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ABSTRACT

This study explores the variability of family income, viewed as a random residual around a permanent income growth path. Using early waves of the Panel Study of Income Dynamics, a survey covering over 4,500 families during the years 1967-1969, a measure of variability is defined and its distributional incidence and behavioral effects are investigated. Some methodological implications for distributional research are also noted.

It is found that the poor are subject to more variability than families with higher incomes, and that this may be considered a welfare loss. Variability causes families to save more than they would otherwise, thus indefinitely postponing consumption opportunities. Evidence is also found that variability and other aspects of income experience shape persons' attitudes toward the economic environment.

ASPECTS OF THE VARIABILITY OF FAMILY INCOME

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Even a cursory examination of the income experience of families shows that there are considerable period-to-period changes in family income. Some of this can be attributed to macroeconomic fluctuations or changes in families' real income-earning capacities, but much of it appears to be due to chance occurrences at the micro level. For some investigative purposes, this apparent random variability can be ignored, but for many it should not.

The purpose of this paper is to bring together some evidence and arguments relating to the phenomenon of income variability. The study examines the distributional incidence, explores some behavioral effects, and notes some methodological implications of this variability.

Year-to-year changes in the income status of individuals were analyzed by Friedman and Kuznets (1945), and were important in Friedman's (1957) study of the consumption function. The flourishing literature on the permanent income theory of consumption has led to ingenious techniques for abstracting from, or ignoring, transitory income.

Students of the distribution of income have sometimes noted the variability of family incomes over time. Using a panel of Wisconsin taxpayers, David (1971) examined the relative income status of individuals, and measured the variation of income among individuals in occupation-age groups as well as the variability of individuals' incomes over time. Recently, other researchers have looked directly at this phenomenon. Benus and Morgan (1972) have used four years' reports from a panel study, and analyzed income "instability" as defined by several measures. They examine correlations between levels, trends, and instability of family income for the

entire population and for a number of subgroups. Kohen, Parnes, and Shea (1972) used panel data for two and three years to calculate "relative instability coefficients" for individual men in different age groups, and examined the instability characterizing various subgroups; in addition, they tried to isolate the sources of the instability.

A problem with these studies is that they lump together all changes of income in the measure of instability. For purposes of distributional analysis, it may be useful to consider separately three types of income change: (1) change due to macroeconomic fluctuations and inflation; (2) change due to real growth in family income-earning capacity; and (3) change due to a host of economic phenomena of a chance or ephemeral nature--illness, unusual overtime, job shifting, to name a few. The analysis of "income variability" in this study relates to the effects of the third group of factors.

I. A Measure of Income Variability

Abstracting from income change of the first type, consider a relatively short sequence of time periods characterized by steady state growth conditions on the aggregate level. Let the i -th family's income be determined as

$$y_i(t) = x_i \cdot (1 + g_i)^t \cdot e^{u_i} \quad (1)$$

where $y_i(t)$ is the income received in period t ,

x_i is a never-observed income base,

g_i is a real rate of growth,

and u_i is a random variable with mean zero.

The family's income is composed of two components: $x_i \cdot (1 + g_i)^t$, the family's permanent income, which is growing at rate g_i ; and e^{u_i} , a multiplicative transitory component which depends on the random term u_i .

A comparison of the variability of different families' income reduces to a comparison of the probability distributions of the random determinants, u_i .

If each u_i were assumed to have a normal distribution, then knowing the standard deviation of each u_i would completely characterize the distribution. This standard deviation is adopted as the measure of each family's income variability in this study.¹ If the standard deviations, σ_u , for two families are equal, they are said to be subject to the same "variability." Of course, being subject to the same variability does not necessarily mean being equally well off; this is a matter to be considered below.

In the unchanging macroeconomic environment of a steady state, chance variations in income are reasonably viewed as multiplicative rather than additive, especially for purposes of comparison among families. For example, one week of unemployment decreases all affected workers' actual incomes in proportion to their permanent incomes.

This simple model will be used to examine the effects of income variability in a panel sample of the U.S. population for the years 1967-1969, which were years of full employment and fairly steady growth. After deflating income and related items by the Consumer Price Index, and by restricting the analysis to these years, the working presumption is made that the data reflect family income experiences in a steady growth economy. Taking natural logarithms of equation (1),

$$\log y_i(t) = \log x_i + t \cdot \log(1 + g_i) + u_i \quad (2)$$

$$\text{or } \log y_i = \alpha_i + \beta_i \cdot t + u_i \quad (2')$$

Fitting this trend line to the data separately for each family provides estimates of the three dimensions of income: $\hat{\alpha}_i$ is permanent income level (say, when $t = 0$), $\hat{\beta}_i$ is a measure of the income trend ($\beta_i \approx g_i$ for small g_i), and $\hat{\sigma}_{u_i}$ is the measure of income variability.²

The micro data to be used here are taken from the Panel Study of Income Dynamics (Morgan et al., 1970), a data set collected by the Survey Research Center (SRC) of the University of Michigan under contract with the U.S. Office of Economic Opportunity. For the first three surveys (relating to the years 1967-1969), income and related data were collected for a continuing sample of 4,645 families. In sampling, families with low incomes have been over-represented, leaving data for high income families relatively thin. The unit described as the family consists of one or more persons, and corresponds roughly to the Bureau of the Census designation "family or unrelated individual." To focus on units with relatively continuous income-earning capacity, those families in which the head or the head's spouse changed over the course of the sample period are excluded. The primary income concept used here is pre-tax total money income, which includes all family members' labor earnings, transfer payments, and income from capital. Capital gains and losses are not included.

Equation (2') is, in effect, fit separately to three income observations (1967-1969) for each family. This introduces considerable error into the estimator, but nonetheless provides useful measures.³ The estimates of permanent income level (for 1968), trend, and variability are then added to the data set containing three years' observations on approximately 3,700 stable families.

II. The Incidence of Income Variability

The measure of variability developed above is useful for comparing the relative uncertainty attached to the income anticipations of different families. Families whose random determinants, u_i , have the same probability distribution face equal prospects of having their observed incomes be determined as any

particular proportion of their permanent incomes. Families whose random determinants have a higher variability face greater chances of having their actual incomes be much greater or much less than their permanent incomes.

Income variability may reasonably be regarded as a burden to families--the greater the variability, the greater the burden. On theoretical grounds, the common behavioral assumption that people are risk averse suggests that most families would prefer to have their incomes come in a steady flow, rather than with some random variation around the same flow. On practical grounds, having a variable source of income makes it more difficult to plan long-term family finances and to contract debt obligations; this is especially so for families with low permanent incomes.

How is the burden of variability distributed among income receivers? One approach to this question is to relate income variability to permanent income level. For this analysis, families were grouped into income classes, and the mean variability measure for each class was computed. This procedure was repeated for three definitions of income: (1) total family income, (2) the sum of the head's and the spouse's labor income, and (3) the head's labor income. Table 1 shows these results.

On average, the measure of variability of total family income decreases as the level of permanent income increases up to \$15,000 or so, while above this level, the measure of variability increases with income for more broadly-defined income classes. The overall relation of variability to permanent income level appears to be U-shaped. In assessing these results, it should not be forgotten that there is wide variation among families in each income class.

When the sum of the head's and the spouse's labor income is examined, the measure of variability first decreases then remains level (or wobbles

TABLE 1
Income Level Incidence of Variability

Permanent Income Class	Variability		
	Total Family Income	Head and Spouse Labor Income	Head's Labor Income
\$ 0- 1,000	.186	.407	.378
1- 2,000	.167	.221	.214
2- 3,000	.139	.172	.173
3- 4,000	.130	.127	.121
4- 5,000	.117	.101	.091
5- 6,000	.108	.089	.081
6- 7,000	.093	.086	.078
7- 8,000	.077	.069	.062
8- 9,000	.083	.069	.059
9-10,000	.074	.063	.055
10-11,000	.064	.063	.051
11-12,000	.074	.056	.060
12-13,000	.066	.054	.049
13-14,000	.061	.059	.058
14-15,000	.072	.068	.070
15-20,000	.064	.059	.074
20-25,000	.084	.073	.069
Above 25,000	.095	.056	.059

a bit) as permanent income increases. When just the head's labor income is examined, the pattern of variability is similar to that of the head-plus-spouse's, but the variability is nearly always smaller in magnitude (especially for families with incomes below \$10,000). This finding suggests that the spouse's job-holding behavior is not predominantly an offset to current diminutions in the head's income. Rather, it seems to be that the spouse's job-holding is independent of the head's, or possibly that it serves as an offset but with some lag.

When either labor-income variability pattern is compared to that for total family income, the patterns are found to cross. For low income levels, total family income is less variable than total labor income; for these families, transfer payments (including unemployment insurance) help to damp the variability of income, but total income is still more variable than that for families with higher incomes. For high income families (above \$20,000), total income is more variable than labor income; in this range, property income, which is highly variable, accounts for this difference.

The welfare implications of the relation between variability and the level of permanent income are interesting to consider. Analysts of the inequality of the distribution of income have always viewed this measure as an imperfect indicator of the distribution of welfare. But, if income variability leads to a welfare loss, and if this burden is distributed as indicated in Table 1, then the distribution of welfare is even more inequitable than one would have determined simply from looking at this distribution of (permanent) income levels.⁴

III. Behavioral Effects of Income Variability

(A) Saving Effect

The hypothesis that increased income uncertainty leads to increased savings by families is widely held.⁵ Such precautionary behavior for "rainy

days" constitutes a second motivation for savings, after life-cycle reasons. In the context of this study, "increased uncertainty" may be taken as equivalent to "increased variability." Unfortunately, a direct test of the savings response to uncertainty is not possible with the available data.

However, it is possible to test the hypothesis indirectly, using the SRC survey. Consider a family allocating its budget among alternative uses. Under the maintained hypothesis, if the family perceived its income future as becoming subject to more variability (uncertainty), it would seek to increase savings out of its fixed budget. In response, all consumption items in the budget would have to decrease or remain the same. Therefore, evidence that consumption expenditures are negatively correlated with income variability among families with identical incomes will support the maintained hypothesis.

This indirect test is carried out with cross-section data on family food expenditures. This item was chosen partially because of its availability, but also because food is the largest budget item which contains no savings component--in contrast to expenditures on houses and consumer durables, for example; the indirect approach necessitates a pure consumption item. Food may well be less responsive to increased savings desire than other consumption items, but this serves only to make the indirect test properly conservative. In using cross-section historical data, the assumption is made that families perceive the degree of income variability to which they will be subject as the same as that which they have recently experienced, and comparison is made among families of differing income variability holding constant the level of income (and sometimes, the trend).

Following Houthakker and Taylor (1970), a modified double-logarithmic Engel curve regression model is postulated. The dependent variable is the

geometric mean of three-years' food expenditure-to-need ratios. The need variable has been developed by the SRC to take into account the age and sex of family members, as well as economies of scale in family living, and the expenditure-to-need ratio form of the dependent variable is suggested by the discussion of Prais and Houthakker (1971). The independent variables are permanent income (taken as its 1968 value) and measured income variability. Fit to 3665 observations on families with permanent incomes less than \$25,000, the results are

$$\log \left(\frac{\text{FOOD EXPENDITURE}}{\text{FOOD NEED}} \right) = 3.273 + .180 \cdot \log (\text{PERMANENT INCOME}) - .144 \cdot \text{VARIABILITY}$$

(.077) (.009)
(3)

(.057)

$$R^2 = .12$$

The null hypothesis that the coefficient on income variability is zero or any positive value can be rejected in favor of the alternative that it is negative using a conventional t-test with a .01 level of significance. Following the logic of this indirect test, the evidence supports the maintained hypothesis that families save as a result of income uncertainty.

Alternative specifications of the food expenditure function included linear and semi-log forms in the above variables, as well as specifications using food expenditures as the dependent variable and family demographic characteristics as independent variables. Also, the income TREND was examined as an additional dimension of the families' income anticipations. Regularly, VARIABILITY had a negative coefficient which was significant (or nearly so) much of the time, and TREND had a negative coefficient.

(B) Attitudes

Measured economic responses, such as savings, are presumed to be affected by variability because of the psychology underlying the utility function. If

income uncertainty does affect economic behavior, then we should be able to detect its effects on other manifestations of the psychic state, especially persons' attitudes toward economic affairs. While behavioralists have given considerable attention to the effects of attitudes on economic behavior, little attention has been given to the feedback effects of the economic environment on the formation of attitudes.

The Survey Research Center investigators (Morgan et al., 1970) developed three indexes of attitudes for the survey: (1) Sense of Personal Efficacy (and Planning Horizon), which "is intended to identify the respondent's satisfaction with himself and confidence about his future;" (2) Trust (or Hostility), which "is operationalized by the respondent's self-assessment of trust in others, tendency to get angry easily, and sensitivity to what others think"; and (3) Aspiration (Ambition), which "includes both personality measures and future employment plans." These indexes are based on answers to a number of "feelings questions" and are coded on 0 to 7, 0 to 5, and 0 to 9 scales, respectively. High scores indicate that the respondent (usually, the family head) has positive feelings of personal efficacy, trusts other people and the economic environment, and has strong ambitions to improve his economic situation.

As an exploratory analysis of one part of what must be a very complex behavioral system, respondents' attitudes as expressed in 1970 are related in linear regressions to three important dimensions of their families' previous income experience: level (permanent income in 1968), trend, and variability. The results are reported in Table 2, for families with permanent incomes less than \$25,000.

High levels of permanent income lead to increased feelings of efficacy and trust, but decreased ambition; this is the effect of "making it." A higher trend (rate of growth of income) has the same effects as a high

TABLE 2
Attitudinal Regressions

	Dependent Variable		
	EFFICACY	TRUST	AMBITION
Constant	2.670* (.059)	1.901* (.044)	2.807* (.057)
PERMANENT INCOME	.104* (.006)	.058* (.004)	-.024* (.006)
TREND	.247* (.109)	.136 (.081)	-.138 (.107)
VARIABILITY	-.135 (.233)	-.517* (.173)	.978* (.228)
R ²	.09	.06	.01

Notes: Parentheses contain standard errors. An asterisk (*) indicates an estimated coefficient which is significantly different from zero, using a 0.05 significance test. The variable means are: EFFICACY = 3.4; TRUST = 2.3; AMBITION = 2.7; PERMANENT INCOME = 72.9 (\$ thousand); TREND = .063; VARIABILITY = .10.

permanent income level--increased feelings of efficacy and trust, and decreased ambition. On the other hand, the higher the degree of income variability (uncertainty), the lower the sense of efficacy and trust; but, ambition is spurred. Experiencing variability makes people feel alienated, but also makes them try harder.

Most of the reported effects for level and variability are "statistically significant" as indicated in Table 2, but the regression results hardly stand as a model of attitude formation. The causal direction, of course, is particularly difficult to prove. Yet, it seems quite reasonable that persons' income experiences do shape the way they approach income-earning activities, and the evidence supports this. In particular, variability seems to be a psychological burden as well as an economic one.

IV. Implications of Income Variability for Distributional Analysis

If a random component model such as (1) describes the essence of the short run determination of family income in a steady state, then investigators of changes in the distribution of income must be aware of certain methodological implications. For example, an appreciation of the various causes of income change, including random variability, is necessary for the analysis of the dimensions of the poverty problem and for the evaluation of various solutions.

In comparing the poverty populations in 1965 and 1966, Terrence Kelly (1970) found that 35 percent of persons who were poor in 1965 were not poor in 1966. Reportedly, this finding was interpreted by policy makers to mean that the poor can work themselves out of poverty, and therefore that there is little need for special anti-poverty programs. However, this much gross flow past the poverty line can be predicted to be due simply to random fluctuations,

with no real change in families' income-earning capacities. This suggests that it remains a reasonable task for the nation to increase the permanent incomes of poor families, by special programs or otherwise.

To see how a prediction of gross flows across the poverty line can be made from the random component model, consider a comparison of incomes for families in "before" and "after" periods t_b and t_a , letting all $g_i = 0$ and assuming that each u_i is normally distributed and not auto-correlated. In addition, assume that permanent income (x_i) is lognormally distributed in the population and that each family is subject to the same variability ($\sigma_{u_i}^2 = \sigma_{u_j}^2$). In the two periods, each family's incomes are determined according to

$$\log y_i^b = \log x_i + u_i^b \quad (4)$$

$$\log y_i^a = \log x_i + u_i^a \quad (4')$$

with $\sigma_u^2 \equiv \sigma_{u^b}^2 = \sigma_{u^a}^2$ being equal for all i . In the population,

$$\text{Var}(\log y) \equiv \text{Var}(\log y^b) = \text{Var}(\log y^a) = \text{Var}(\log x) + \sigma_u^2. \quad (5)$$

In period b , $\log y^b$ has a normal distribution among families, and likewise for $\log y^a$. Therefore, $\log y^b$ and $\log y^a$ have a bivariate normal distribution with positive covariance, and

$$\rho(\log y^b, \log y^a) = \frac{\text{Var}(\log x)}{\text{Var}(\log y)}. \quad (6)$$

Two parameters need to be determined to make this prediction: the correlation coefficient (ρ) between log values of successive years' incomes, and the relative poverty line. Friedman (1957) cites studies indicating that ρ is likely to range between .8 and .9; here, .85 is taken as a reasonable value for this parameter. In 1965, 13.9 percent of all families and 17.3

percent of all persons were poor; for convenience, the poverty line is taken to be that income which defines 15.9 percent of all families as poor.

From tabulations of the bivariate normal distribution (Pearson, 1931) the probability of escaping poverty in period t_a after having been in poverty in period t_b is found to be .335--nearly the same as actually occurred in 1966, according to Kelly. The point to be made is not that the simple model used here fully accounts for the observed facts, but that much of the movement into and out of poverty is due to transitory forces rather than permanent changes in families' income earning capacities.⁶

As a second example, a simple approach in the investigation of the effect of a change in macroeconomic conditions on the distribution of income would be to compare income reports for families in "before" and "after" periods and attribute the pattern of income change to the change in conditions. The problem with this is that the random component model suggests that "before-after" comparisons are biased in a particular way.

To see this, suppose first that the "before" and "after" periods, t_b and t_a , are characterized by the same aggregate conditions, and that $g_i = 0$ and σ_{u_i} is the same for all families. Then, relating family incomes in period t_a to those in period t_b yields the pattern indicated in Figure 1 by the solid line, illustrated as being linear only for simplicity. This line depicts the population regression function of $y(t_a)$ on $y(t_b)$ --i.e., $E[y(t_a) | y(t_b)]$ --rather than the paired income observations for every family. For families with observed incomes below \bar{y}_b in period t_b , observed incomes in period t_a are higher than their previous incomes, on average, and vice versa for families with observed incomes above $\bar{y}(t_b)$. This is the familiar regression-to-the-mean phenomena, noted by Friedman (1957).

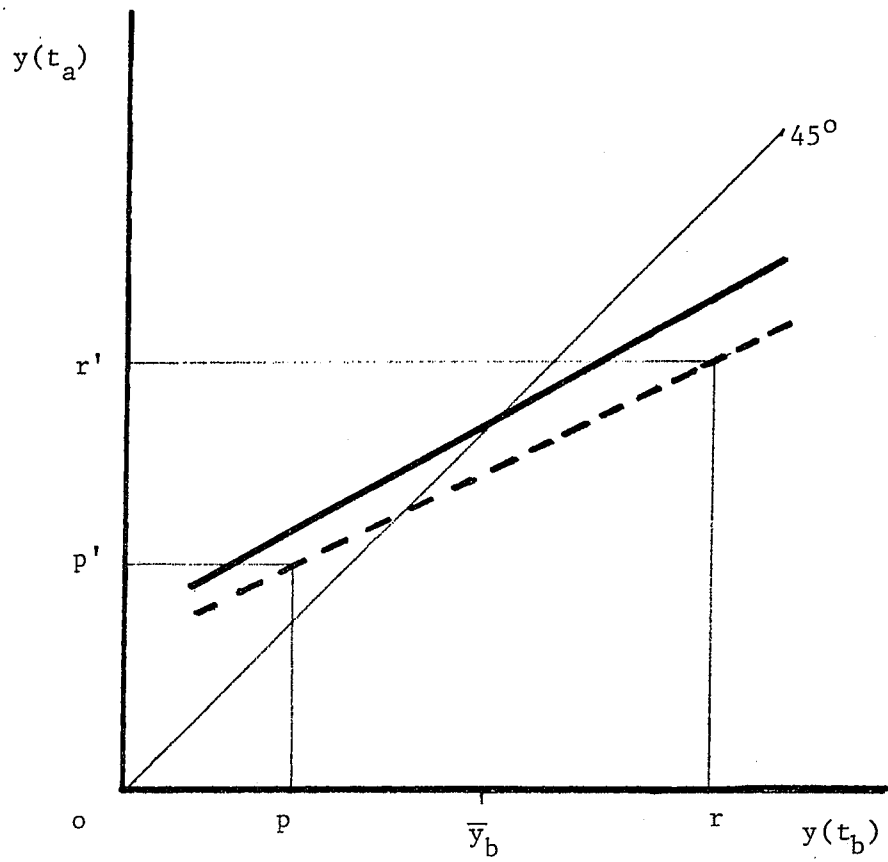


Figure 1.

Comparing Incomes in Two Periods

Now, if period t_b were the full employment state before a recession, and t_a the period of the recession, the relation between the two years' observed incomes might be that indicated by the broken line in Figure 1. This line is drawn to represent the effects of a recession which affects all family incomes equally, in a proportional sense: each family's income is equal to some proportion (the same proportion for all families) of the income it would have received in t_a if there had been no recession. All families are equally affected, yet a simple comparison of "after" to "before" situations would suggest this were not the case: a poor family with "before" income op had its income increased to op' , while a rich family with "before" income or had its income decreased to or' .⁷

V. Conclusion

The variability of family income receipts over time, when viewed as a random residual around a permanent income growth path, has several implications for welfare analysis. The burden of variability falls more heavily on the poor than on those who are better off (except possibly those who are quite well off), decreasing their welfare. For families of all income levels, variability seems to cause an increase in savings, thus decreasing certain families' consumption opportunities on average. Also, this phenomenon raises some problems for the study of changes in the distribution of income.

The causes of this variability have largely been ignored here; at least from the macroeconomist's point of view, the phenomenon is largely random. However, if variability does lead to a net loss in social welfare, public policy might be implemented to alleviate or shift part of this loss. Unemployment insurance is one existing response to the problem. Further action to help reduce friction in labor markets and to improve job information may yield benefits which would justify its costs.

NOTES

¹For distributions other than the normal, σ_u does not fully describe what one would want to mean by variability; indeed, for some distributions the standard deviation does not exist. These problems are not too pressing, however, for the empirical sections of this paper.

² $\hat{\sigma}_u$ is the root mean square error around the fitted line. This would be the maximum likelihood estimator of σ_u under assumptions of normality.

³In this method, estimated permanent income for 1968 is equal to the geometric mean of the three years' incomes. If one knew the rate of growth of families' incomes, this information could be used to get more efficient estimates of σ_u . Such a procedure was followed by Holbrook and Stafford (1971) in a consumption study using extraneous information on the growth of class incomes. Of course, this is not "knowing" family income growth rates, and such an ad hoc procedure has unknown effects.

⁴In this comparison, "inequitable" means that low income families are relatively worse off. Given the U-shaped incidence of the variability of total income, the Lorenz curve of the utilities derived from permanent income anticipations would cross that derived from the level-plus-variability anticipations. The relative inequality in these two states is ambiguous, if one measures inequality by the Gini coefficient.

⁵While most formulations of this hypothesis have been inductive, Sandmo (1970) derives it from the theory of choice under uncertainty.

⁶A related observed phenomenon is predictable from the simple income variability model: when the inequality of the distribution of income is calculated on the basis of multi-year total income for families, it is found to be less unequally distributed than any one year's income.

⁷This problem has been taken into account by Mirer (1973) in a study of the distributional impact of the 1970 recession.

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