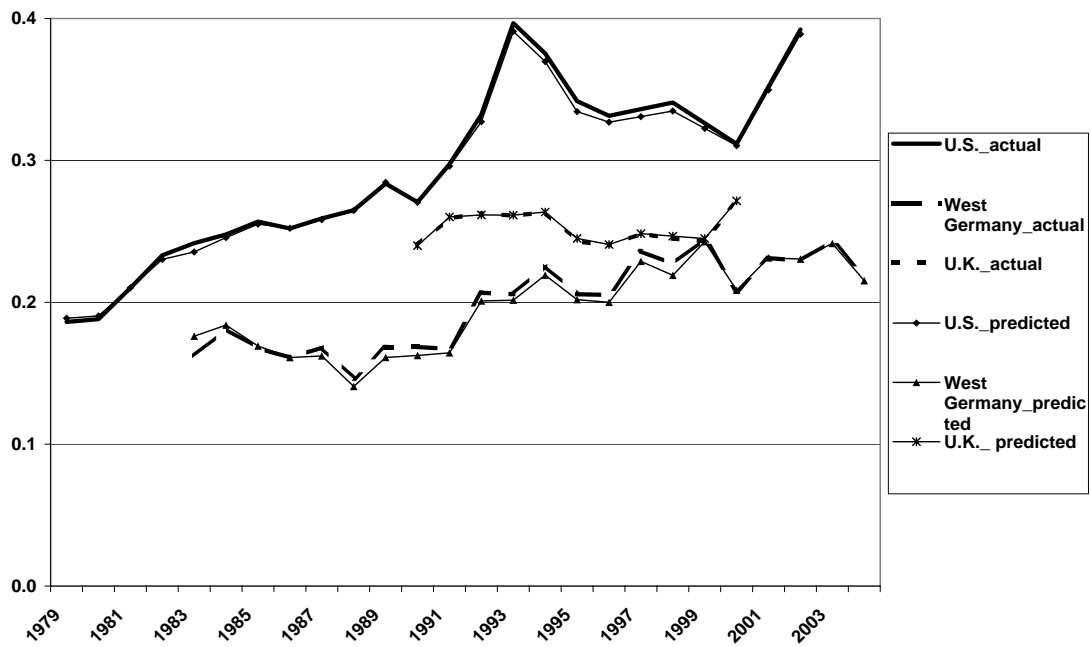


Figure 1: Actual and predicted cross-sectional variance in log household income in the U.S., West Germany and the U.K.

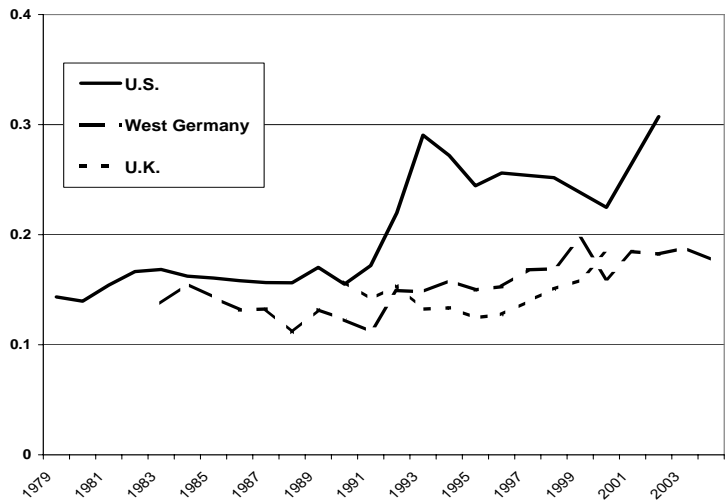
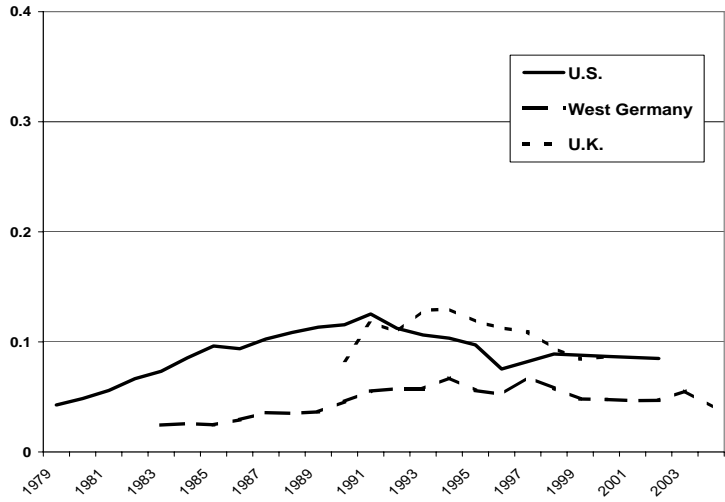


Figure 2: Trends in the permanent variance (top) and transitory variance (bottom) of log household income in the U.S., West Germany and the U.K.

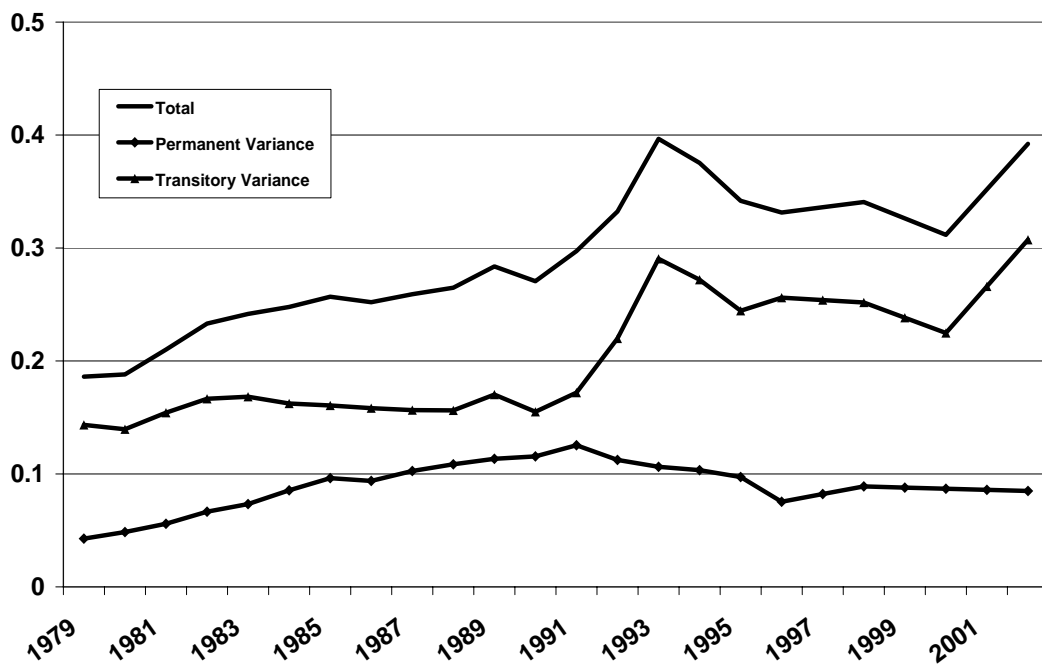


Figure 3: Total variance, permanent variance and transitory variance of log household income in the U.S., 1979-2002

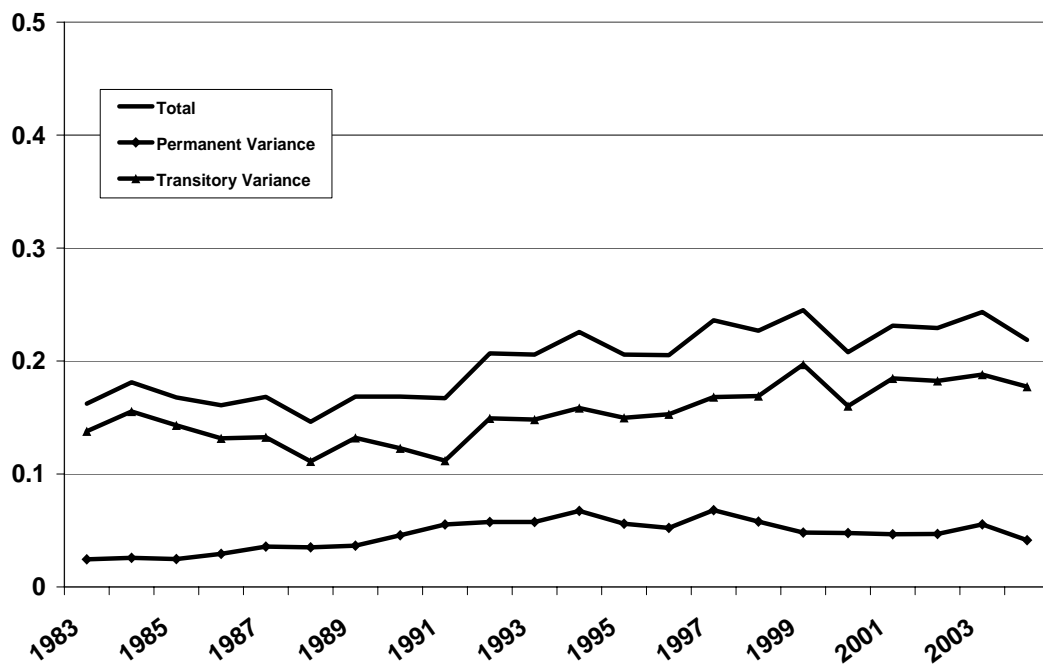


Figure 4: Total variance, permanent variance and transitory variance of log household income in the West Germany, 1983-2004

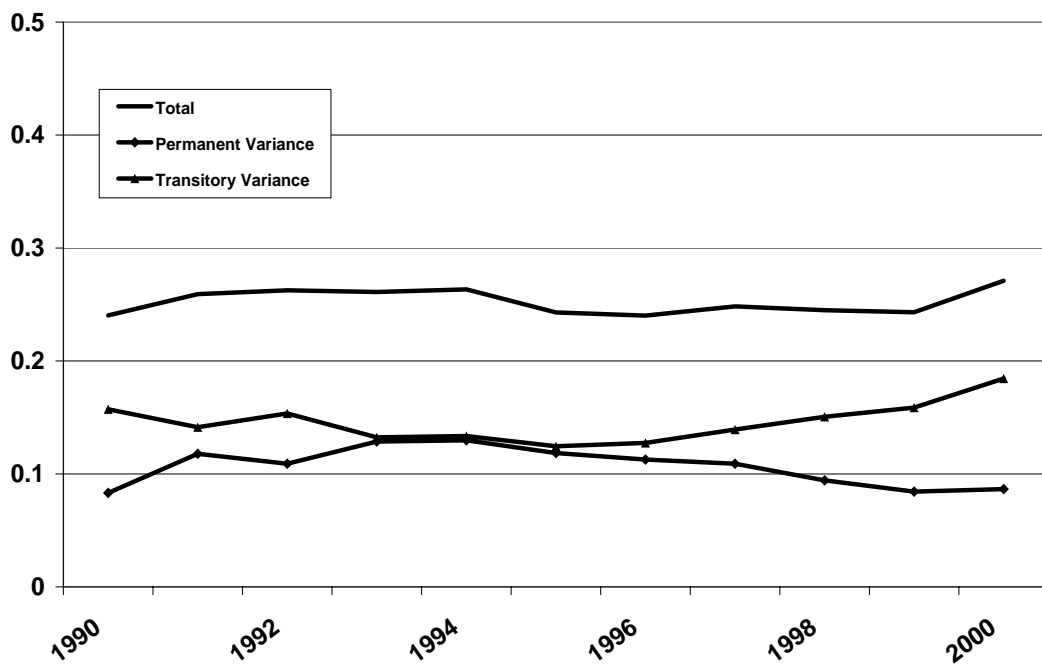


Figure 5: Total variance, permanent variance and transitory variance of log household income in the U.K., 1990-2000

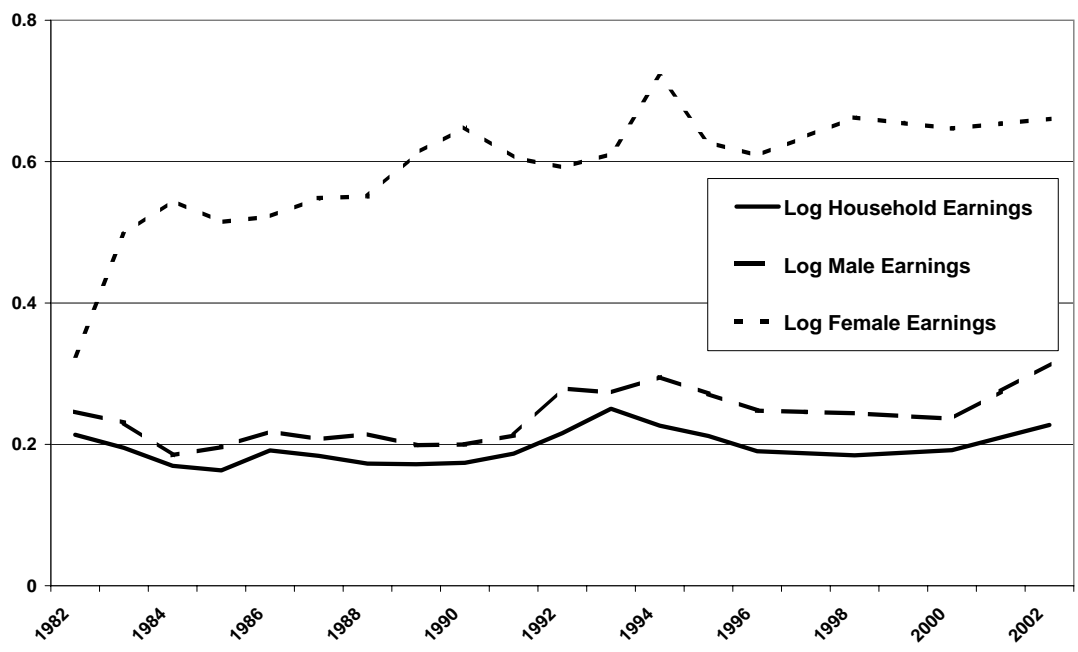


Figure 6: Earnings volatility for married men, married women and household earnings volatility in the U.S.

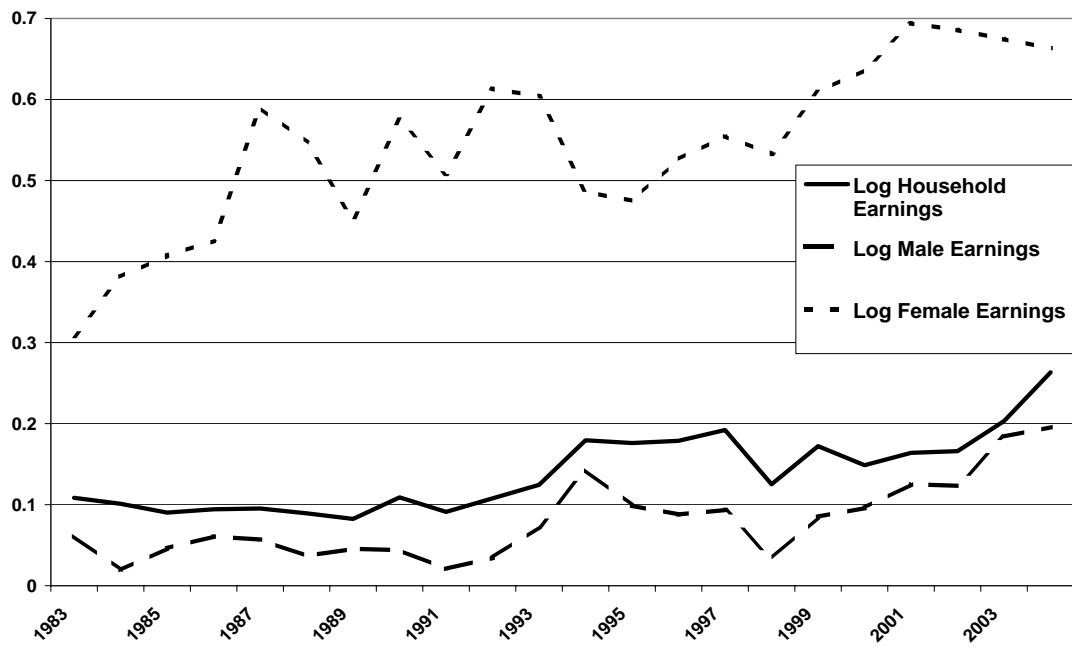


Figure 7: Earnings volatility for married men, married women and household earnings volatility in the West Germany

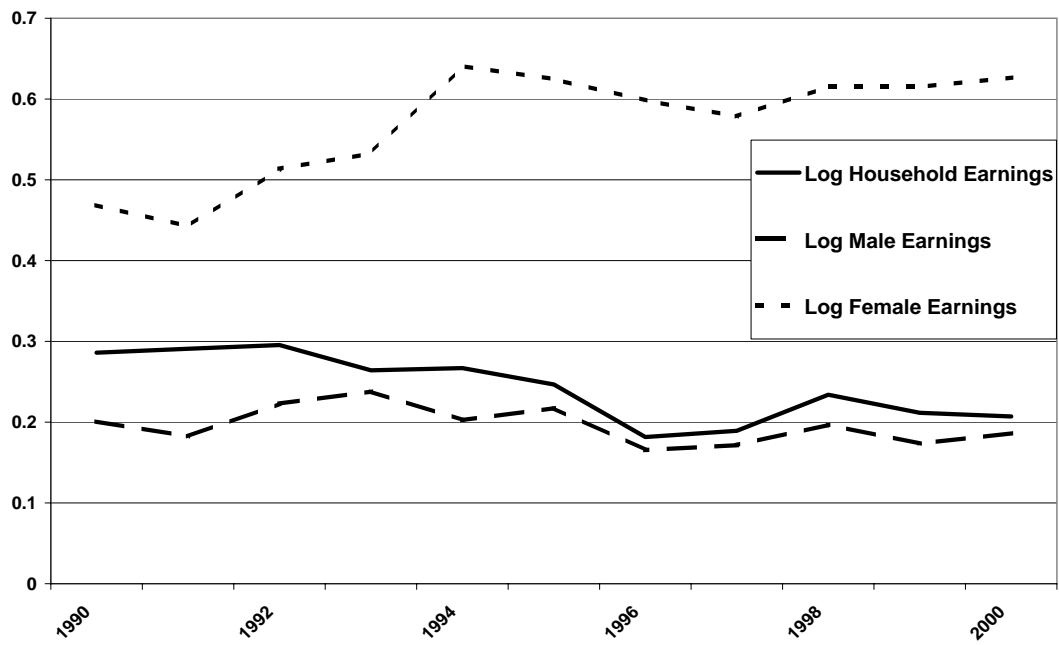


Figure 8: Earnings volatility for married men, married women and household earnings volatility in the U.K.

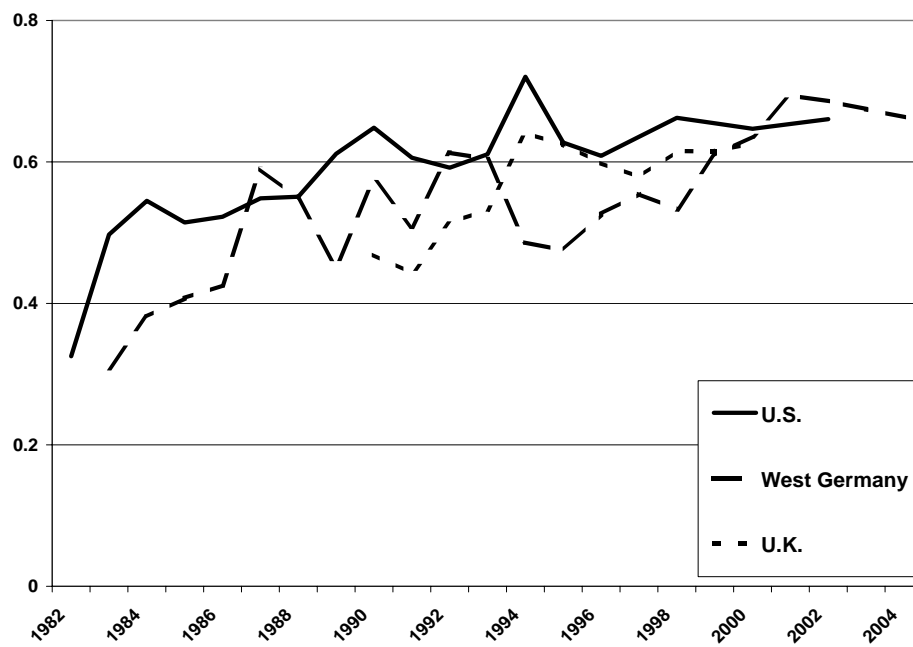


Figure 9: Transitory variances in married women's log earnings in the U.S., West Germany and the U.K.