A COMPARISON OF PERMANENT AND MEASURED INCOME INEQUALITY

THESIS

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The degree of inequality present in the distribution of income may be measured with a gini coefficient. If the distribution is found to empirically fit a particular distribution function, then the gini coefficent may be derived from the mean value of income and the variation from the mean. For the purpose of this study, the Beta II distribution was used as the function which most closely approximates the actual distribution of income. The Beta II function provides the skewness which is normally found in an income distribution as well as fulfilling other required characteristics.

The degree of inequality was approximated for the distribution of income from all sources and from ten separate components of income sources in constant (1973) dollars. Next, permanent income from all sources and from the ten component sources was estimated based upon actual income using the double exponential smoothing forecasting technique. The estimations of permanent income, which can be thought of as expected income, were used to derive measures of permanent income inequality. The degree of actual income inequality and the degree of permanent income inequality, both being represented by the hypothetical gini coefficent, were compared

and tested for statistical differences. For the entire period under investigation, 1952 to 1979, the net effect was no statistically significant difference between permanent and actual income inequality, as was expected. However, significant differences were found in comparing year by year.

Relating permanent income inequality to the underlying, structural inequality present in a given distribution, conclusions were drawn regarding the role of mobility in its ability to alter the actual distribution of income. The impact of business fluctuations on the distribution of permanent income relative to the distribution of actual income was studied in an effort to reach general conclusions. In general, cyclical upswings tend to reduce permanent inequality relative to actual inequality. Thus, despite the empirically supported relationship between income inequality and economic growth, it would appear that unexpected growth tends to favor a more equal distribution of income.

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Chapter I

Milton Friedman's permanent income hypothesis asserts that permanent consumption is a proportional function of permanent income. "The basic idea is that the consumer disregards fortuitous variations in income when drawing up consumption plans; only expected, 'normal', or permanent income is considered." (4, p. 13) Friedman defines permanent income for practical purposes as expected income. The difference between actual income (Y) and expected income (PY) is termed transitory income (TY). Similarly, permanent consumption is planned or expected consumption and the difference between actual consumption (C) and planned consumption (PC) is transitory consumption (TC). Friedman uses the term consumption to denote the actual use of goods and services, rather than expenditures. Therefore, expenditures for consumption goods and services must be converted from a stock to a flow before they are applicable to the permanent income hypothesis. This conversion was performed for expenditures on consumer durables. Thus, the permanent income hypothesis may be simply stated by the following equations: (2, p. 26)

$$Y = PY + TY$$

$$C = PC + TC$$

$$PC = kPY$$

The average propensity to consume (k) is hypothesized to be independent of the size of permanent income, thus resulting in a proportional consumption function. Under the permanent income hypothesis, the ratio k depends on:

> ...(1) the rate of interest or sets of rates of interest at which the consumer unit can borrow or lend; (2) the relative importance of property and nonproperty income, symbolized by the ratio of nonhuman wealth to income; and (3) the factors symbolized by the portmanteau variable determining the consumer unit's tastes and preferences for consumption versus additions to wealth. (2, p. 26)

Thus, the average propensity to consume is assumed independent of the level of income, but dependent upon the above variables.

Note that a nonproportional consumption function of the form:

$$PC = a + cPY$$

where a = autonomous consumption (consumption which is independent of the level of income) and
c = the marginal propensity to consume

yields an average propensity to consume (APC) which varies inversely with the level of permanent income:

$$APC = \frac{PC}{PY} = \frac{a}{PY} + c$$

The permanent income hypothesis carries strong implications for the long-run trend in inequality. Keynes' absolute income hypothesis was based on a nonproportional consumption function, implying that the average propensity to consume varies inversely with the level of income. If this tendency is empirically supported, then a trend toward inequality would be expected over time as the savings to income ratio increases for those on the upper end of the distribution, assuming a growing economy. "If the proportional hypothesis is correct, then the distribution of permanent income does not affect the proportion of income consumed." (3, p. 336) If the average propensity to consume does not change as the level of income changes, then there is no inevitable link between economic growth and increasing inequality as implied by a nonproportional consumption function.

> The constant proportion between permanent consumption and permanent income leads Friedman to conclude that the high observed average consumption propensity of the poor reflects primarly the high proportion of poor (rich) people temporarily below (above) their permanent incomes. The implication of these results for the long period is that equalization of personal incomes will have no measurable effect on permanent consumption as a percentage of income. (1, p. 109)

It is an empirical fact that short-run or cross-sectional regressions of actual consumption against actual income yield a nonproportional consumption function; the intercept term is statistically significant. Friedman explains this phenomenon within the context of the permanent income hypothesis. Saving is considered to be a residual, that is, actual income minus actual consumption. Thus, Friedman does not attempt to describe motivations to save, aside from as a residual.

> Negative saving at low measured incomes reflect precisely the fact that measured income is not a valid index of wealth; that many people have low incomes in any one year because of transitory factors and can be expected to have higher incomes in other years. Their negative savings are financed by positive savings in years when their incomes are abnormally high, and it is these that produce the high ratios of saving to measured income at the upper end of the measured income scale. (2, p. 39)

This type of reasoning is very similar to the relative income hypothesis, which stresses that consumers behave in such a way as to 'defend' their consumption positions. This is a reasonable explanation of observed consumption and saving to income ratios, and certainly does not contradict the permanent income hypothesis. Friedman's reasoning seems to extend this explanation, not replace it. The major difference between the two theories is a matter of approach rather than result. Is the unit jealously guarding the consumption position in order to impress others, or is the permanent level of consumption automatically maintained out of 'habit'? The second proposition does not contradict the first, it is merely a more general statement.

Thus, cyclical fluctuation in the saving or consumption ratio is explained by the effects of cyclical fluctuation in transitory income. The ratio of actual consumption to actual income differs from the ratio of permanent consumption to permanent income due to changes in the transitory components. Consider the ratio of permanent consumption to permanent income (k) to be relatively constant over time; recall that this ratio is assumed to be determined by factors other than income and that these factors are slow to change. It is immediately obvious that if transitory factors are causing permanent income to differ from actual income and permanent consumption to differ from actual consumption, then the actual consumption ratio will be different from the permanent consumption ratio. Friedman extends the hypothesis by asserting that the expected coefficient of correlation between transitory consumption and transitory income is zero. This assertion dictates that the actual and permanent consumption ratios will be different whenever the average transitory component of either is not zero, making the permanent income hypothesis more substantial and subject to testing. Since transitory income is a component of actual income, any variation in transitory income can be expected to influence the distribution of actual income; however, variation in transitory income will only influence the distribution of permanent income to the extent that transitory income becomes incorporated into permanent income. In the formation of expectations, past values of transitory income are used to forecast future expected income; thus, these transitory changes in actual income alter permanent income somewhat. It is the purpose of this study to determine how the distribution of actual income compares to the distribution of permanent income; if the two are significantly different, then transitory factors alter the distribution of actual income and the presence of dynamic variation and mobility causes a redistribution of actual income.

The foundations and theoretical implications of the permanent income hypothesis will be further explored in Chapter II. Additionally, the method of estimating permanent income and permanent consumption from actual income and consumption will be described and some testing of Friedman's proportionality hypothesis undertaken.

Measured income distributions reflect the influence of differences among individuals in both permanent and transitory income. "Yet these two types of differences do not have the same significance; the one is an indication of deep-seated long-run inequality, the other, of dynamic variation and mobility." (2, p. 209) Measured income inequality is the result of both influences. One example of this distinction is the comparative degree of inequality of income in Britian and the United States. "Casual observation suggests that relative income status is decidedly less variable--the transitory component of income less important--in Britian than in the United States, so that distributions of annual income are a misleading basis for judging the degree of underlying inequality." (2, p. 209)

The issue of primary concern is whether transitory income-earning opportunities tend to alter the distribution of measured income and, if so, in what way. In order to address this issue, some measure of permanent income inequality must be estimated and compared to actual income inequality. According to Friedman's permanent income hypothesis, the effect of inequality depends critically on the source of the inequality.

> Insofar as the inequality is attributable to differences in permanent income status, it has no effect on the saving ratio. Insofar as it is attributable to differences in transitory components, it does. (2, p. 235)

The permanent income hypothesis makes information obtained from studies of the distribution of income relevant to the study of the aggregate consumption function; clearly, the relation is reciprical. (2, p. 209) "If accepted, the hypothesis makes information from studies of consumption behavior relevant to the analysis of the distribution of income." (2, p. 209)

The measure of inequality used in this study is the gini coefficient for a univariate Beta II distribution, similar to the type IV from the Pearson family. The Beta II distribution is used because it follows the Pareto Law (it is skewed right) and has been shown to fit empirical data very well in previous studies. The method of computing the gini coefficient given the distribution parameters will be discussed in Chapter III. The coefficients are computed for the purpose of comparison and to determine long-run trends underlying each type of distribution. The period under analysis is 1952 to 1979; gini coefficients will be estimated for each distribution in these years. Further, income is divided into ten sources and the gini coefficient for each income source computed in order to study the effects of the distribution of income from human wealth versus property wealth.

The gini coefficient measures the degree of inequality present in a distribution. Use of the Lorenz Curve facilitates visualization of this measure. This curve is known in English-speaking countries as the Lorenz curve, and in Latin countries as the Gini Curve. "It was applied to distribution problems at approximately the same time, and apparently independently, by two economic statisticians, the American Max Lorenz and the Italian Corrado Gini." (1, p. 45) A hypothetical Lorenz Curve is presented in Figure 1. The area between the 45 degree line and the Lorenz Curve is multiplied by two to get the gini coefficient, so the range of values is between zero (perfect equality) and one (perfect inequality). With perfect equality, where the 'poorest' quartile of households hold 25 per cent of income, the shaded area would be zero. At the other extreme, if only one household held 100 per cent of income, the shaded area would be equal to 0.5. The hypothetical distribution represented shows that the poorest quartile holds approximately 10 per cent of the income (point A on the curve), while the richest quartile holds approximately 40 per cent of the income (point B on the curve).

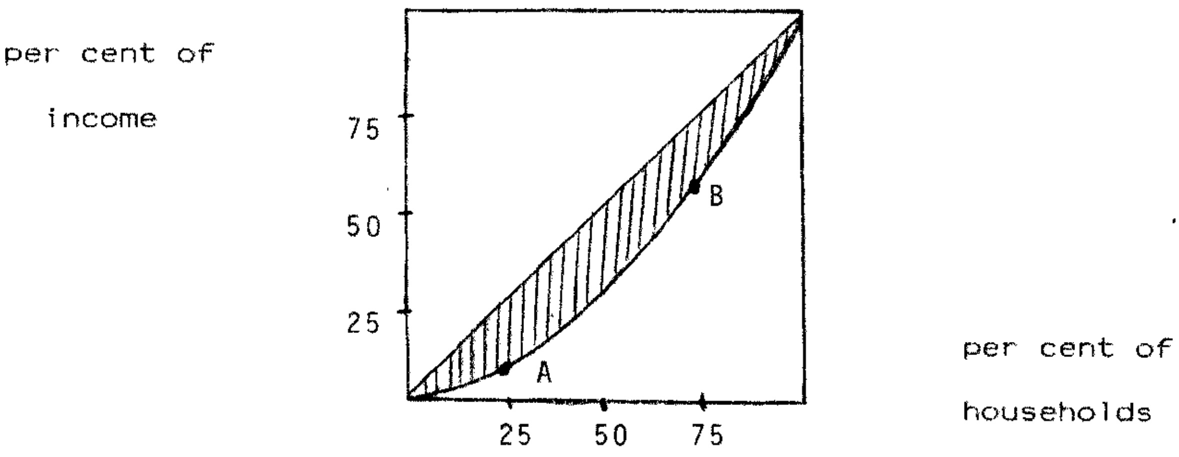

Figure 1--Hypothetical Lorenz Curve

The gini coefficients computed for this study are based on the assumption that a Beta II distribution function adequately describes the empirical distribution function. Additionally, it is assumed that both actual and permanent income can be described by the same distribution function. The second assumption is more important, since the objective is to compare inequality rather than to develop the most accurate measure of inequality. Testing of this assumption is beyond the scope of this study. However, it seems reasonble to assume that any underlying differences in the two distribution functions will not significantly alter the results. Therefore, comparison of measured income inequality and permanent income inequality is made assuming that the underlying distribution functions are the same.

In order to test the null hypothesis that the distribution of actual income is the same as the distribution of permanent income, with the alternate hypothesis that the two are different, the ratio of the permanent gini over the actual gini is computed for each year in the study. These ratios are also computed for each of the components of actual and permanent income. One observation was lost in estimating permanent income variance and three observations were lost in computing the gini coefficients for permanent income (total) and the wages and salaries component due to the size of the parameters in three of the periods and the inability of the program to find a gamma function for large numbers. This problem will be further discussed in Chapter III. Hypothesis testing was performed on the mean value of each ratio for the sample period; a Student's T test was performed with 24 degrees of freedom for income from all sources, 25 degrees of freedom for income from wages and salaries, and 26 degrees of freedom for income from all component sources other than wages and salaries. The reasons for the loss of degrees of freedom will be discussed in Chapter IV. The probablity of a Type I error taken to be acceptable was $\alpha = 0.05$. The tests were performed in order to determine whether this ratio is statistically equal to one (Fail to Reject the Null Hypothesis) for the sample or statistically different from one (Reject the Null Hypothesis) for the sample. The results of these tests will be given in Chapter III.

All estimation is performed using per capita income values in constant (1973) dollars rather than aggregate values. All relationships expressed can be transformed to per capita values with no loss of theoretical accuracy. The consumer price index, with the base year at 1967, was used to deflate income and consumption data to constant, 1973, dollars.

The final step in this study is the development of a model relating the derived gini coefficients to macroeconomic growth variables in order to explain the variation in actual and permanent income inequality. In addition, the coefficients are regressed against time to determine the trend in actual and permanent income inequality. The question of economic growth versus income inequality has long been a major theoretical and policy issue. Do the variables which are thought to bring about economic growth affect the distribution of actual income? Do they affect the distribution of permanent income? How do these variables influence the distributions? These questions are addressed in Chapter IV. The variables used include those which are thought to cause growth and those which are a measure of growth. They are:

1) the rate of inflation,
2) the relative change in real output,
3) the relative size of the public sector,
4) Capital deepening, defined as

$$(\ln K_t - \ln K_{t-1}) - (\ln P_t - \ln P_{t-1})$$

where K = net capital stock and P = population,

5) the net capital stock to output ratio,
6) the saving to output ratio, and
7) a representative rate of interest.

The stepwise and backward elimination procedures are used to identify significant variables in each model.

In addition to the above independent variables, the ratio of the average propensity to consume from permanent income to the average propensity to consume from measured income was tested as an independent variable in the model. According to the permanent income hypothesis, the difference between these two propensities to consume can be explained by transitory or unexpected factors. If there is a redistributive effect associated with transitory income, then a difference in the two propensities to consume should be associated with a difference between the respective gini coefficients. The variation from unity in the ratio of the permanent gini to the measured gini should be associated with the variation from unity in the ratio of the permanent propensity to consume to the measured propensity to consume, according to Friedman's hypothesis. The implications of this variable will be discussed further in Chapter IV.

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Chapter 2

The Adaptive Expectations Model

Milton Friedman estimated permanent income using an adaptive expectations approach to model the process of expectation formation on the part of the individual. "The hypothesis of adaptive expectations, introduced by Cagan (1956), postulates that individuals use information on past forecating errors to revise current expectations." (1, p. 23) Under this hypothesis, permanent or expected income in time period t is given by:

$$PY_t = \theta Y_t + (1 - \theta)PY_{t-1}$$

which may be written equivalently as:

$$PY_t = PY_{t-1} + \theta(Y_t - PY_{t-1})$$

Where θ is the coefficient of adjustment. Note that $Y_t - PY_{t-1}$ is the forecast error made in the period t-1. If no error was made (actual income was exactly expected), then the individual does not adjust the next forecast; expected income in period t is equal to actual income in period t-1. This would be the best forecast assuming that the individual had no reason to expect the level of income to be increasing over time. In an economy characterized by overall economic growth, per capita income is increasing over time. Thus, the average individual will expect income growth, even when previously forecasted values are correct. As Friedman notes, "one obvious defect of [the adaptive expectations] approach is that it does not allow for predicted secular growth." (3, p. 144)

> Being an average of earlier observations, the estimated permanent income is necessarily between the lowest and the highest, so that this method of estimation applied to a steadily growing series yields estimated values systematically below the observed values. (3, p. 144)

To correct this problem, Friedman assumes a constant growth rate (α) and adjusts expected income accordingly:

$$PY_t = Y_o e^{\alpha T} + \theta Y_t + (1 - \theta)PY_{t-1}$$

For the present study, the restrictive assumption of a constant rate of growth is avoided by employing the double exponential smoothing technique.

Double Exponential Smoothing

The Adaptive Expectations model employed by Milton Friedman to estimate permanent income is equivalent to single exponential smoothing, a technique of forecasting data which varies around a constant level. Double exponential smoothing was designed to forecast data which varies around a linear trend. By employing an exponential smoothing procedure, it is assumed that the consuming unit rationally forecasts expected income by adjusting for past forecast errors. Note that within the context of the permanent income hypothesis, the forecast error represents an estimation of transitory income. Thus, the individual is adjusting expectations in light of past values of transitory income.

Exponential smoothing forecasting techniques are appropriate for data which varies randomly around a constant trend, implying that transitory income cannot be systematically explained or predicted. The use of single exponential smoothing is appropriate when the data varies around a zero trend, or a constant level. Double exponential smoothing is appropriate when the data varies around a linear non-zero trend. This assumption represents a major weakness of the adaptive expectations approach. Transitory income includes both random and cyclical components; a seasonal component is not present due to the fact that annual data is used in the study. Exponential smoothing techniques do not adjust expected values to account for an expected cyclical component.

Recall that Friedman explains transitory additions to or subtractions from actual income using cyclical factors. Per capita transitory income should be greater than zero during a 'boom' period and less than zero during a recessionary period. However, the theoretical motivating force behind consumption behavior, under the permanent income hypothesis, is that of expectations. Therefore, it is the expectation of transitory income, rather than the post hoc value of transitory income, which motivates the consumer. Estimations of transitory income may not be highly correlated with the actual business cycle, but these estimations should be capable of explaining the cyclical behavior of the actual consumption ratio; this is the foundation of the permanent income hypothesis.

Single exponential smoothing and double exponential smoothing techniques forecast future values through use of an exponentially declining moving average weighting pattern. Single exponential smoothing "smooths" the series by adjusting the values to follow a constant average level. Double exponential smoothing adjusts the trend of the series as well. Thus, expectations for future values are formed by giving exponentially declining weight to past averages and past trends. The equations used in the iterative technique may be obtained from a Forecasting textbook. (2)

Table I includes actual per capita income from all sources as well as the values from ten separate sources. The sum of per capita income from the ten sources is equal to total per capita income from all sources.

Table I PER CAPITA INCOME IN 1973 DOLLARS

Year	Total Income	Wages & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	6393.8	5163.29	174.118	55.249	16.742
1953	6568.6	5393.79	167.829	58.159	19.940
1954	6681.4	5418.22	205.023	69.444	23.148
1955	7074.9	5718.99	224.046	73.022	18.256
1956	7372.8	5955.17	237.095	80.121	17.987
1957	7386.0	6018.69	241.570	86.839	20.525
1958	7305.2	5918.82	227.469	95.291	23.055
1959	7699.4	6257.06	236.317	111.298	22.869
1960	7733.9	6341.41	234.088	124.547	7.503
1961	7928.1	6447.03	239.164	136.665	8.913
1962	8147.6	6638.84	249.746	167.477	32.320
1963	8388.1	6795.81	259.813	209.012	60.962
1964	8758.2	7084.82	260.756	222.072	68.771
1965	9004.3	7235.29	270.425	235.213	74.649
1966	9215.7	7436.91	273.868	258.805	86.268
1967	9460.8	7646.62	268.862	276.848	93.170
1968	9696.4	7822.48	263.134	291.236	103.465
1969	9748.5	7973.85	252.139	313.961	110.311
1970	9909.9	8195.46	243.769	338.758	121.312
1971	10042.3	8312.98	230.429	364.297	137.160
1972	10358.0	8525.[illegible]2	229.446	374.974	150.839
1973	10381.0	8516.02	232.000	399.000	164.000
1974	9720.1	8104.10	213.987	405.720	171.190
1975	9680.3	7986.81	219.631	435.960	209.723
1976	986[illegible].8	8122.61	225.606	447.309	226.387
1977	1001[illegible].8	8205.97	252.267	462.000	274.267
1978	10099.6	8272.76	240.452	464.556	269.742
1979	10025.9	8118.83	247.343	487.340	270.608

Table I--Continued

Rents & Royalties	Business, Profess., & Farms	Partner-ships	Sale of Capital Assets	Estates & Trusts	Other
92.0816	483.846	261.178	73.665	50.2265	23.4392
89.7305	478.560	237.619	59.820	48.1886	14.9552
90.9377	492.719	248.012	97.552	19.8408	16.5341
87.9588	524.433	257.238	136.087	14.9364	19.9153
76.8512	588.650	245.270	125.905	16.3513	29.4323
85.2600	536.820	246.306	91.575	15.7890	42.6298
87.6064	537.935	239.764	112.198	15.3695	47.6457
82.3299	542.767	237.842	158.561	15.2464	35.0666
82.5309	517.696	220.583	130.549	15.0058	60.0225
84.6731	546.660	216.881	184.201	14.8547	49.0214
79.3312	561.195	218.895	135.157	16.1603	48.4803
74.0252	560.268	211.915	148.050	15.9660	52.2528
70.2035	561.627	213.476	176.225	17.1927	83.0977
63.3810	583.104	221.129	208.453	18.3099	94.3670
64.3593	590.186	209.510	198.554	19.1706	78.0524
58.5642	570.996	214.291	259.545	18.6343	53.2403
60.0353	554.373	232.478	318.061	19.1603	31.9335
53.3368	543.069	189.104	238.804	23.0319	50.9127
50.3563	513.862	211.724	144.201	22.8891	67.5228
51.5723	503.651	159.105	193.121	23.0427	66.9339
54.1748	527.937	180.583	233.695	25.4937	55.2369
60.0000	561.997	138.000	207.000	24.9999	78.0002
54.7806	427.976	112.985	138.664	30.8139	59.9165
52.8436	431.004	108.165	141.192	25.5959	69.3572
53.8647	441.844	107.729	170.961	26.5419	42.9356
44.0000	422.400	112.933	176.000	23.4664	45.4667
43.5945	433.221	114.436	191.408	23.1597	46.3193
20.8158	388.767	185.507	187.956	25.1015	93.6722

Table II includes the expected values of per capita income from all sources in 1973 dollars as well as income from the ten major sources. The expected value was calculated using the double exponential smoothing iterative technique.

Table II PER CAPITA PERMANENT INCOME IN 1973 DOLLARS

Year	Total Income	Wages & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	6447.0	5224.84	182.545	50.299	20.631
1953	6562.1	5296.94	181.042	64.231	15.684
1954	6725.2	5531.86	170.932	67.338	18.878
1955	6837.3	5555.47	212.144	77.719	23.521
1956	7232.7	5861.97	239.035	81.119	18.538
1957	7591.1	6141.86	253.718	87.193	17.253
1958	7625.7	6202.40	255.650	93.676	20.218
1959	7481.9	6035.85	234.374	102.260	23.779
1960	7815.2	6358.85	238.870	119.698	23.948
1961	7893.7	6479.62	236.092	135.282	5.787
1962	8072.0	6577.01	240.930	148.502	4.798
1963	8302.6	6772.82	253.635	181.932	33.165
1964	8564.9	6944.39	266.302	230.465	71.113
1965	8964.2	7259.68	267.264	247.680	83.448
1966	9255.6	7431.17	276.584	257.665	87.503
1967	9473.4	7629.39	280.059	279.006	97.373
1968	9708.6	7842.84	272.554	297.000	103.384
1969	9940.9	8018.54	263.236	310.259	112.951
1970	9980.0	8159.23	248.642	332.337	119.388
1971	10094.0	8378.66	237.528	358.641	130.232
1972	10208.3	8492.20	222.078	386.113	147.529
1973	10520.5	8698.50	221.255	396.494	162.960
1974	10569.8	8665.95	227.001	418.694	176.871
1975	9833.1	8132.81	208.407	424.286	183.334
1976	9594.3	7892.89	213.926	453.485	225.093
1977	9759.0	8039.17	223.909	466.307	246.617
1978	9986.3	8189.62	257.699	479.280	299.154
1979	10131.4	8299.13	247.471	479.184	294.792

Table II--Continued

Rents & Royalties	Business, Profess., & Farms	Partner-ships	Sale of Capital Assets	Estates & Trusts	Other
90.794	493.879	256.366	75.643	39.959	12.742
90.930	494.939	257.979	83.161	44.844	21.941
88.885	491.195	235.842	80.214	45.629	24.407
89.815	496.848	240.930	95.603	21.480	26.227
87.325	518.540	253.100	123.221	9.258	28.356
75.671	568.738	245.363	134.903	7.748	33.222
81.589	563.221	244.395	124.455	8.437	41.511
86.343	558.781	238.137	126.516	9.703	48.860
82.511	557.644	235.038	149.318	11.085	48.378
81.726	540.418	217.843	149.385	12.111	57.647
83.898	547.652	210.466	174.308	12.859	59.173
79.241	559.920	212.154	165.443	14.625	59.506
72.768	565.399	207.324	164.821	15.306	60.794
67.643	568.397	208.765	177.129	16.725	73.772
60.153	582.316	217.867	199.754	18.242	86.974
60.121	593.432	209.479	208.463	19.489	89.051
55.346	586.794	212.084	242.426	19.349	79.856
56.475	571.979	231.302	291.279	19.629	64.275
50.902	556.289	193.529	282.512	23.026	60.740
47.145	529.664	205.222	229.089	23.971	64.827
48.265	509.105	157.682	217.127	24.195	67.296
52.006	513.481	167.188	228.503	26.195	64.106
59.352	537.717	130.721	222.410	26.256	70.947
56.058	469.929	98.439	184.905	31.138	68.250
52.970	435.131	89.006	161.879	28.030	70.022
53.209	424.550	90.868	161.863	27.414	60.405
43.485	409.188	100.632	164.828	24.351	54.600
40.818	409.597	107.625	174.650	22.948	50.882

The smoothing constant, or the coefficient of adjustment, employed was computed by performing a simulation of each income series and finding the value of the smoothing constant which generated the smallest variance in the forecast error. Permanent income was estimated using the optimal smoothing constant; the forecasted value was defined to be permanent income.

Assumptions of the Permanent Income Hypothesis

Friedman specializes the permanent income hypothesis by making the following assumptions:

$$\rho_{TYPY} = \rho_{TCPC} = \rho_{TYTC} = 0$$

where ρ is the correlation coefficient. "Zero correlation implies only that the average transitory component is the same for all values of the permanent component." (3, p. 27) The first two assumptions are plausible given the random occurrence of transitory components of income and consumption. The assumption that the correlation between transitory income and transitory consumption is zero is much stronger. This assumption implies that a person who receives a windfall addition to income will not engage in 'riotous living' (as Friedman terms it). Friedman emphasizes that the term consumption does not refer to purchases of consumption items, but rather the actual use or consumption of these items. Thus, the assumption implies that consumers maintain a permanent level of actual use of goods and services (note that this permanent level may be increasing over time for the average individual) and do not alter the level of their consumption with every temporary change in income. For example, a person who experiences temporary unemployment, given that this person expects to become re-employed in the near future, will probably not alter consumption habits; the person will simply use past savings or borrow against future earnings to finance present consumption.

> The common notion that savings are a 'residual' speaks strongly for the plausibility of the assumption. For this notion implies that consumption is determined by rather long-term considerations, so that any transitory changes in income lead primarily to additions to assets or to the use of previously accumulated balances rather than to corresponding changes in consumption. (3, p. 28)

These assumptions are used to estimate the variance in permanent income, as derived below.

Variance in Permanent Income

The relationship between actual consumption and actual income, in the short-run, is often estimated by a linear function of the form:

$$C = \beta_0 + \beta_1 Y$$

The least squares estimate of β_1 computed from the regression of C on Y is:

$$b_1 = \frac{\Sigma C_i Y_i}{\Sigma Y_i^2}$$

Under the permanent income hypothesis:

$$C = PC + TC$$

$$Y = PY + TY$$

$$\text{and } PC = kPY$$

Substituting these relationships into the above equation yields:

$$b_1 = \frac{\Sigma(kPY_i^2 + kPY_iTY_i + TC_iPY_i + TC_iTY_i)}{\Sigma Y_i^2}$$

Given the previously mentioned assumptions:

$$kPY_iTY_i = 0$$

$$TC_iPY_i = 0$$

$$\text{and } TC_iTY_i = 0$$

Thus, the equation reduces to:

$$b_1 = \frac{\Sigma(kPY_i^2)}{\Sigma Y_i^2}$$

which may be rewritten as:

$$b_1 = k \frac{\text{var (PY)}}{\text{var (Y)}}$$

This relationship is used to estimate permanent income, given the variance in actual income, the short-run marginal propensity to consume, and the ratio of permanent consumption to permanent income (k). The short-run marginal propensity to consume (MPC) is estimated by:

$$MPC = \frac{C_t - C_{t-1}}{Y_t - Y_{t-1}}$$

Nominal values are used to compute the marginal propensity to consume in order to avoid problems with money illusion or price confusion.

Testing the Proportionality Hypothesis

The regression of permanent consumption on permanent income was performed in order to test the significance of the intercept term in the model:

$$PC = a + kPY$$

At an α-value of 0.05, the hypothesis that the intercept was statistically equal to zero could not be rejected, implying that the permanent consumption function for the sample period (1952 - 1979) is proportional.

The estimates of permanent income and permanent income variance are used to compute theoretical gini coefficients in Chapter III in order to compare permanent income inequality and measured income inequality.

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CHAPTER III

The gini coefficient may be defined as exactly one half of the arithmetic average of the absolute values of differences between all pairs of income. (2, p. 10). For this study, the Gini ratio for the hypothetical distribution of income is used to measure the degree of inequality. The hypothetical distribution of income which has been found to fit empirical data very well in previous studies is the marginal distribution of income derived from a joint distribution of commodity expenditures and components of income. The marginal total income distribution is given by: (2, p. 20)

$$g(M) = \frac{K^{b^*} Y^{c-1}}{B(c,b^*)(K+M)^{b^*+c}} \quad , \quad M > 0$$

$$= 0 \qquad\qquad \text{otherwise}$$

where M = income per capita,

K = Minimum level of income/expenditures such that the probability that an individual will have total income or total expenditures less that K is equal to zero,

c = the income inequality parameter,

and b* = the generalized Pareto parameter.

This marginal distribution function was derived from a multivariate Beta II distribution function.

The mean of the distribution is defined as: (2, p. 21)

$$\mu'_1 = \frac{Kc}{b^* - 1} \qquad (1)$$

The second raw moment of the distribution is defined as: (2, p. 22)

$$\mu'_2 = \frac{K^2 c(c + 1)}{(b^* - 1)(b^* - 2)} \qquad (2)$$

Using the definition of variance in (3):

$$s^2 = \mu'_2 - (\mu'_1)^2 \qquad (3)$$

We can express the variance of income as: (2, p. 22)

$$s^2 = \frac{\mu'_1(\mu'_1 + K)}{(b^* - 2)}$$

Applying the generalized method of moments we can solve for b* and c: (2, p. 23)

$$b^* = \frac{\mu'_1(\mu'_1 + K)}{s^2} + 2 \qquad (4)$$

$$c = \frac{\mu'_1(b^* - 1)}{K} \qquad (5)$$

"The lower terminal K is found by locating the individual in the survey who has the lowest aggregate total income and expenditures on commodities." (2, p. 23) This value was taken from the 1973 Consumer Expenditure Survey and assumed to be constant for the sample period for both measured and permanent income.

Inequality parameters for each of the components of income are computed by substituting mean income from the ith component for mean total income. Thus:

$$c_i = \frac{M_i(b^* - 1)}{K}$$

where M_i = Mean income from the ith source

and c_i = the inequality parameter for the ith income component.

The inequality parameters for actual per capita income in 1972 dollars, from all sources and from each component source, are given in Table III.

The generalized Pareto parameter (b*) and the Pareto Lower Terminal (K) can be shown to be the same for the marginal distribution of income from the ith source and the distribution of total income. (1) The generalized Pareto parameters for the series are given in Table IV. The value of the Pareto Lower Terminal was taken to be constant at $1821.60; this was the value found in the 1973 Consumer Expenditure Survey, as was previously discussed. Assuming constant prices, the value does not change over the series. The same value was used for the Pareto Lower Terminal of permanent income.

Table III INEQUALITY PARAMETERS FOR MEASURED INCOME

Year	Total Income	Wages & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	14.1487	11.4257	0.385301	0.122259	0.037048
1953	15.1051	12.4036	0.385940	0.133742	0.045854
1954	14.7824	11.9876	0.453606	0.153641	0.051214
1955	17.9368	14.4993	0.568021	0.185133	0.046283
1956	16.4918	13.3207	0.530341	0.179218	0.040233
1957	17.0306	13.8778	0.557009	0.200232	0.047327
1958	14.3850	11.6551	0.447921	0.187643	0.045398
1959	14.9180	12.1235	0.457881	0.215646	0.044311
1960	15.3171	12.5592	0.463612	0.246665	0.014859
1961	15.3430	12.4768	0.462849	0.264485	0.017249
1962	15.7051	12.7968	0.481403	0.322823	0.062299
1963	15.6713	12.6965	0.485404	0.390494	0.113894
1964	15.8805	12.8463	0.472804	0.402664	0.124696
1965	16.0657	12.9094	0.482499	0.419673	0.133190
1966	14.6119	11.7916	0.434231	0.410348	0.136783
1967	14.5860	11.7890	0.414513	0.426825	0.143643
1968	14.7428	11.8936	0.400081	0.442808	0.157313
1969	15.5752	12.7398	0.402842	0.501615	0.176243
1970	15.5681	12.8748	0.382954	0.532179	0.190577
1971	15.9961	13.2415	0.367044	0.580279	0.218478
1972	16.6187	13.6788	0.368131	0.601622	0.242012
1973	16.8460	13.8195	0.376482	0.647484	0.266134
1974	16.0203	13.3568	0.352685	0.668690	0.282148
1975	16.1880	13.3560	0.367281	0.729039	0.350712
1976	16.8896	13.9054	0.386223	0.765765	0.387560
1977	15.4442	12.6497	0.388875	0.712184	0.422789
1978	19.6182	16.0696	0.467070	0.902385	0.523965
1979	15.8936	12.8703	0.392100	0.772552	0.428980

Table III--Continued

Rents & Royalties	Business Profess., & Farms	Partner- ships	Sale of Capital Assets	Estates & Trusts	Other
0.203765	1.07069	0.577952	0.163012	0.111145	0.051868
0.206344	1.10050	0.546429	0.137563	0.110815	0.034391
0.201196	1.09012	0.548717	0.215829	0.043897	0.036581
0.223000	1.32959	0.652171	0.345020	0.037868	0.050491
0.171903	1.31671	0.548630	0.281630	0.036575	0.065835
0.196592	1.23779	0.567930	0.211154	0.036406	0.098295
0.172511	1.05928	0.472133	0.220934	0.030265	0.093822
0.159520	1.05165	0.460835	0.307223	0.029541	0.067944
0.163453	1.02530	0.436865	0.258552	0.029719	0.118875
0.163866	1.05794	0.419726	0.356480	0.028748	0.094870
0.152916	1.08174	0.421936	0.260524	0.031150	0.093449
0.138300	1.04674	0.395917	0.276600	0.029829	0.097623
0.127294	1.01835	0.387076	0.319533	0.031174	0.150674
0.113086	1.04039	0.394543	0.371926	0.032669	0.168372
0.102045	0.93577	0.332187	0.314817	0.030396	0.123756
0.090290	0.88032	0.330379	0.400149	0.028729	0.082082
0.091280	0.84289	0.353470	0.483593	0.029132	0.048553
0.085216	0.86766	0.302131	0.381538	0.036798	0.081343
0.079108	0.80726	0.332612	0.226536	0.035958	0.106076
0.082148	0.80225	0.253435	0.307618	0.036704	0.106617
0.086920	0.84704	0.289733	0.374949	0.040903	0.088624
0.097366	0.91199	0.223942	0.335912	0.040569	0.126576
0.090287	0.70537	0.186217	0.228540	0.050786	0.098752
0.088368	0.72075	0.180879	0.236109	0.042803	0.115983
0.092213	0.75641	0.184425	0.292674	0.045438	0.073503
0.067827	0.65114	0.174089	0.271308	0.036174	0.070088
0.084681	0.84152	0.222289	0.371803	0.044987	0.089974
0.032998	0.61629	0.294074	0.297956	0.039792	0.148493

Table IV GENERALIZED PARETO PARAMETERS FOR MEASURED INCOME

1952	5.03096
1953	5.18895
1954	5.03022
1955	5.61827
1956	5.07462
1957	5.20023
1958	4.58701
1959	4.52947
1960	4.60768
1961	4.52530
1962	4.51126
1963	4.40326
1964	4.30294
1965	4.25014
1966	3.88823
1967	3.80842
1968	3.76964
1969	3.91037
1970	3.86168
1971	3.90158
1972	3.92264
1973	3.95603
1974	4.00229
1975	4.04619
1976	4.11846
1977	3.80804
1978	4.53840
1979	3.88768

Thus, empirically determined values of mean income (in total and from ten components of income) and variance are used to compute the inequality parameters for total income (c) and for each income source (c_i) and the generalized Pareto parameter (b*). These values are used to calculate the gini coefficient in the following equation:

$$G(c,b^*) = \frac{\Gamma(c+b^*)\Gamma(c+0.5)\Gamma(b^*)}{\Gamma(0.5)\Gamma(c+1)\Gamma(c+b^*+0.5)} \times [1+2c/(2b^*-1)]$$

Table VIII GINI COEFFICIENTS FOR MEASURED INCOME

Year	Total Income	Wages & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	0.308228	0.315984	0.716680	0.874106	0.956071
1953	0.301865	0.308689	0.715360	0.864208	0.946294
1954	0.306825	0.314139	0.689280	0.849066	0.940772
1955	0.286143	0.292814	0.646157	0.824077	0.945405
1956	0.302263	0.309093	0.662182	0.830114	0.952520
1957	0.297942	0.304369	0.652685	0.815137	0.944699
1958	0.321043	0.328202	0.695155	0.826364	0.947529
1959	0.321852	0.328636	0.692030	0.808261	0.948768
1960	0.318466	0.324847	0.689194	0.788934	0.981838
1961	0.321165	0.327761	0.690266	0.779278	0.979057
1962	0.320973	0.327357	0.683821	0.749021	0.930223
1963	0.324817	0.331319	0.683570	0.719516	0.883128
1964	0.328128	0.334521	0.689061	0.715499	0.874571
1965	0.329818	0.336319	0.686297	0.709297	0.867988
1966	0.347503	0.354057	0.708107	0.717202	0.867007
1967	0.351236	0.357665	0.716654	0.711971	0.862255
1968	0.352790	0.359180	0.722825	0.706628	0.852437
1969	0.344777	0.350569	0.719872	0.684338	0.838135
1970	0.347007	0.352415	0.728539	0.675395	0.828834
1971	0.344480	0.349765	0.734740	0.660586	0.810792
1972	0.342563	0.347857	0.734024	0.654319	0.796632
1973	0.340735	0.346091	0.730087	0.641719	0.782833
1974	0.339988	0.345129	0.739851	0.635671	0.773865
1975	0.337841	0.343290	0.732981	0.620804	0.740257
1976	0.333742	0.339111	0.724174	0.611586	0.723620
1977	0.349723	0.355421	0.726805	0.628867	0.713499
1978	0.314278	0.319399	0.688617	0.578375	0.669274
1979	0.345278	0.351257	0.724469	0.614263	0.710076

Gini coefficients were computed for total mean income in 1973 dollars for the period 1952 - 1979 and for mean income from ten different sources in 1973 dollars for the period 1952 - 1979. Table V gives all of the computed gini coefficients for total mean income and mean income from the ten sources.

Table V--Continued

Rents & Royalties	Business Profess., & Farms	Partner-ships	Sale of Capital Assets	Estates & Trusts	Other
0.813474	0.544198	0.647750	0.842023	0.883559	0.940083
0.811113	0.537883	0.656093	0.861129	0.883452	0.958893
0.815183	0.541346	0.656694	0.805616	0.948579	0.956589
0.798681	0.503389	0.621973	0.731490	0.954664	0.940877
0.835353	0.511545	0.656342	0.766544	0.956555	0.925678
0.817592	0.519311	0.649324	0.807912	0.956631	0.894526
0.936925	0.552080	0.626333	0.804611	0.964061	0.900067
0.846614	0.554110	0.690955	0.756595	0.964930	0.924588
0.843375	0.556899	0.699136	0.782093	0.964655	0.878235
0.843443	0.553243	0.904537	0.733172	0.965826	0.899296
0.851616	0.550002	0.705800	0.781592	0.963146	0.900617
0.863299	0.556896	0.717270	0.773487	0.964735	0.897205
0.872468	0.562989	0.721908	0.752323	0.963348	0.854260
0.884382	0.560512	0.719346	0.728856	0.961760	0.841569
0.895267	0.583994	0.750412	0.758611	0.964744	0.877251
0.905875	0.595189	0.752168	0.722271	0.966688	0.913267
0.905163	0.602820	0.742244	0.692414	0.966303	0.945763
0.910030	0.595352	0.764581	0.728521	0.957772	0.913568
0.915801	0.607748	0.750517	0.806251	0.958756	0.891950
0.912860	0.607960	0.790334	0.761966	0.957888	0.891308
0.908442	0.598910	0.770709	0.731129	0.953382	0.906908
0.899032	0.586612	0.807023	0.747942	0.953674	0.874646
0.905117	0.626931	0.830727	0.803883	0.942942	0.897636
0.906685	0.622670	0.834051	0.799038	0.951148	0.882818
0.902975	0.613589	0.831176	0.767347	0.948247	0.920232
0.926594	0.643368	0.840342	0.781487	0.958620	0.924438
0.908574	0.589763	0.804046	0.726274	0.948036	0.903697
0.961907	0.650946	0.768855	0.766900	0.854623	0.858139

The gini coefficients for permanent income were derived using the estimates of mean permanent income from all sources and from the ten component sources which were obtained using double exponential smoothing, as described in Chapter II. The procedure used to estimate the variance in permanent income was described in Chapter II. Inequality parameters were computed using the same method as for actual income; mean permanent income values were substituted for mean income (total and for each component) to derive the inequality parameter (pc):

$$pc = \frac{P\mu'_1(pb^* - 1)}{K}$$

for mean income from all sources and:

$$pc_i = \frac{PM_i(pb^* - 1)}{K}$$

for mean income from the ith source.

The permanent variance was used in the place of actual variance to derive the generalized Pareto parameter for permanent income (pb*):

$$pb^* = \frac{P\mu'_1(P\mu'_1 + K)}{ps^2} + 2$$

Table VI INEQUALITY PARAMETERS FOR PERMANENT INCOME

Year	Total Income	Wage & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	.	.	.	.	.
1953	13.4138	10.8277	0.370076	0.131298	0.032060
1954	33.6952	27.7161	0.856415	0.337381	0.094584
1955	16.5286	13.4300	0.512844	0.187880	0.056860
1956	26.4423	21.4311	0.873900	0.296567	0.067774
1957	18.9813	15.3575	0.634411	0.218022	0.043140
1958	16.8580	13.7115	0.565160	0.207088	0.044696
1959	15.2663	12.3158	0.478224	0.208655	0.048519
1960	12.3501	10.0487	0.377477	0.189154	0.037844
1961	31.5477	25.8963	0.943560	0.540665	0.023128
1962	14.0626	11.4581	0.419735	0.258712	0.008359
1963	15.9413	13.0040	0.486987	0.349315	0.063678
1964	15.6545	12.6925	0.486731	0.421230	0.129976
1965	13.0058	10.5328	0.387762	0.359348	0.121071
1966	12.3087	9.8825	0.367819	0.342660	0.116367
1967	17.0932	13.7659	0.505318	0.503418	0.175693
1968	12.9440	10.4564	0.363381	0.395974	0.137836
1969	14.2330	11.4806	0.376890	0.444216	0.161718
1970	19.9412	16.3030	0.496814	0.664045	0.238550
1971	14.8070	12.2908	0.348433	0.526095	0.191039
1972	13.8875	11.5529	0.302118	0.525273	0.200700
1973	13.9900	11.5672	0.294222	0.527253	0.216702
1974	12.1358	9.9499	0.260634	0.480728	0.203076
1975	16.8076	13.9013	0.356227	0.725226	0.313370
1976	13.8638	11.4053	0.309124	0.655288	0.325260
1977	13.0107	10.7178	0.298514	0.621678	0.328789
1978	16.5489	13.5714	0.427046	0.794240	0.495744
1979	16.0944	13.1837	0.393125	0.761217	0.468298

The inequality parameters for permanent income are given in Table VI. The generalized Pareto parameters for permanent income (pb*) are given in Table VII.

Table VI--Continued

Rents & Royalties	Business Profess., & Farms	Partner-ships	Sale of Capital Assets	Estates & Trusts	Other
.	.	.	.	.	.
0.185874	1.01173	0.52735	0.169993	0.091668	0.044851
0.445338	2.46102	1.18163	0.401894	0.228614	0.122286
0.217122	1.20110	0.58243	0.231114	0.051926	0.063402
0.319256	1.89576	0.92532	0.450490	0.033847	0.103668
0.189212	1.42210	0.61352	0.337319	0.019374	0.083070
0.180367	1.24510	0.54028	0.275130	0.018651	0.091768
0.176177	1.14016	0.48590	0.258147	0.019798	0.099696
0.130389	0.88122	0.37142	0.235962	0.017517	0.076450
0.326624	2.15982	0.87063	0.597029	0.048403	0.230391
0.146162	0.95409	0.36666	0.303670	0.022402	0.103088
0.152145	1.07506	0.40734	0.317656	0.028080	0.114253
0.133001	1.03340	0.37893	0.301250	0.027975	0.111116
0.098140	0.82466	0.30289	0.256989	0.024266	0.107033
0.079995	0.77440	0.28973	0.265646	0.024259	0.115664
0.108478	1.07075	0.37797	0.376136	0.035165	0.160677
0.073790	0.78234	0.28276	0.323213	0.025797	0.106468
0.080859	0.81894	0.33117	0.417041	0.028104	0.092026
0.101708	1.11153	0.38669	0.564490	0.046008	0.121365
0.069158	0.77697	0.30104	0.336053	0.035163	0.095095
0.065660	0.69259	0.21451	0.295382	0.032915	0.091550
0.069157	0.68282	0.22232	0.303860	0.034834	0.085247
0.068146	0.61739	0.15009	0.255362	0.030146	0.081459
0.095819	0.80324	0.16826	0.316056	0.053224	0.116659
0.076542	0.62877	0.12861	0.233916	0.040503	0.101182
0.070938	0.56601	0.12114	0.215795	0.036548	0.080532
0.072061	0.67809	0.16676	0.273145	0.040353	0.090480
0.064842	0.65067	0.17097	0.277444	0.036455	0.080830

Table VII GENERALIZED PARETO PARAMETERS FOR PERMANENT INCOME

1952	.
1953	4.7236
1954	10.1267
1955	5.4036
1956	7.6597
1957	5.5548
1958	5.0270
1959	4.7169
1960	3.8786
1961	8.2802
1962	4.1735
1963	4.4975
1964	4.3294
1965	3.6429
1966	3.4225
1967	4.2868
1968	3.4286
1969	3.6081
1970	4.6398
1971	3.6721
1972	3.4781
1973	3.4223
1974	3.0915
1975	4.1136
1976	3.6322
1977	3.4285
1978	4.0187
1979	3.8937

These parameters were used to calculate gini coefficients for permanent income using the same equation used to compute gini coefficients for actual income:

$$PG(pc,pb^*) = \frac{\Gamma(pc+pb^*)\Gamma(pc+0.5)\Gamma(pb^*)}{\Gamma(0.5)\Gamma(pc+1)\Gamma(pc+pb^*+0.5)} \times [1+2pc/(2pb^*-1)]$$

Permanent income gini coefficients are shown in Table VIII. Missing values for the first observation in the series are due to the use of one lag in calculating the marginal

Table VIII GINI COEFFICIENTS FOR PERMANENT INCOME

Year	Total Income	Wages & Salaries	Dividends	Interest on Assets	Pensions and Annuities
1952	.	.	.	.	.
1953	0.318951	0.326819	0.725536	0.867637	0.961917
1954	.	.	0.553887	0.723663	0.893006
1955	0.293642	0.300472	0.665465	0.822844	0.934394
1956	0.239838	0.245309	0.558500	0.749458	0.921086
1957	0.286052	0.292339	0.627275	0.802101	0.948885
1958	0.302958	0.309390	0.651640	0.811300	0.947721
1959	0.315062	0.322126	0.682949	0.811731	0.944037
1960	0.352966	0.360217	0.730604	0.829648	0.956710
1961	.	0.232402	0.542319	0.643177	0.970756
1962	0.336585	0.343306	0.710111	0.785063	0.989791
1963	0.321022	0.327276	0.682027	0.736653	0.928874
1964	0.327538	0.333957	0.683932	0.707858	0.870201
1965	0.362601	0.369441	0.729548	0.741375	0.880771
1966	0.376119	0.383322	0.741126	0.751870	0.885936
1967	0.326786	0.332905	0.678175	0.678804	0.836197
1968	0.374300	0.380992	0.742878	0.729681	0.869253
1969	0.361841	0.368256	0.734492	0.708627	0.850475
1970	0.310459	0.315625	0.677233	0.628013	0.793543
1971	0.357487	0.362848	0.745725	0.680391	0.830054
1972	0.369540	0.374946	0.769755	0.684251	0.825679
1973	0.372522	0.378028	0.774385	0.684783	0.816460
1974	0.397506	0.403605	0.796433	0.706732	0.828772
1975	0.334064	0.339314	0.737094	0.620550	0.757032
1976	0.361313	0.367248	0.764343	0.645727	0.756723
1977	0.374159	0.380158	0.772197	0.658499	0.757968
1978	0.338448	0.343952	0.709122	0.607393	0.684744
1979	0.344679	0.350247	0.723977	0.616522	0.695791

propensity to consume (recall that this value was used to derive the variance in permanent income). The other missing values are the result of relatively large inequality parameters for which the gamma function could not be found.

Table VIII--<u>Continued</u>

Rents & Royalties	Business Profess., & Farms	Partner- ships	Sale of Capital Assets	Estates & Trusts	Other
.	.	.	.	.	.
0.826925	0.557329	0.666302	0.838122	0.901662	0.947925
0.674526	0.384180	0.496779	0.693005	0.786546	0.867498
0.803242	0.521551	0.643338	0.794385	0.939574	0.927659
0.737355	0.433310	0.548431	0.677902	0.958213	0.886119
0.821416	0.493928	0.633127	0.735500	0.976041	0.908028
0.829485	0.520677	0.659389	0.770361	0.977135	0.900857
0.833732	0.538650	0.680256	0.781645	0.975954	0.894442
0.872036	0.593557	0.733153	0.800530	0.979202	0.918210
0.732196	0.411155	0.556588	0.625065	0.941482	0.787680
0.858306	0.575400	0.731902	0.761280	0.973349	0.893206
0.852257	0.551187	0.711731	0.751650	0.966605	0.882492
0.867790	0.560152	0.725084	0.761170	0.966890	0.885747
0.899773	0.609054	0.767234	0.790960	0.971847	0.892240
0.916826	0.624184	0.776603	0.788942	0.972179	0.886500
0.888149	0.555415	0.725908	0.726691	0.958975	0.846927
0.922446	0.622447	0.780017	0.760512	0.970490	0.893951
0.915195	0.610947	0.754325	0.718632	0.967678	0.905244
0.892876	0.543760	0.719030	0.655579	0.946805	0.876053
0.925790	0.617751	0.767783	0.751257	0.959951	0.902261
0.929831	0.640277	0.817168	0.773045	0.962731	0.906316
0.926768	0.643835	0.813117	0.769699	0.960820	0.912137
0.929298	0.668227	0.863424	0.799197	0.966541	0.917371
0.899785	0.603913	0.842420	0.755725	0.940211	0.881962
0.919043	0.652362	0.874879	0.804065	0.954399	0.897227
0.925082	0.673387	0.882096	0.816935	0.959004	0.916313
0.921897	0.633114	0.844055	0.778481	0.953791	0.904884
0.929208	0.641968	0.841902	0.777377	0.958169	0.914099

The relationship between measured income inequality and permanent inequality will be tested in Chapter IV using the above gini coefficients for measured and permanent income. As described in Chapter I, hypothesis testing will be performed to see if the two measures are significantly different. Additionally, explanatory models will be developed for the ratio of the permanent gini coefficient to the measured gini coeffocient corresponding to income from all sources as well as to income from each of the component sources. The long-run behavior of measured and permanent income inequality will be tested by fitting a simple regression model with time as the independent variable.

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CHAPTER IV

Hypothesis testing was performed in order to see if the degree of inequality found in the actual distribution of income differed significantly from the degree of inequality found in the permanent distribution of income for the period 1952 to 1979. The ratio of the gini coefficient for actual income (G) divided by the gini coefficient for permanent income (PG) was constructed for per capita income from all sources in 1973 dollars. The derivation of the gini coefficients was described in Chapter III. In addition, the ratio of the gini coefficient for actual income from the ith source (G_i) divided by the gini coefficient for permanent income from the ith source (PG_i) was constructed. Next, the mean ratio for the sample period was calculated, as well as the standard deviation from the mean. These mean ratios were used as the test criteria: a ratio which is significantly different from unity implies a significant difference between the distribution of actual income and the distribution of permanent income for the sample period. A Student's T test was performed since the sample size is less than 30. The test statistic was computed using the following equation:

$$t^* = \frac{G/PG - 1}{s/(n)^{1/2}}$$

for income from all sources and:

$$t^* = \frac{G_i/PG_i - 1}{s/(n)^{1/2}}$$

for income from the ith source. The standard deviation is denoted by the letter s and $n^{1/2}$ is the square root of the sample size. Table V lists the mean ratio, standard deviation, sample size (n), and test statistic (t*) for each ratio over the sample period.

Table V

	Mean Value	Standard Deviation	Sample Size	Test Statistic (t*)
PG/G	1.0246	0.0797	25	1.5441
PG1/G1	1.0125	0.0996	26	0.6408
PG2/G2	0.9940	0.0772	27	-0.4038
PG3/G3	1.0045	0.0648	27	0.3619
PG4/G4	1.0112	0.0331	27	1.7655
PG5/G5	0.9894	0.0506	27	-1.0888
PG6/G6	0.9913	0.0977	27	-0.4619
PG7/G7	0.9937	0.0814	27	-0.4015
PG8/G8	0.9911	0.0745	27	-0.6231
PG9/G9	0.9981	0.0356	27	-0.2746
PG10/G10	0.9919	0.0436	27	-0.9705

The income sources one through ten are defined in Table IX.

Table IX

(1) Income from Wages and Salaries

(2) Income from Dividends

(3) Income from Interest on Assets

(4) Income from Pensions and Annuities

(5) Income from Rents and Royalties

(6) Income from Business, Professions, and Farms

(7) Income from Partnerships

(8) Income from Sale of Capital Assets

(9) Income from Estates and Trusts

(10) Income from Other Sources (This category includes income from sources such as alimony, state income tax refunds, small business corporate profit, and so forth.

The null hypothesis for the test was that the ratio of actual income gini coefficient divided by permanent income gini coefficient is statistically equal to one. The alternate hypothesis varied, depending upon whether the mean ratio was greater than or less than one. For a ratio which is greater than one, the alternate hypothesis is that this ratio is statistically greater than one; for a mean ratio which was less than one, the alternate hypothesis is that this ratio is statistically less than one. Thus, a one-tailed test was performed in each case. The critical value for the t distribution was found for 24 degrees of freedom, t = 1.711, 25 degrees of freedom, t = 1.708, and 26 degrees of freedom, t = 1.706 with $\alpha = 0.05$. Thus, the decision rule was based on these values for a one-tailed test with the alternate hypothesis that the mean ratio is statistically greater than one and negative values for a one-tailed test with the alternate hypothesis that the mean ratio is statistically less than one.

Referring to the test statistics given in Table V, it is obvious that the null hypothesis can be rejected only in the case of income from pensions and annuities. For all other sources of income, the null hypothesis cannot be rejected. This is the expected result over an extended period since permanent income equals measured income in the long-run according to the permanent income hypothesis. The statistical difference in the category of pensions and annuities is probably attributable to structural changes in the financial market which have altered expectation formation. This alteration could not be represented in the adaptive (double exponential smoothing) model.

The next issue to be analyzed is the long-term trend of actual and permanent income inequality. To determine the trend, the parameters of two simple regression models were estimated with time as the independent variable in both models and the gini coefficient for actual income and permanent income as the dependent variables.

$$G_t = \alpha_0 + \alpha_1(\text{time}) + E_t$$

$$PG_t = \beta_0 + \beta_1(\text{time}) + U_t$$

The ordinary least squares estimates of α_1 and β_1 were both positive, implying that the trend has been towards a higher gini coefficient and thus a less equal distribution of actual and permanent income. The parameter estimates are given below.

$$\alpha_1 = 0.001687063$$

$$\beta_1 = 0.002949797$$

The probability of a Type I error for the α_1 estimate was 0.0001 and for the β_1 estimate, the probability was 0.0004. Since the trend has been toward increased inequality for the period 1952 to 1979, a model relating the ratio of permanent to measured gini coefficients to growth variables was estimated.

Both the Stepwise and the Backward Elimination procedures were used to test for significant variables; these procedures yielded different models. There are no set criteria for choosing which model is superior; however, it is common to compare the coefficients of determination (R^2) for the two models or to choose the model with the most explanatory variables. As a rule, the backward elimination procedure yielded both a higher coefficient of determination and provided more significant explanatory variables; thus the models chosen by this procedure were selected.

The independent variables used in the backward elimination procedure were:

1) The rate of inflation in consumer goods and services, computed using the consumer price index.

   (denoted by X1)

2) Relative change in real per capita output.

   (denoted by X2)

3) The federal budget deficit as a fraction of total output.

   (denoted by X3)

4) Capital deepening, computed using the equation

   $$(\ln K_t - \ln K_{t-1}) - (\ln P_t - \ln P_{t-1})$$

   where K is net capital stock in 1973 dollars and P is the population.

   (denoted by X4)

5) The net capital stock to total output ratio (both in 1973 dollars).

   (denoted by X5)

6) The stock of savings to output ratio (both in 1973 dollars).

   (denoted by X6)

7) The Treasury-bill rate of interest.

   (denoted by X7)

Data Source: Survey of Current Business, various issues.

Additionally, the ratio of the permanent average propensity to consume to the measured average propensity to consume was tested as an independent variable in the model. This variable is denoted by X8.

The variables chosen by the backward elimination procedure as significant were:

1) The relative change in per capita output (X2),

2) Capital deepending (X4),

3) The capital to output ratio (X5), and

4) The ratio of the permanent average propensity to consume to the measured average propensity to consume (X8).

The coefficient of determination for the model relating these variables to the ratio of the permanent gini coefficient to the measured gini coefficient for income from all sources was 0.7734 at a level of significance of 0.0001. There was insufficient evidence of autocorrelation of the residuals in the model, according to a hypothesis test performed on the Durbin-Watson statistic. The parameter estimates are given below:

X2: 1.852616 (t = 4.3454)

X4: -0.054477 (t = -2.3471)

X5: 1.485260 (t = 4.9200)

X8: -4.264511 (t = -6.4398)

The dependent variable in the model is the ratio of the gini coefficient for permanent total income to the gini coefficient for measured total income. As this ratio increases, the underlying, structural inequality present in the system is greater than the actual income inequality; this is due to transitory factors. However, the fact that actual income inequality is small relative to permanent income inequality is a temporary event which cannot reasonably be expected to continue. By definition, transitory income is that portion of actual income which is not expected based on past values. The income inequality which is of long-term importance is the permanent income inequality. Factors which tend to reduce permanent income inequality relative to actual income inequality will generate a more equitable distribution of income in the long-run.

General Conclusions

The relative change in per capita output, which represents economic growth, varies directly with the gini ratio (refer to parameter estimates given above). Thus, the assertion that economic growth is associated with increasing income inequality also applies to permanent income inequality. That is, economic growth is associated with an increasing permanent gini to measured gini ratio. In the sample period, 1952-1979, both actual and permanent income inequality were directly correlated with time, but the rate of increase in actual income inequality was greater than the rate of increase in permanent income inequality. The sample period was also characterized by substantial economic growth. Since economic growth is statistically associated with increasing permanent relative to actual income inequality, other factors are clearly operating to partially offset this effect. If other factors were not acting to partially offset the effect of economic growth on the distribution of income, then one would expect that the change in permanent income inequality with respect tot time would be greater than the change in actual income inequality.

Capital deepening, which may be interpreted as changes in the capital to worker ratio, is inversely related to the gini ratio. This variable is significant at a 0.05 level, but not at a 0.01 level. Thus, interpretations of the relationship between capital deepening and income inequality cannot be made with any certainty based on available data. However, there is a theoreticaly link between the capital stock per worker and the distribution of income, especially income from wages and salaries, which is the largest component of total income. To the extent that the worker is made more productive by the increased availability of capital, labor's share may be increased somewhat. Alternately, as the worker becomes more productive, the firm's costs may be reduced. This could be translated into more job security by the reduction of lay-offs and so forth. Thus, there are many possible explanations for the association between a higher capital per worker ratio and the reduction of permanent relative to actual income inequality.

The capital to output ratio is directly related to the gini ratio for income from all sources as well as to gini ratios from the component sources. This variable is associated with increased economic growth; an increased capital to output ratio increases productive possibilities. Thus, this relationship supports the suspected relationship between economic growth and income equality as discussed above. A higher capital to output ratio may be associated with increased permanent relative to actual income inequality based on the possibility that any additions in the net capital stock will be owned mainly by the upper income groups. Owners of capital may be accumulating capital at the expense of the other factors of production, which is in turn affecting both the permanent and the actual distribution of income.

The last variable in the model is the ratio of the permanent average propensity to consume to the measured average propensity to consume. Recall that the permanent income hypothesis begins with the division of measured consumption and income into permanent and transitory components. Further, the cyclical variation in the measured average propensity to consume was thought to be attributable to transitory changes in the level of permanent income. Thus, when the ratio of the permanent average propensity to consume to the measured average propensity to consume is greater than unity, either per capita permanent consumption is greater than per capita measured consumption (per capita transitory consumption is therefore negative), or per capita measured income is greater than per capita permanent income (per capita transitory income is therefore positive). Recall Friedman's assumption that the correlation between per capita transitory consumption and per capita transitory income is zero, therefore both of the above possibilities are assumed not to occur simultaneously. However, either possibility is theoretically associated with a cyclical fluctuation above the trend. In a good year, transitory consumption is negative because transitory saving is positive for the average individual. In a poor year, transitory saving is negative because the individual is defending his consumption position by borrowing; thus, borrowing is financed by positive transitory saving in good years. Likewise, transitory income is positive in good years for the average individual and negative in poor years. The relationship between the ratio of gini coefficients and the ratio of average propensities to consume is inverse. The dependent variable, the ratio of the permanent gini to the measured gini, is inversely correlated with the propensity to consume ratio. Thus, permanent income inequality is increased relative to measured income inequality during a 'poor' year, when the permanent average propensity to consume is less than the measured average propensity to consume. During a 'good' year, permanent income inequality is reduced relative to measured income inequality. Therefore, while general economic growth is associated with increasing permanent relative to actual income inequality, this relationship is reversed during years when the economy is growing above trend. It would appear that above trend growth tends to reduce permanent income inequality relative to actual income inequality; there are many factors which could explain this phenomenon. During an extremely good year, the average income-earner is receiving unexpected additions to permanent income, causing per capita actual income to be greater than per capita permanent income. At the same time, permanent income inequality is reduced relative to actual income inequality. The deep-seated, structural inequality is reduced by the opportunities provided by a surge in business activity. This observation supports the notion than the economic system of the U.S. is characterized by a high degree of mobility which tends to erode the underlying inequality caused by factors such as inheritance and unequal opportunities within an environment of economic growth.

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