CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2005

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WP05/16

September 2005

DEPARTMENT OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4

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Abstract: This paper analyses data from the Irish Household Budget Surveys of 1987, 1994 and 1999 to examine the evolution of inequality of income and expenditure over that period. The paper calculates Lorenz and Generalised Lorenz curves and also the Growth Incidence Curve of Ravallion and Chen to investigate the extent to which growth was "pro-poor". The paper also examines the composition of changes in inequality of income over the period.

Key Words: Growth, inequality, Lorenz, Generalised Lorenz, growth incidence curve.

JEL Code: D31, D63, I31 .

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We are grateful to Jim Dalton of the Central Statistics Office for helpful discussion. We remain responsible for any errors.

Growth and Inequality in Ireland: 1987-1999

1. Introduction

By almost any standards Ireland's growth experience from the mid 1980s to the end of the last century can be described as a roller-coaster ride. The weak growth experience of the early to mid 1980s was followed by a partial recovery in the late 1980s, followed by another trough in the early 1990s and then a period of unprecedented growth from about 1994. This latter stage gave rise to the phrase "the Celtic Tiger" and there have been varying attempts in the literature to explain the origins of this growth. For example, Honohan and Walsh (2002) suggest that Ireland experienced a delayed structural transformation whereby labour shifted out of the low-productivity agriculture sector into high-productivity industry and services. This was accompanied by (and contributed to) productivity increases in the agricultural and non-agricultural sectors. On the other hand Krugman (1997) maintained that Ireland's extraordinary high growth period should be regarded as a regional boom.[1] In any event, general perceptions of Ireland's economic performance changed dramatically over the period, perhaps best summarised by the contrasting (sub)titles of Dornbusch's 1989 paper, "Ireland's Failed Stabilisation" (Dornbusch, 1989) and Honohan and Walsh's "The Irish Hare".

The contribution of this paper is to examine the evolution of inequality of income and expenditure over the period. As explained below, economic theory is relatively agnostic as to the effect of rapid economic growth on inequality. Clearly, however during periods of rapid growth, should that growth be concentrated in certain parts of the income distribution, then there is a potential for significant changes in inequality. We analyse changes in inequality by examining Lorenz curves for income and expenditure drawn from the Household Budget Surveys of 1987/88, 1994/95 and 1999/2000 (for convenience we simply label them 1987, 1994 and 1999 respectively). In addition, we calculate a variety of summary inequality indices and also examine Lorenz curves. We also calculate the Growth Incidence Curve (GIC) introduced recently by Ravallion and Chen

[1] See Barry (2002) for an attempt to disentangle these explanations.

(2003) which throws light on the issue of the extent to which Ireland's recent growth was "pro-poor". Finally, in the case of disposable income, we examine the composition of changes in inequality over the 1987-1999 period.

The remainder of the paper is structured as follows: in the next section we briefly review what economic theory has to say about the relationship between growth and inequality and we also summarise existing evidence for Ireland for the period under review. In section three we discuss our data, present some summary statistics and also present Lorenz curves and summary inequality indices. Section 4 discusses whether growth was pro-poor using the GIC. Section 5 examines the composition of changes in inequality of disposable income, while section 6 concludes.

2. Growth and Inequality: Theory and Existing Evidence for Ireland

In this section we briefly review what economic theory has to say about the relationship between growth and inequality. We also briefly review the existing evidence on developments in inequality for Ireland over the 1987-2000 period.

For a long time, economic theory had relatively little to say about the impact of growth upon inequality. The empirical regularity noted by Kuznets (1955) suggested that in the early stages of development economic growth was accompanied at first by rising inequality but subsequently accompanied by falling inequality. Hence the famous "inverted-U" hypothesis of Kuznets. Subsequent empirical work using more reliable data has cast some doubt over the original Kuznets hypothesis (for example see Deiniger and Squire, 1996). However, in a purely mechanistic way it is possible to see how the type of story told by Walsh and Honohan could lead to rising and then falling inequality. Imagine an economy with say only five people, all engaged in agriculture and earning 100 units of income, giving an income vector of [100, 100, 100, 100, 100]. Now suppose one of them migrates to higher-productivity industry and their income

rises to 200. The income vector now changes to [100, 100, 100, 100, 200]. Imagine that each period another person switches until eventually the income vector is [200, 200, 200, 200, 200]. If we calculate the Gini coefficient for each successive vector we will see that it rises and then falls.[2]

Even allowing for the relative lack of robust evidence supporting the Kuznets hypothesis, it is arguable that a country as rich as Ireland would be beyond the peak of the "inverse U" and so should have relatively low inequality. However, evidence for some mature economies such as the UK and the US has suggested rising levels of inequality, particularly in earnings, since around the end of the 1970s. Aghion, Caroli and Garcia-Peñalosa (1999) suggest a number of reasons for the increase in the premium for skilled labour over unskilled labour: (a) increased trade, particularly with the rapidly growing East Asian economies has increased the relative demand for skilled labour (b) skill-biased technological change and (c) organisational change within firms. They conclude that all three factors are key components of growth and all of them may have the effect of widening the income distribution but they are inclined to put the greatest weight upon technological change.

While Aghion et al. provide explanations for rising *earnings* inequality they point out that there are no such universal trends in *income* inequality. In particular, movements in government taxes and transfers may offset to a large degree developments in earnings. We now turn to review existing evidence for Ireland.

Recent Developments in Inequality in Ireland

The most recent comprehensive analysis of inequality in Ireland (which covers broadly the same time period as this paper) is that of Nolan et al. (2000). They analyse the 1994, 1997 and 1998 waves of the *Living in Ireland Survey* and present trends in inequality for what they term direct income, gross income and disposable income. Direct income is income obtained from the market, in the

[2] This simple example is adapted from Fields (1980) but it is interesting to note that it was speculation from a similar, but slightly more complicated example, that led Kuznets to his "inverted U" hypothesis (see Kuznets, 1955).

form of wages and salaries etc. Gross income is direct income plus social welfare payments, while disposable income is gross income less income tax and social security contributions. Their analysis suggests that between 1987 and 1994 income distribution in Ireland was broadly unchanged (this applies to both gross and disposable income). There was an increase in the share of income going to the very poorest decile, but this was offset by reductions for the third, fourth and fifth decile. For the rest of the 1990s the broad trend was for a reduction in inequality for direct income (presumably reflecting higher employment levels), but a slight increase in inequality for disposable income as the offsetting effect of taxes and transfers was somewhat dampened. This trend appeared to accelerate between 1997 and 1998. In a subsequent article Nolan (2003) points out that income growth for the bottom 30% lagged substantially behind that for the very top incomes for the 1994-2000 period but that growth for the top 10% was not significantly different from that for the middle range.

We now turn to our own analysis of income inequality in Ireland which replicates the Nolan et al analysis (but using a different dataset) and also includes inequality measures for expenditure. We also present measures of the GIC of Ravallion and Chen.

3. Inequality Measures for Ireland, 1987-1999.

Before describing the inequality measures which we calculate, we first of all discuss our data. We use the Household Budget Surveys of 1987/88, 1994/95 and 1999/2000 published by the Central Statistics Office. This is a nationally representative survey carried out approximately every five years (prior to 1994 it was carried out every seven years) and collects a variety of information for over 7000 households. Households answer questions over a two-week period about consumption patterns, sources of income plus other information regarding demographic and housing circumstances etc.. The primary function of the HBS is the calculation of weights for use in the construction of the consumer price index, but the wealth of information on households has also made it a valuable source of data for research into other areas such as inequality and poverty (e.g. Madden,

2000a, 2000b). In all, 7644 households co-operated with the 1999/2000 survey, 7877 with the 1994/95 survey and 7705 with the 1987/88 survey.

We analyse inequality for two measures of household resources: disposable income and expenditure. As our definition of household disposable income we employ the same one as used by Nolan et al i.e. direct income plus transfer payments less income tax and social security contributions. Our expenditure measure is total expenditure excluding repayments of loans other than house purchase mortgages, savings and taxes. It includes an adjustment incorporating the value of home grown food consumed.

There are a variety of arguments for and against both income and expenditure as an accurate measure of household resources. Amongst the issues which must be considered are the following[3]: certain components of income may be difficult to measure e.g. income from self-employment. Furthermore, cross-section studies typically provide income measures which are snapshots in time and thus take no account of the difference between transitory and permanent income (which once again may be particularly pronounced for the self-employed). Since expenditure decisions are usually made with reference to permanent income then expenditure measures may be preferable. However, such measures also have drawbacks. Expenditure on items such as alcohol and tobacco are typically under-reported. Also, expenditure over a two-week period may not be a reliable measure of consumption, particularly for mature households who may have a large stock of durables from which they derive services.

A further problem specific to the HBS is that income observations are "top-coded" e.g. for 1987 and 1994 values of income in excess of £800 per week are simply entered as £800 per week. Thus the distribution of income is censored on the right hand side at a value of £800. To avoid this problem and also to minimise the potential influence of measurement error (typically most severe at the top and bottom of the distribution) we follow the practice of Barrett et al. (2000) and trim the top and bottom 3 per cent of observations in both the income and expenditure

[3] For a detailed discussion see Blundell and Preston (1998).

distributions. In addition, when carrying out the decomposition analysis in section 6 it was discovered that for some, mainly high-income, observations there was a discrepancy between the overall figure for disposable income and the sum of the components of disposable income. These observations were dropped (30 in 1987, 289 in 1994 and 88 in 1999).

Below we present summary statistics for our definitions of weekly disposable income and total expenditure (standard deviations in brackets) for 1987/88, 1994/95 and 1999/2000. All measures are in euros at Q3 2000 prices.

Table 1: Average Expenditure and Income, 1987-1999

	Total exp.	**Disposable Inc.**	**No. of Observations**
1987/88	372.76 *(261.19)*	343.34 *(196.04)*	7213
% change	11.1	8.1	
1994/95	414.31 *(255.53)*	371.19 *(214.04)*	7116
% change	38.6	41.7	
1999/2000	574.36 *(351.97)*	526.11 *(310.47)*	7098

Note that total expenditure exceeds disposable income for all years, reflecting the understatement of income typical in surveys such as the HBS. We also note that average real household expenditure increased by 11.1 per cent between 1994 /95 and 1987/88 and by 38.6 per cent between 1994/95 and 1999/2000. The corresponding figures for disposable income were 8.1 per cent and 41.7 per cent respectively.

Finally before presenting our results we wish to scale household income/expenditure to take account of differing household size and composition. There is an extensive literature on the appropriate choice of equivalence scale.[4] Here we use a scale which has been widely used in poverty studies in the EU.

[4] See Deaton and Muellbauer (1980) for a discussion.

The weights are 1 for the first adult in the household, 0.7 for additional people aged over 14 and 0.5 for people aged less than 14.

A final, related, issue is whether the focus should be on income distribution on a per person or per household basis. Atkinson, Rainwater and Smeeding (1995) maintain that if no adjustment is made to household income/expenditure for household size then it makes sense to accord an equal weight to each household. However, should an adjustment along the lines of the equivalence scale described above, be made to income/expenditure then person weights are more appropriate. Thus each household is weighted by the number of persons therein.

These adjustments lead to revised estimates of the change in expenditure and disposable income over the periods in question as the table below shows when we compare it to table 1. The actual values are not of any great interest since they are sensitive to the equivalence scale employed, but the percentage changes are greater in all cases, reflecting the fact that household size has declined over the period.

Table 2: Average Equivalised Expenditure and Income, 1987-1999

	Total exp.	**Disposable Inc.**	**No. of Observations**
1987/88	142.94 *(77.71)*	132.08 *(72.28)*	7213
% change	20.7	17.2	
1994/95	172.53 *(92.53)*	154.84 *(83.33)*	7116
% change	40.8	43.3	
1999/2000	242.95 *(132.52)*	221.97 *(117.82)*	7098

We now present the first of our inequality measures, the Lorenz curve. Strictly speaking the Lorenz curve is a not a measure but a graphical device which can be obtained by ordering all income (expenditure) units, starting with the lowest, and plotting, against the cumulative proportion of the population so ordered (running

from zero to one along the horizontal axis) the cumulative proportion of income received by these units.[5] If everybody received the same income then the "curve" would be a straight line from (0,0) to (1,1) i.e. a perfect diagonal. If there is any inequality in the distribution of income than the Lorenz curve will lie below the perfect diagonal. Intuitively the further below the diagonal the curve is, the more unequal is the income distribution. Thus if we wished to represent two income distributions by Lorenz curves, and one Lorenz curve lay everywhere below the other, then that income distribution is more unequal. This gives rise to the idea of "Lorenz Dominance". More formally, suppose we have two distributions, $F(y)$ and $G(y)$, with associated Lorenz curves $L_F(p)$ and $L_G(p)$ then we say that distribution F *Lorenz Dominates* distribution G if $L_F(p) \geq L_G(p) \forall p \in [0,1]$ and $L_F \neq L_G$. Note that Lorenz curves are independent of scale, so that if distribution F was simply a scaled up version of distribution G then their Lorenz curves would be equal. However, what if there is no Lorenz dominance i.e. if the Lorenz curves cross? Then it is not possible to unambiguously rank one distribution as more unequal that the other. It will always be possible to find two inequality measures giving a different ranking.

Unless there are dramatic changes in inequality, Lorenz dominance can be difficult to test visually by mere inspection of Lorenz curves. In these situations it is easier to inspect the difference between the line of equality and the Lorenz curve (see Deaton, 1997). Transformed Lorenz curves for the three pairwise comparisons (1987-1994, 1994-1999 and 1987-1999) for income and expenditure are presented as figures 1 to 6. Figures 2-4 and figure 6 show clear crossings indicating that we cannot make any unambiguous statements regarding developments in inequality for these cases. In the other cases even the transformed Lorenz curves are difficult to interpret visually so it is necessary to examine the actual values of the ordinates of the curves.[6] These show that for figure 1, the Lorenz curve for income between 1987 and 1994, Lorenz dominance applies in the sense that the curve for 1994 always lies above that for 1987, though

[5] We explain the Lorenz curve and other inequality concepts here in terms of income, but it should be understood that the analysis applies to any measure of household resources, including expenditure.
[6] These values are available from the authors on request.

the difference could not be described as economically significant in the sense outlined by McCloskey and Ziliak (1996).

For figure 5, the Lorenz curve for expenditure between 1994/95 and 1999/2000 the ordinates show that the Lorenz curve for 1994 lies above that for 1999 right up to the 92nd percentile, after which the Lorenz curve for 1999 lies above. Thus for virtually all but the very upper part of the expenditure distribution, inequality was lower in 1994/95 than in 1999/2000.

Given that almost all of the possible pairwise Lorenz comparisons show crossings (albeit some at very high levels of expenditure), what are the results for individual inequality measures? The table below shows results for five different inequality measures, the Gini coefficient (G) , the coefficient of variation (C), and the Atkinson inequality measure with inequality aversion coefficients of 1, 2 and 5 (A-1, A-2, A-5) with bootstrapped standard errors in brackets.

Table 3: Inequality Indices, 1987-1999

	Income			**Expenditure**		
	1987	**1994**	**1999**	**1987**	**1994**	**1999**
Gini	0.283 *(0.001)*	0.278 *(0.001)*	0.282 *(0.001)*	0.282 *(0.001)*	0.282 *(0.001)*	0.290 *(0.001)*
Coef. Var.	0.547 *(0.004)*	0.538 *(0.004)*	0.531 *(0.004)*	0.544 *(0.004)*	0.536 *(0.004)*	0.545 *(0.003)*
Atkinson – 1	0.120 *(0.001)*	0.115 *(0.001)*	0.122 *(0.001)*	0.121 *(0.001)*	0.121 *(0.001)*	0.130 *(0.001)*
Atkinson – 2	0.219 *(0.002)*	0.210 *(0.002)*	0.232 *(0.002)*	0.225 *(0.002)*	0.226 *(0.002)*	0.248 *(0.002)*
Atkinson - 5	0.433 *(0.005)*	0.408 *(0.004)*	0.474 *(0.004)*	0.448 *(0.004)*	0.442 *(0.003)*	0.492 *(0.003)*

In discussing these figures it is perhaps best to discuss developments in the G, C and A-1 values first, as these are the inequality measures which put least emphasis on developments in the lower part of the distribution. Dealing with the figures for income first, they suggest that inequality fell slightly between 1987 and 1994, but appeared to rise slightly between 1994 and 1999. In the case of expenditure, inequality is pretty much unchanged between 1987 and 1994 and then rises somewhat in 1999.

Turning now to the A-2 and A-5 measures it is important to remember that developments in these measures will be more heavily influenced by what happens at the lower end of the distribution. In that sense they may throw more light on the issue of the extent to which growth over the period was "pro-poor". For the 1987-1994 period there is relatively little change in the A-2 index but the A-5 index falls, suggesting that developments at the lower end of the income distribution were pro-equality over this period. However, both indices, and the A-5 one in particular, show fairly substantial increases between 1994 and 1999. We will investigate this issue in more detail below, but it does suggest that the 1994-1999 period saw a relative worsening in the position of those at the very lowest part of the income/expenditure distribution.

4. Was Growth in Ireland Pro or Anti Poor?

The results in section 3 suggested that there was little change in inequality over the 1987-1994 period, but that in the period between 1994 and 1999 there was a relative worsening in the position of those at the lowest part of the income distribution. We can investigate this more formally by examining what Ravallion and Chen (2003) term the "growth incidence curve". Following their notation let $F_t(y)$ be the cumulative distribution function (CDF) of income (expenditure), giving the proportion of the population with income less than *y* at date *t*. Inverting the CDF at the *p*th quantile gives the income of that quantile. Thus

$$y_t(p) = F_t^{-1}(p) = L_t'(p)\mu_t \text{ with } y_t'(p) > 0$$

where $L_t(p)$ is the Lorenz curve with slope $L_t'(p)$ and μ_t is the mean.

Now, comparing two dates *t* and *t-1*, the growth rate in income of the *p*th quantile is $g_t(p) = [y_t(p)/y_{t-1}(p)] - 1$. Thus when *p* varies from zero to one, $g_t(p)$ traces out what Ravallion and Chen (2003) term the "growth incidence curve" (GIC). From the expression for $y_t(p)$ above it is clear that

$$g_t(p) = \frac{L_t'(p)}{L_{t-1}'(p)}(\gamma_t + 1) - 1$$

where $\gamma_t = (\mu_t / \mu_{t-1}) - 1$ is the growth rate in mean income. If $g_t(p)$ is a decreasing function of *p* for all *p*, then growth rates for poorer quantiles are greater than for richer quantiles and so inequality must be falling between period *t* and *t-1* for all inequality measures satisfying the Pigou-Dalton transfer principle.

Pro-poor growth can be investigated visually via inspection of the GIC curves, but it can also be measured by a summary statistic related to the Watts index of poverty (see Watts, 1968 and Zheng, 1993). For a given poverty line *z*, the headcount index measures the fraction of individuals with income less than or equal to *z*. Thus the headcount index $H_t = F_t(z)$. The Watts index can be expressed in terms of the quantile function as

$$W_t = \int_0^{H_t} \log[z / y_t(p)]dp .$$

The change in the Watts index over time can be expressed as

$$-\frac{dW_t}{dt} = \int_0^{H_t} \frac{d \log y_t(p)}{dt} dp = \int_0^{H_t} g_t(p)dp .$$

If we divide the last expression by the headcount index, H_t, we obtain the measure of the rate of pro-poor growth which is the mean growth rate of the poor i.e.

$$\frac{\int_0^{H_t} g_t(p)dp}{H_t}$$

Note that this measure differs from the growth rate in the mean income of the poor, a measure which is frequently quoted. We now present GIC curves for income and expenditure for Ireland for 1987-1999 and also the associated rates of pro-poor growth for various percentiles.

Figures 7 and 8 show the GIC curves for the 1987-1999 period for expenditure and income respectively. The curves are extremely useful as it is possible to see precisely what parts of the distribution are driving the movements in the various inequality indices. For expenditure, the 1994-1987 curve is pretty flat, suggesting that growth was neither particularly pro or anti poor, and confirming the results for the various inequality indices in table 2. For income the 1994-1987 curve has a gradual downward slope until about the 40th percentile. It then gradually slopes up until about

the 70th percentile before declining again. All indices show a decrease in inequality with the decrease most pronounced for the A-5 index, reflecting the downward slope up to the 40th percentile.

Turning now to the 1999-1994 and 1999-1987 curves and dealing with expenditure first, we observe that for 1999-1987, with the exception of a section between about the 7th and 11th percentile, the graph slopes gradually upwards until about the 70th percentile. After that it flattens out and then drops after about the 90th percentile (though at percentiles beyond the 90th there may be some measurement error). This is reflected in the slight increases in the inequality indices. As is to be expected, the index showing the greatest increase is the A-5 index, since developments in this index will be very insensitive to the downward sloping part of the GIC curve after the 70th percentile. For the 1999-1994 curve we see that it slopes up gradually until about the 45th percentile, after which it is flat. Once again, movements in the A-5 index reflect what happens in the lower part of the distribution.

Turning now to income, 1999-1987 is quite steeply sloped upward as far as the 12th percentile. The curve then slopes downward, until about percentile 26, followed by a gradual upward sloped section as far as percentile 50. After this the curve has a very gentle downward slope which accelerates slightly after about the 80th percentile. This pattern is broadly repeated for the 1999-1994 curve. This complex pattern of slopes is reflected in the changes in the various inequality indices, with some showing a rise and some showing a fall. The A-5 index shows the clearest change, reflecting the steeply sloped upward section of the GIC curve as far as percentile 12.

Table 4: Rates of Pro-Poor Growth for Equivalised Expenditure

	1987-94	1994-99	1987-99
	Growth rate in Mean Expenditure		
	20.7	40.8	70.0
p=	Growth Rate for Poorest p%		
10	21.0	28.8	55.9
15	20.2	30.2	56.5
20	20.1	31.4	57.7
25	19.9	32.6	59.0
50	19.7	36.9	63.8
100	20.7	39.5	68.4

Table 5: Rates of Pro-Poor Growth for Equivalised Income

	1987-94	1994-99	1987-99
	Growth rate in Mean Income		
	17.2	43.3	68.1
p=	Growth Rate for Poorest p%		
10	22.55	25.70	54.06
15	22.05	30.16	58.82
20	21.58	32.46	60.99
25	21.03	33.68	61.72
50	18.55	39.64	65.34
100	17.87	42.52	67.88

The rates of pro-poor growth reflect developments in the GIC curves.

In summarising the results from section 4 it seems to fair to say that growth over the 1987 to 1994 period was mildly pro-poor. Since 1994, growth has been relatively less favourable to the poor, mainly on account of developments in the lowest decile. For the other deciles, growth has been more or less neutral. In terms of changes in overall inequality indices, there is evidence of a slight increase in inequality of expenditure but inequality of disposable income is pretty much unchanged. However, it is

possible that even though inequality of disposable income is unchanged, the same might not be true of the components of disposable income. That is the subject matter of section 5.

5. Sources of Income Inequality Over Time

In this section we show how the Gini coefficient for overall income may be decomposed by sources of income.[7] Before doing so, we briefly discuss general issues concerning the decomposition of inequality. Shorrocks (1982) discusses in general how inequality may be decomposed by factor components. He shows that the contribution of any factor expressed as a proportion of total inequality can be made to give any value between plus and minus infinity. This rather negative result arises from the fact that the particular functional representation used for any inequality index is not uniquely determined. In this paper a decomposition with reasonable intuitive appeal is used whereby each component's contribution to inequality is the product of its own inequality, its share of total income and its correlation with the rank of total income.

We start off by noting that the Gini coefficient, G, can be expressed in terms of the area under the Lorenz curve, where as explained above the Lorenz curve relates the cumulative proportion of income units to the cumulative proportion of income received when units are arranged in ascending order of their income. A value of G=1 represents maximum inequality while G=0 represents zero inequality. More specifically, we have

$$G = 1 - 2\int_0^1 L(p)\,dp$$

where G is the Gini coefficient, and $L(p)$ is the Lorenz curve (we suppress the time subscript for convenience). If we integrate this expression by parts we obtain

$$G = 2\int_0^1 p\,L'(p)\,dp - 1$$

Suppose now we transform the variables with the substitution of $p=F(y)$ where $F(y)$ is the cumulative distribution of income. This gives us

[7] The following discussion draws on Lerman and Yitzhaki (1985).

$$G = -1 + 2\int_0^{\infty} \frac{y\,F(y)\,f(y)\,dy}{\mu_y}$$

where *f(y)* is the frequency distribution of income and μ_y is mean income. From the formula for covariance between two random variables *X* and *Z* we have $Cov(X,Z) = E(XZ) - E(X)E(Z)$. Letting *X* be income, *y*, and *Z* be *F(y)*, the cumulative distribution of income, we have

$$Cov\,[y, F(y)] = \int_0^{\infty} y\,F(y)\,f(y)\,dy - \frac{\mu_y}{2}$$

since $E[F(y)] = \int_0^{\infty} F(y)\,f(y)dy = \int_0^{1} pdp = 1/2$ and $E(y) = \mu_y$. Combining we obtain

$$G = 2\,\frac{Cov\,[y, F(y)]}{\mu_y}$$

i.e. the Gini coefficient can be expressed in terms of the covariance between incomes and their ranks.

Now we let $y_1,...,y_k$ represent components of income. Then since $y = \sum_{k=1}^{K} y_k$ we can write

$$G = 2\,\frac{\sum_{k=1}^{K} cov[\,y_k\,, F(y)]}{\mu_y}$$

where $cov[y_k, F(y)]$ is the covariance of income component k with the cumulative distribution of income. Multiplying and dividing each component k by $cov[y_k, F(y_k)]$, i.e. the covariance between income component y_k and the cumulative distribution of that component, and μ_k yields the decomposition

$$G = \sum_{k=1}^{K} \frac{cov[\,y_k\,, F(y)]}{cov[\,y_k\,, F(\,y_k)]} \bullet \frac{2\,cov[\,y_k\,, F(\,y_k)]}{\mu_k} \bullet \frac{\mu_k}{\mu}$$

i.e. $G = \sum_{k=1}^{K} R_k G_k S_k$ where R_k is the "Gini correlation" between income component k and total income, G_k is the relative Gini of component k, and S_k is component k's share

of total income. As discussed in Stark, Taylor and Yitzhaki (1986) the Gini correlation has the following properties:

(a) $-1 \le R_k \le 1$. If y_k and y are independent, then R_k equals zero. If y_k is a monotonically increasing function of y, then R_k is 1, while if it is a monotonically decreasing function, then R_k is -1 (this property is similar to Spearman's rank correlation, since it tells us that if households' rank according to y_k is exactly the same as their rank according to y, then $R_k=1$.)

(b) If y_k and y are normally distributed, then $R_k = \rho$, Pearson's correlation coefficient.

Using the above decomposition of inequality by source, we can examine how changes in particular income sources will affect overall inequality. Suppose we have an exogenous change in each household's income component j by a factor of e, such that $y_j(e)=(1+e)y_j$. Then[8]

$$\frac{\partial G}{\partial e} = S_j(R_j G_j - G)$$

Dividing by G we also obtain

$$\frac{\partial G / \partial e}{G} = \frac{S_j G_j R_j}{G} - S_j$$

Thus the relative effect of a marginal percentage change in component j upon inequality equals the relative contribution of component j to overall inequality minus the relative contribution to total income. Thus if the Gini correlation between component j and total income, R_j, is negative or zero, an increase in component j will *decrease* inequality. If R_j is positive, then the impact upon inequality depends upon the sign of R_jG_j-G. A necessary condition for inequality to *increase* is that the inequality of component j must exceed the inequality of total income i.e. $G_j>G$ since $R_j \le 1$.

It is also possible to decompose changes in the Gini coefficient over time. Along the lines of the decomposition outlined above, the change in inequality between year 1 and year 0 is decomposed by income source and the three factors introduced above: income shares S_k, the "Gini correlation" R_k, and the Gini coefficient for each source of income,

[8] For this derivation, see Stark, Taylor and Yitzhaki (1986).

G_k. As shown by Karoly (1994) the change in the overall Gini can be decomposed as follows:

$$\Delta G = G_1 - G_0 = \sum_{k=1}^{K}(S_{k1} - S_{k0})G_{k1}R_{k1} + \sum_{k=1}^{K}(R_{k1} - R_{k0})S_{k1}G_{k1} + \sum_{k=1}^{K}(G_{k1} - G_{k0})S_{k1}R_{k1}$$

$$+ \sum_{k=1}^{K}(G_{k1} - G_{k0})S_{k1}R_{k1} + \text{residual.}$$

Thus the total change in inequality is decomposed along two dimensions: the contribution of each income source due to changes in S_k, R_k and G_k, and the contribution of changes in S_k, R_k and G_k across the different components of income. In table 7 below we present the decomposition of the Gini for 1987, 1994 and 1999 respectively. Disposable income is decomposed into five parts: earned income of head of household, other earned income, other income, transfers and taxes. Table 6 first of all gives the values of S_k, G_k and R_k for each of the components.

Table 6: Gini Coefficients, Gini Correlations and Shares of Income for Disposable Income Components, 1987-1999

	1987			1994			1999		
	S_k	G_k	R_k	S_k	G_k	R_k	S_k	G_k	R_k
Earned income, hoh	0.66	0.58	0.69	0.61	0.59	0.7	0.58	0.56	0.68
Other earned income	0.25	0.8	0.69	0.24	0.78	0.64	0.35	0.66	0.65
Other income	0.09	0.85	0.48	0.12	0.84	0.51	0.11	0.82	0.42
Transfers	0.22	0.57	-0.33	0.22	0.57	-0.38	0.15	0.60	-0.39
Taxes	-0.23	0.66	0.78	-0.19	0.65	0.76	-0.19	0.62	0.79

Amongst the more notable feature of this table is the relative decline in the importance of earned income of the head of household. This is offset by a fall in direct taxes (especially between 1987 and 1994, reflecting the changes in tax rates over that period) and also by a marked rise in earned income from other members of the household. This latter development reflects the increase in households with more than one earner following the increase in employment during the Celtic Tiger years (it

is also noticeable that the Gini coefficient for this item falls as opportunities for employment increase). Transfers diminish in relative importance as unemployment falls.

Table 7: Gini Decomposition by Source of Income, 1987-1999

	1987			1994			1999		
	Gini Cont.	$\frac{\partial G}{\partial e}$	$\frac{\partial G / \partial e}{G}$	Gini Cont.	$\frac{\partial G}{\partial e}$	$\frac{\partial G / \partial e}{G}$	Gini Cont.	$\frac{\partial G}{\partial e}$	$\frac{\partial G / \partial e}{G}$
Earned income, hoh	0.27	0.08	0.29	0.25	0.08	0.29	0.22	0.06	0.22
Other earned income	0.14	0.07	0.24	0.12	0.05	0.18	0.15	0.05	0.19
Other income	0.03	0.01	0.04	0.05	0.02	0.06	0.04	0.01	0.03
Transfers	-0.04	-0.1	-0.37	-0.05	-0.11	-0.39	-0.04	-0.08	-0.28
Taxes	-0.12	-0.05	-0.19	-0.09	-0.04	-0.15	-0.09	-0.04	-0.14
Disp. Income	0.28	0	0	0.28	0	0	0.28	0	0

As table 7 shows, the overall Gini coefficient for disposable income changes very little over the period. However, the relative contribution of each component does not remain unchanged. The average and marginal contribution of earned income of household head to the Gini falls. This presumably reflects the fact that as employment opportunities expanded, more individuals in households who had previously been at the lower end of the income distribution found jobs and their earned income contributed to a fall in inequality. The same is likely to be true for other earned income. The contribution of taxes and transfers in reducing inequality has also fallen. This is once again explicable in terms of employment. As table 6 shows, transfer income becomes less important in terms of its share of disposable income. It also becomes more concentrated amongst the lower part of the income distribution (witness the change in R_k for transfers). The combination of these two factors lead to a reduction in its role in terms of lowering inequality at the margin. Taxes also fall as a percentage of disposable income reflecting changes in tax rates and also presumably a greater percentage of taxpayers paying taxes at the standard rather than the higher rate.[9]

[9] We carried out a similar decomposition for Donaldson and Weymark's "generalised Gini" (Donaldson and Weymark, 1980, 1983) , which resembles Atkinson's index in that the degree of inequality aversion can be changed with differing weight on different parts of the distribution. The results (which are available on request) are qualitatively very similar to those in table 7.

We now turn to changes over time. We will reserve the discussion to the changes over the period as a whole i.e 1987-1999. Looking first of all at changes in S_k, G_k and R_k, it is interesting to note that while the overall Gini has remained essentially unchanged, this has been due to offsetting factors.[10] Thus changes in S_k on their own would have led to an increase in the Gini of 0.51. This is primarily because of the reduced share of earned income of the head of the household (which had a relatively low Gini) to earned income of others in the household (which has a relatively high Gini). Changes in the share of disposable income accounted for by taxes and transfers also contributed to a rise of about 0.034 in the Gini. However, changes in G_k and R_k led to reductions in the Gini of 0.034 and 0.025 respectively. The principal contributor to the change in G_k was the reduced Gini for earned income of other household earners, which accounted for over 90% (.031/.034) of the total fall in G_k.

Turning now to the decomposition along the dimension of sources of income (we are now looking at the *column* marked "total") we see that for 1987 to 1999 the overall change in the Gini was tiny, but that this once again masked offsetting factors. Changes arising from earned income of the head of household contributed to a lowering of 0.043 in the Gini, but this was offset by increases in other factors, primarily changes in direct taxation.

It seems fair to say in summary that overall inequality of disposable income is essentially unchanged over the 1987 to 1999 period. Despite that there is some "churning" in terms of the components of inequality. The drop in the share of earned income of the household head in disposable income exerts downward pressure on inequality – on its own this would lead to a fall in the Gini of 0.034 (a fall of over 10%). But this is offset by a combination of other factors, principally the change in the shares of earned income of others, taxes and transfers. Changes in the Ginis of individual components of income and in the Gini correlations of the different components of disposable income generally exert downward pressure on inequality.

[10] Thus here we are looking at the *row* marked total for each period.

Table 8: Change in Gini Decomposition by Source of Income, 1987-1999

1987-1994	G_k	R_k	S_k	**Total**
Earned y, hoh	0.005	0.001	-0.022	**-0.016**
Earned y, others	-0.003	-0.01	-0.006	**-0.019**
Other y	-0.001	0.003	0.012	**0.014**
Transfers	0	-0.007	0.001	**-0.006**
Taxes	0.001	0.002	0.02	**0.023**
Total	**0.002**	**-0.011**	**0.005**	**-0.004**
Residual				**-0.001**
Change in G				**-0.005**

1987-1999	G_k	R_k	S_k	**Total**
Earned y, hoh	-0.006	-0.003	-0.034	**-0.043**
Earned y, others	-0.031	-0.01	0.042	**0.001**
Other y	-0.001	-0.005	0.009	**0.003**
Transfers	-0.002	-0.006	0.017	**0.009**
Taxes	0.006	-0.001	0.017	**0.022**
Total	**-0.034**	**-0.025**	**0.051**	**-0.008**
Residual				**0.007**
Change in G				**-0.001**

1994-1999	G_k	R_k	S_k	**Total**
Earned y, hoh	-0.01	-0.004	-0.013	**-0.027**
Earned y, others	-0.026	0.002	0.047	**0.023**
Other y	-0.001	-0.008	-0.001	**-0.01**
Transfers	-0.002	-0.001	0.017	**0.014**
Taxes	0.005	-0.003	-0.003	**-0.001**
Total	**-0.034**	**-0.014**	**0.047**	**-0.001**
Residual				**0.005**
Change in G				**0.004**

6. Discussion and Conclusion

This paper has examined the changes in inequality in Ireland over the 1987/88 to 1999/2000 period using both income and expenditure data from the Irish Household Budget Survey. In particular we have investigated the extent to which the rapid growth observed over the period was "pro-poor". We find that on average growth was not particularly pro or anti poor but that different parts of the income and (to a lesser extent) expenditure distribution had different experiences. In relative terms, between 1994 and 1999, those at the very lowest part of the income distribution (the

lowest 14%) fared less well than others. Those from about the 50th to the 70th percentile did best, but those at the very top fared no better than average. The overall gradient for expenditure was less pronounced with a gradual upward slope, arising from developments between 1994 and 1999.

One implication of these figures is that for the lowest decile, particularly over the 1994-1999 period, the growth in expenditure exceeded that in income, suggesting some form of dissaving going on, though the possibility of measurement error cannot be ruled out here, despite the trimming of the data.

While overall inequality indices for disposable income show little change over the period, it is still possible that individual components might show some movement. The decomposition of the Gini coefficient for disposable income in section 5 investigates this issue. The results show that the degree of change for individual components of disposable income was relatively limited. A fall in the share of disposable income arising from the earned income of the head of the household exerted downward pressure on inequality but this was offset by a host of other factors including changes in the Ginis and the Gini correlations of individual components of income.

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Fig 1: Transformed Lorenz Curves, 1987 & 1994

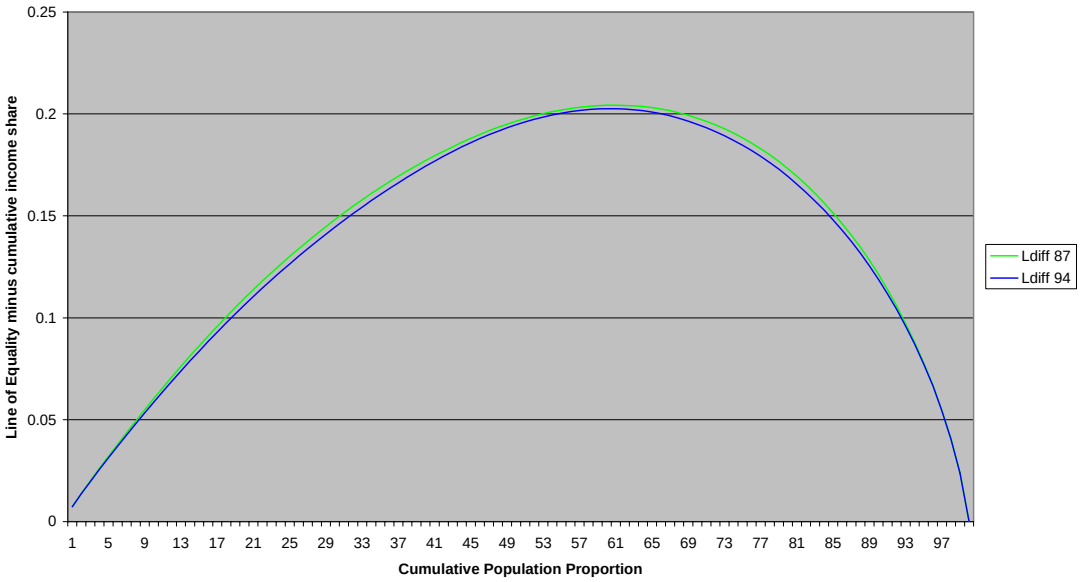

Fig 2: Transformed Lorenz Curves, 1994 & 1999

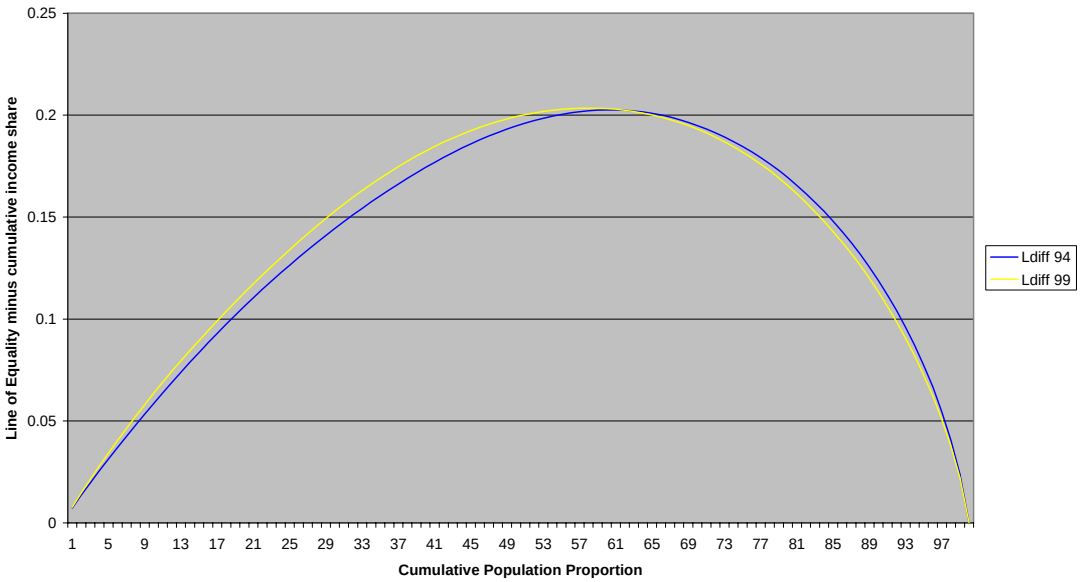

Fig 3: Transformed Lorenz Curves, 1987 & 1999, Income

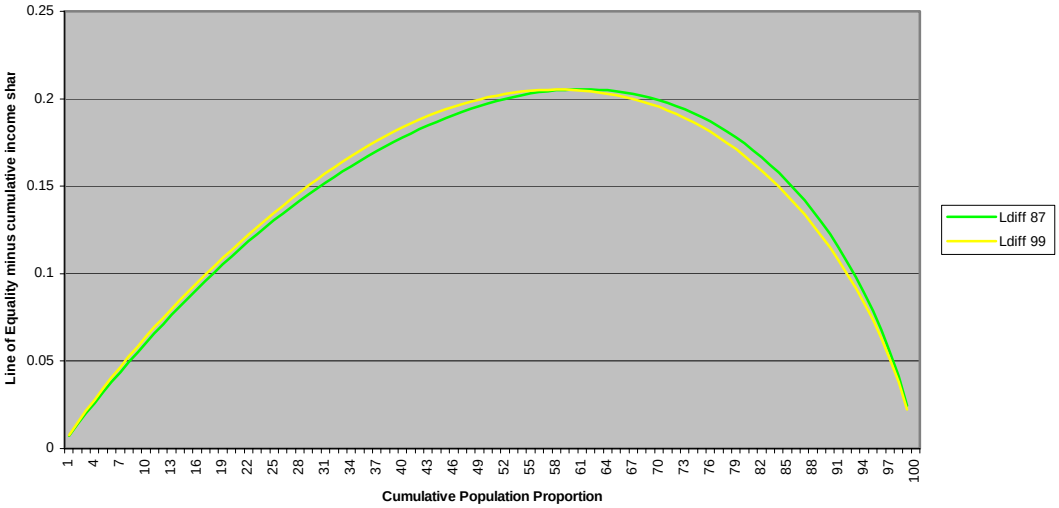

Fig 4: Transformed Lorenz Curves, 1987 & 1994, Exp

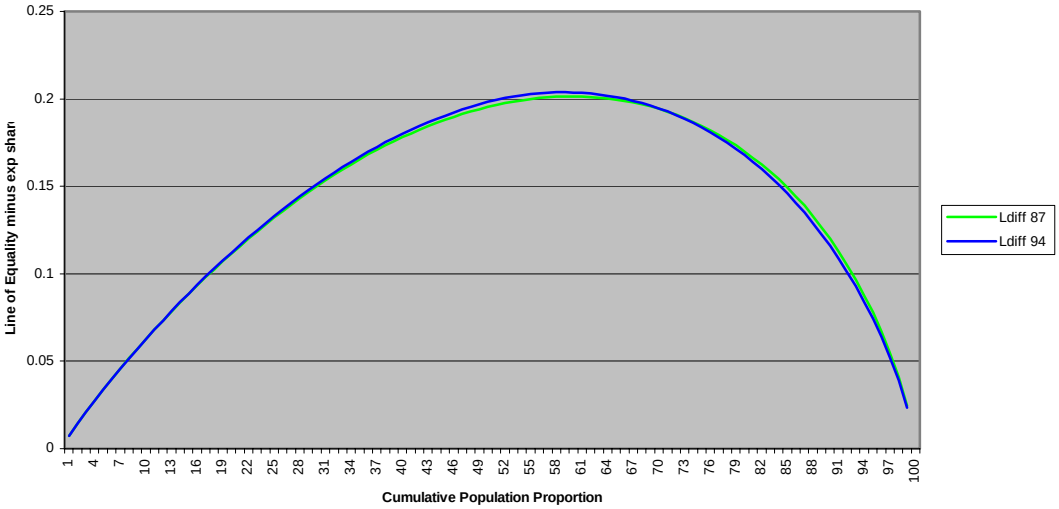

Fig 5: Transformed Lorenz Curves, 1994 & 1999, Exp

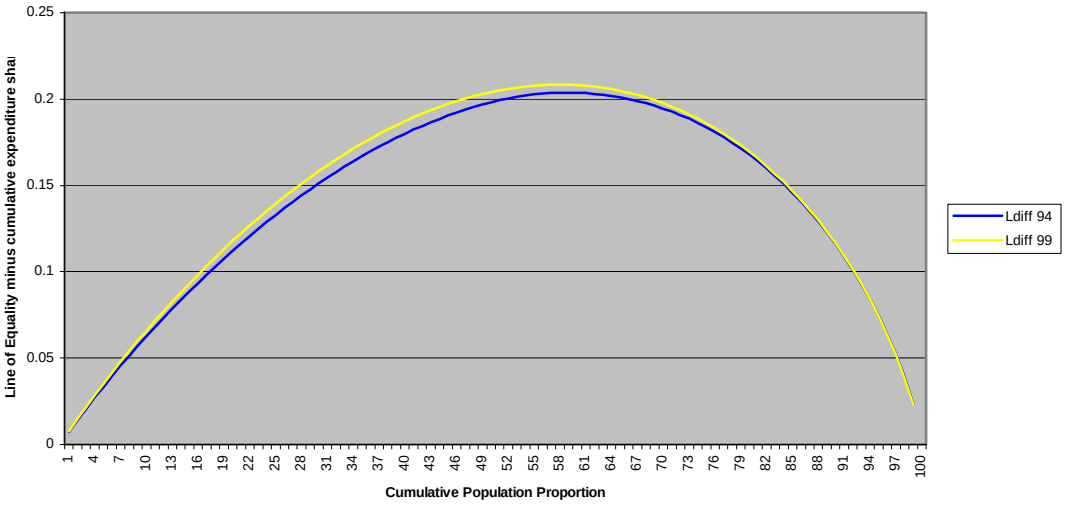

Fig 6: Transformed Lorenz Curves, 1987 & 1999, Exp

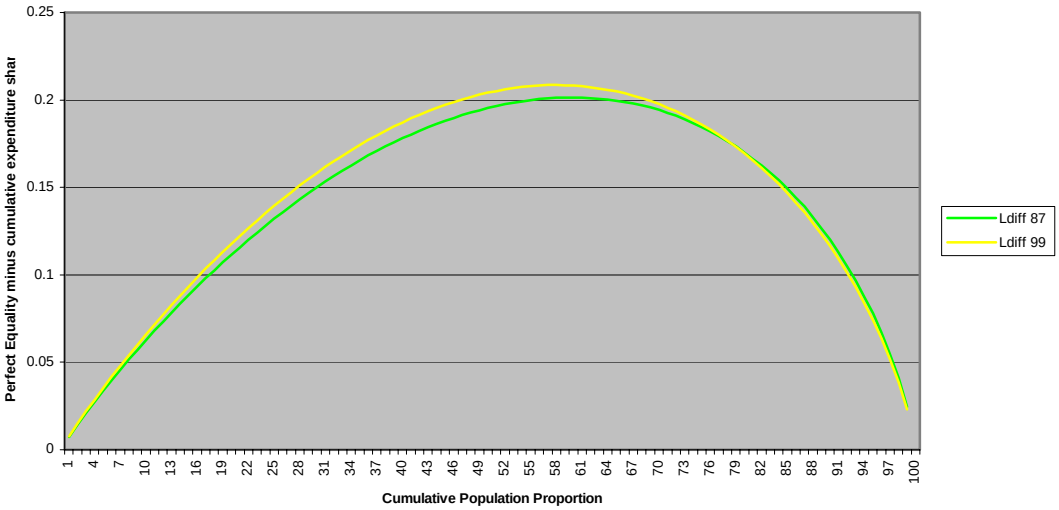

Fig. 7 GIC Curve Expenditure 1987-99

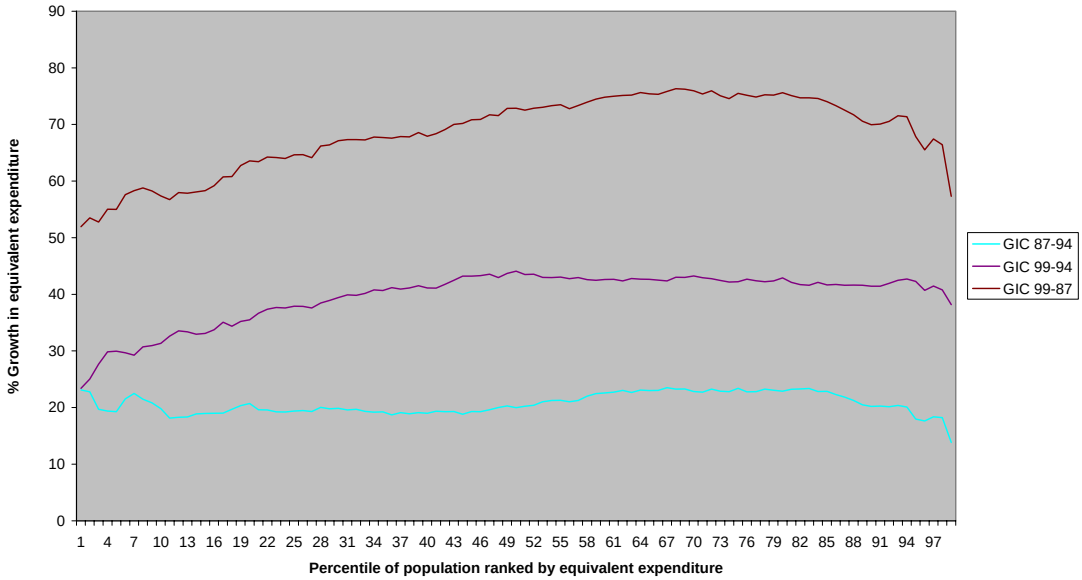

Fig 8: GIC Curve Income, 1987-99