Working Paper Series

Polarization, growth and social policy. The case of Israel, 1997 to 2008

Rosa María García-Fernández
Daniel Gottlieb
Federico Palacios-González

ECINEQ WP 2011 – 191

ECINEQ 2011-191
January 2011

www.ecineq.org

Polarization, growth and social policy. The case of Israel, 1997 to 2008*

Rosa María García-Fernández
University of Granada

Daniel Gottlieb
National Insurance Institute and Ben-Gurion University, Israel

Federico Palacios-González†
University of Granada

Abstract

In this paper we apply the methodology developed by García-Fernández and Palacios-González (2008,2009) based on multiresolution analysis, to the measurement of polarization to Israeli income data over the past decade. This methodology allows us, in contrast to other polarization measures, to detect sub-populations empirically as incomes concentrated around an optimal number of micropoles. Based on this procedure a polarization measure is developed, consisting of three components: an indicator of alienation and identification; the number of income classes and the distribution of the sizes of the groups. The proposed approach allows us to study polarization beyond mere income class membership, by including ethnic-cultural, individual, family and other demographic characteristics by means of a Probit analysis. The identification-alienation index fluctuated around two sub-periods - the first, showing an increase in identification-alienation from 2001 to 2004, coinciding with the harsh socio-economic policy during that period, and the second, showing a sharp decline, during the period of rapid economic growth (2005 to 2008). The increase in the size of the middle class - reducing polarization - and the decreasing number of classes - raising it - had offsetting effects on the overall index which has been relatively stable over the observation period. The Probit analysis reveals that belonging to the Haredi (Jewish Ultra-orthodox) community sharply raises their probability of belonging to the low income group. Being Arab yields a similar though less pronounced result. Furthermore, group-related characteristics of labor-force participation and small family size increase the chances of belonging to a higher income group.

Keywords: Polarization, poverty, multiresolution analysis.
JEL Classification: H54, I21, I3, J1, O15, O53.

---

* We thank Alexander Fruman and Maor Hod for technical help in preparing the empirical section. We are grateful for comments received from the participants of the Third ECINEQ Conference, held in Buenos Aires, 21st to 23rd of July, 2009 and the conference of the Israel Economic Association, June 2nd, 2010, Maale Hahamisha, Jerusalem, Israel.
† **Address of correspondence**: danielgt@nioi.gov.il.

1. INTRODUCTION

Among 19th century economists the question concerning the division of the income distribution into income classes was a natural one to ask. In recent years this issue has been rediscovered, with a growing number of scholars developing methodologies for the measurement of such polarity within society. While earlier approaches were somewhat richer in their identification of the underlying causes of polarization, relating it to the theory of value to land, capital and human resources, today the focus has shifted mainly to income polarization. However there may be important cultural forces, that cause minorities to become marginalized in a political process. The theoretical underpinnings of polarization have been analyzed by Foster and Wolfson (1992), Wolfson (1994), Esteban and Ray (1994) among others. An interesting question is to try to understand the forces that evoke the formation of income classes. Part of the renewed interest in the question of income distribution relates to globalization, which appears to be a powerful redistributing force within and between countries incomes.[2]

The Israeli economy is an interesting case for the study of polarization, due to the cultural heterogeneity of its population, its exposure to various macroeconomic and other shocks, as well as to its dynamic economic development. The economy experienced sharp economic fluctuations, from rapid growth to a severe recession, followed by a quick turnaround and a growth period of four and a half years, that was interrupted by the global crisis of 2008/9. During and immediately after the recession of 2002/3, two consecutive governments carried out a harsh social policy reform, cutting deeply into social security, especially on child benefits, unemployment eligibility and income support benefits, moderated by only a small scale pilot project of proactive labor market policy.[3] The largely export-led growth period thereafter was mainly concentrated in medium and hi-tech industries, thus benefiting mainly the high skilled labor force. Such an extreme development may be expected to have a destabilizing effect on social stability. Indeed, official poverty and inequality reports point to a severely deteriorating poverty and inequality. Nonetheless, we show that the values of the new measure proposed as well as those defined according to Esteban and Ray (1994) and Zhang and Kanbur (2001), fluctuated around a trend that can be considered horizontal.

[2] See Duro, 2005 or Burtless, 2007 or Seshanna and Decornez, 2003

[3] According to an OECD report on the Israeli labor market and social policy, (2010), Israeli budgets on active labor market policies (ALP) was about one tenth of a GDP percent compared to an average corresponding figure for OECD countries for 2006 of 0.6%.

Distinctly from measures, such as Foster and Wolfson (1992, 2009), Silber et al. (2007), which use the Gini coefficient, the suggested polarization indicator avoids social weighting but concentrates on the positive rather than normative aspect of polarization, such as the variance. Consequently, the alienation-identification component of our polarization index, rather than reflecting a welfare measure, it should be understood as a mirror of class society, giving an equal relative weight to each class, notwithstanding the ranking of the income of its members. This approach views polarization as a neutral phenomenon, differentiating it from the concept of social weighting which is an important feature of accepted poverty and inequality measures, such as the poverty indices of Sen, Foster, Greer and Thorbecke or the Gini-inequality index. To stress this conceptual difference, imagine a society in which poverty has been eradicated. The issue of polarization will still be relevant, focusing for example on the extremely rich and the resulting concentration of political power and threat to democracy.[4] In this case for example, the social weighting such as for example the squared income gap as that applied in typical FGT measures or the rank in the Gini index would be misleading since the richest (and possibly most harmful) observation would get the lowest weight. Thus, while the differential weighting is a necessary feature of typical welfare measures, the weighting, should not necessarily decrease with income such as in the Gini coefficient and in the FGT. We think that while being a crucial characteristic in poverty and inequality measures it is not helpful in the alienation-identification component of polarization.

The polarization index used here was developed by Palacios and García (2008,2010) and is applied to Israeli income survey data over the past decade. After the introduction the methodology for measuring polarization is presented in the second section. Empirical results are presented in the third section. After a description of the data and of relevant stylized facts about the Israeli economy we compare the various approaches to polarization by use of Israeli data on net equivalized income. In the fourth section we analyze the allocation of households to one of the three classes, as produced by the algorithms for each of the three years 2001, 2004 and 2007 by a probit analysis. The explanatory variables are personal and demographic characteristics, as well as variables reflecting socioeconomic policies of the period 2002-2004. We chose the years that best reflected the three periods: (1) before the restrictive policy of cuts in social benefits, (2) immediately after the policy and (3) after three consecutive years of economic growth. Conclusions are drawn in the last section.

[4] See for example Rubinstein, 2009, p. 186-189. In that section there is also a reference to a newspaper article on the problem of economic abundance by the same author in 2003.

2. STATISTICAL APPROACH

2.1 The model

To model the income distribution we are going to use a family of density functions based on multiresolution analysis (henceforth MRA) that provides an easy way to detect sub-populations (Palacios and Garcia, 2009). We focus on the MRA model because it is especially useful to study polarization since it allows us to identify, by its own method of estimation, those sub-populations whose incomes are concentrated around poles. As a consequence the number of poles can be established from the income distribution.

To define the MRA probability density function let us assume that the income distribution is built over a closed interval[5] $[a, b]$ which is partitioned at $m$regular segments. Let $\theta(x)$ be the box spline of degree three[6] (Mallat S., 1999) which is a density function symmetric with compact support $[-2,2]$ and with mean and variance equal to 0 and $1/3$ respectively.

For each $m \in \mathbb{Z}^+$ fixed, the following family of density functions is obtained:

$$\left\{ f_m(x) = \sum_{k=0}^{m} a_{mk}\theta_{mk}(x) \right\}_{m\in\mathbb{Z}^+} \quad (1)$$

where $a_{mk} > 0 \;\; \forall k = 0,1,\dots,m;\; \sum_{k=0}^{m} a_{mk} = 1,$.

$\theta_{mk}(x)$ is a density function given by

$$\theta_{mk}(x) = s\theta(s(x-a) - k)\; k = 0,\dots,m$$

where $s = m/(b-a)$ determines the level of resolution .

The MRA pdf is a flexible family of density functions that may be used to model a great variety of distributions, which can be asymmetric and multimodal. The *m*+1 points of the partition, over which the mix of distributions is defined, show the location of the population around different poles. In particular, each $\theta_{mk}(x)$ is an "atomic-scanner" density located at the

[5] In the applications [a,b] will be the sample range.

[6] It is a translation of 4 convolutions of $\mathbf{1}_{[0,1]}$ with itself. It is centered at $t = 0$. Its Fourier transformation is:

$$F_\varphi(\omega) = \left(\frac{\sin(\omega/2)}{\omega/2}\right)^4$$

micropole $x_k = a + \frac{k}{s}$. The coefficients a_k are interpreted as the share of population captured by the micropole $x_k = a + \frac{k}{s}$ and distributed around it in accordance with the pdf given by $\theta_{mk}(x)$. Several coefficients located together may generate, by a grouping effect, a unimodal distribution that is not necessarily symmetric, capturing a sub-population. This is the basis of the algorithm that we use to detect sub-populations in section 2.2 which breaks down the vector of coefficients into the sum of *q* sub-vectors defining the sub-populations. The sum of the components of each sub-vector is equal, in proportion, to the size of the respective sub-population.

The coefficients of the MRA pdf for the overall population are estimated by the maximum likelihood procedure for a given value of m using the EM algorithm (Hartley, 1958; Dempster et al., 1977; McLachlan and Krishman, 1997) and therefore they are consistent, asymptotic unbiased and asymptotic efficient. Different approximations of the theoretical distribution are performed by increasing the resolution level$m$. In accordance with the parsimony principle, the model with minimum $m$which is not rejected by the Kolmogorov-Smirnov test provides a good fit to the pdf and can be used to detect the modes and the subgroups in a population.

2.2 An Algorithm to detect sub-populations

As we pointed out in the previous section, the MRA pdf's capability for local analysis allows us to identify sub-populations. Given that the emergence of multiple modes reveals the existence of different sub-populations placed around these modes, we part from obtaining the modes of the estimated MRA pdf. After obtaining the modes we select those associated with homogeneous and significantly sized groups. For this a four steps algorithm is defined.

The first step of the algorithm involves estimating the modes of the density family which are denoted by $\hat{x}_j$, $j = 1,\ldots,q_0$.

The second step is to break down the estimated vector of coefficients, $\hat{a} = (\hat{a}_0, \hat{a}_1, \ldots, \hat{a}_m)$, into the sum of $q_0$vectors $\hat{a}_j = \left(\hat{a}_{0,j}, \hat{a}_{1,j}, \ldots, \hat{a}_{m,j}\right)$, $j = 1, \ldots, q_0$, such that $\hat{a} = \sum_{j=1}^{q_0} \hat{a}_j$ is verified.

Taking into consideration that $x_k = a + \frac{k}{s}$ is the micropole where $\theta_{mk}(x)$ is located, the coefficient $\hat{a}_k$ is broken down into the sum of $q_0$values according to the distance between the micropoles x_k, and the modes $\hat{x}_j$ using the expression

$$\hat{a}_{jk} = \hat{a}_k \frac{\left|x_k - \hat{x}_j\right|^{-p}}{\sum_{j=1}^{q_0}\left|x_k - \hat{x}_j\right|^{-p}} \ . \tag{2}$$

Parameter p regulates the importance of the distance between the mode $\hat{x}_j$ and the micropole x_k. For higher values of p the coefficients $\hat{a}_{jk}$decline quickly as the modes $\hat{x}_j$ move away from x_k. For smaller values of p the coefficients decrease slowly. A value of p is selected that makes the groups more homogeneous in term of symmetry, thus minimizing the quadratic distance

$$\sum_{j=1}^{q}\left(\mu_j(p) - \hat{x}_j\right)^2 \tag{3}$$

where $\mu_j(p)$ represents the expected value of the density defined by the vectors of coefficients $\hat{a}_j = \left(\hat{a}_{0,j}, \hat{a}_{1,j}, \dots, \hat{a}_{m,j}\right)$ obtained applying expression (2)

Observe that in the second step the population is divided into homogeneous income groups in terms of symmetry. The underlying idea is that the existence of different levels of income produces asymmetry in the distribution of income. Therefore, reducing this asymmetry, especially for lower incomes, produces more homogeneous income groups.

The third step is to reallocate the coefficients of the model into significant groups. For this, a threshold or critical size, β, is established. Since the sum of the coefficients of each vector, $\sum_{k=0}^{m}\hat{a}_{kj}$, is equal to the size of the sub-population defined by such vector, the sub-populations smaller than β , that is $\sum_{k=0}^{m}\hat{a}_{kj} \leq \beta$, are not labelled as significant groups. In other words, the modes around which sub-populations smaller than β are located are considered negligible, since their contribution to generating social conflict is minimal and they do not supply relevant information for evaluating income polarization. Observe that this step is consistent with the third feature of polarization of Esteban and Ray (1994, see section 2.3), which says that groups of insignificant size should carry little weight.

In the fourth step, the coefficients of the MRA pdf are reallocated into the $q$significant groups, repeating step 2.

This algorithm can be summarized as follows:

1. Estimate the modes of the MRA pdf.
2. Divide each estimated coefficient of the MRA pdf into q_0 vectors of coefficients using expressions (2) and (3).
3. Select the q significantly sized groups.

4. Reallocate the coefficients into the significant q groups, repeating step 2.

We remark that the coefficients, provided by the algorithm, define a MRA density, $f_{mj}(x)$, for each sub-population. For a given level of resolution, the original density $f_m(x)$ can be written as the following q-components mixture form

$$f_m(x) = \sum_{j=1}^{q} p_j \, f_{mj}(x)$$

where $p_1, \dots, p_q$ represent the mixing weights or the sizes of the sub-populations.

As in any other mixture of pdf once the model is generated, we can calculate conditional probabilities that one household with a certain level of income comes from a component of the mixture. These probabilities allow us to classify each household into income groups. In particular, we cluster data by assigning each household to the level of income to which it has the highest conditional probability of belonging (see McLachlan and Peel, 2000). In the empirical section of the paper we use the classification into income groups provided by the posterior probabilities to estimate an ordered probit model. In this way we can study the position of the households in the income distribution according to their socioeconomic characteristics.

2.3 Measurement of polarization

The notion of polarization was introduced by Wolfson (1994) and Esteban and Ray (1994) independently to explain distributional changes that are not explained by the standard measures of inequality. Following Esteban and Ray (1994) "polarization is viewed as the sum of antagonisms between individuals that belong to different groups. Antagonism is the joint result of inter-group alienation, combined with the sense of identification with the own group". According to the previous concept of polarization, they pointed out the following basic features that the polarization of a distribution of individual attributes must present:

1. There must be a high degree of homogeneity within each group.
2. There must be a high degree of heterogeneity across groups.
3. There must be a small number of significantly sized groups. Groups of insignificant size (e.g. isolated individuals) carry little weight.

Since the mid-nineties, several measures of polarization have been defined attending to different approaches [see among others, Esteban, Gradín and Ray (1999), Tsui and Wang (2000), D'Ambrosio (2001), Zhang and Kanbur (2001), Duclos et al (2004), and Silber et al (2007)]. The measure of polarization used in this paper is consistent with the notion of polarization provided by Esteban and Ray (1994) although introduces modifications to calculate identification and alienation (this measure is defined in detail in Palacios and Garcia, 2008,2010). This measure is developed considering three contributing polarization factors: the alienation and the identification felt by individuals, the number of significantly sized groups and the distribution of the size of the groups. To evaluate the effect that the listed factors have on polarization three indices are defined. The product of these indices provides the following normalized measure of polarization

$$PG = I_{ia} I_g I_m \in [0,1]$$

where

$$I_{ia} = \frac{V_B}{V} = 1 - \frac{V_W}{V}$$

$$I_{\mathrm{g}}(k) = \begin{cases} 0 & k = 1 \\ \dfrac{2}{k} & k = 2,3,\ldots \end{cases}$$

$$I_m = \begin{cases} \dfrac{1-2d}{(1+d)} & \text{for } k = 2 \\ \dfrac{3-2d}{3(1+d)} & \text{for } k = 3,4,\ldots \end{cases}.$$

V_B, V_W and V are the between groups variance, the intra-group variance and the total variance respectively, k is the number of groups and d is the Euclidean distance between the distribution of the size of the groups and the distribution of maximum polarization which is given by

$$p^H = \left(\frac{1}{2}, \quad \frac{1}{2}\right) \text{ for } k = 2 \text{ and } p^H = \left(\frac{1}{2}, \quad 0, \quad \ldots, 0, \quad \frac{1}{2}\right) \text{ for } k \geq 3.$$

The index I_{ia} complies with the first and second basic features of Esteban and Ray. We assume that identification is related to the similarity of the income within the group. An individual feels a sense of identification with the group to which he belongs when his income is closer to the average income of the group. In keeping with the second feature, we presume that alienation is linked to the distance among the mean incomes of the groups. Attending to the previous arguments we consider, on the one hand that a global measure of identification should be inversely proportional to the intra-group variance (V_W). On the other hand, a global measure of alienation felt by individuals that belong to the same group with respect to individuals belonging to the other groups should be proportional to the variance between groups(V_B). The ratio of the inter groups variance to the intra-group variance quantifies the contribution of identification- alienation to polarization. This ratio has been normalized using the decomposition property of the variance obtaining I_{ia}. The index I_g is related to feature 3 and is decreasing with the number of groups, in such a way that the higher the number of groups the smaller the contribution of this index to polarization. I_m captures the effect that the clustering of population around the extremes of the income distribution, or equivalently the influence of a diminishing middle class has on polarization. Movements of individuals from the middle to the bottom and the top of the income distribution will involve an increase of I_m and hence of polarization.The measure above described assumes that the population is bunched into income groups. In this paper, the number of groups and their sizes are obtained using the estimated coefficients of the MRA model and the algorithm described in section 2.2. For the data used, the estimated number of groups is equal to three (excepting the years 1997 and 2008 in which there are four and two groups). For this reason, we compare the proposed measure with the measures of Esteban and Ray (1994) and the Zhang and Kanbur (2001) which can be computed for any number of poles and are also obtained following an alienation and identification framework.

The measure of Esteban, and Ray (1994, henceforth ER) is given by the expression

$$ER = \sum_{i=1}^{n}\sum_{j=1}^{n} p_i^{1+\alpha} p_j \left|y_i - y_j\right| \quad 1 \le \alpha \le 1.6$$

where $\left|y_i - y_j\right|$ represents the alienation (distance) felt by individuals of income y_i and y_j. The share of population is given by p_i and p_i^{α} represents the sense of group identification of each of the p_i members of group *i* within their own group. The more people in the group which have the same income level the more sense of identification they feel. The parameter α falls into the interval $[1, 1.6]$ to be consistent with the set of axioms proposed by Esteban and Ray (1994).

Zhang and Kanbur (2001, henceforth ZK) provided an alternative approach to polarization based on the idea that polarization is generated by two tendencies. For k exogenously given groups, as income differences within group decrease, that is as the groups are more homogeneous internally, differences across groups are, magnified and polarization is higher. In a similar way, for given within group differences, the further apart are the means of the groups the higher the polarization. These authors quantified these tendencies by the ratio of the between groups inequality to the within group inequality, that is

$$ZK = \frac{between - group\ inequality}{within - group\ inequality}.$$

For the Theil index the above expression can be written as follows

$$ZK = \frac{T_B}{T_W} = \frac{\sum_{j=1}^{K} \frac{n_j}{N}\frac{\mu_j}{\mu} ln\left(\frac{\mu_j}{\mu}\right)}{\sum_{j=1}^{K} \frac{n_j}{N}\frac{\mu_j}{\mu} T_j}$$

where

$$T_j = \frac{1}{n_j}\sum\nolimits_{j=1}^{K} \frac{y_j}{\mu_j} ln\left(\frac{y_j}{\mu_j}\right)$$

K is the number of groups; N is the total population; n_j is the population of the jth group; μ is the total sample mean; μ_j is the mean of the jth group and y_j is the jth income.

The polarization measure used in this paper has the following advantages with the respect to those provided by of ER and ZK. PG is a normalized measure of polarization that takes values between 0 and 1 and can be interpreted as a percentage portraying the degree of polarization.

The expressions of Zhang and Kanbur (2001) and Esteban and Ray[7] (1994) are not normalized and consequently the results cannot be interpreted in terms of percentages. Indeed the results of both measures are difficult to interpret since there is not an established standard of measurement. For example it can be shown that the Zhang and Kanbur polarization measure increases systematically with the number of groups. The introduction of the I_g index in the PG measure compensates the effect that the increasing of the number of groups has on the intra-group variance and hence on polarization, thus correcting this drawback of the ZK measure.

Furthermore it is easy to see, that the Zhang and Kanbur measure tends to infinity when the within-group inequality tends to zero. However, this drawback of the index can be corrected by normalizing the measure, using the decomposition property of the Theil[8] index, as follows

$$ZKN = 1 - \frac{T_W}{T}$$

where $T = T_W + T_B$.

Observe that such a normalized Zhang and Kanbur measure resembles the alienation-identification index (I_{ia}). The main modification introduced by I_{ia}, concerns the way in which we compute identification and alienation. According to the concept of polarization, if there is a high degree of homogeneity within each group and a high degree of heterogeneity across groups, society is polarized. In other words polarization focuses on dispersion and for this reason we prefer to use the intra-group and the inter-groups variance instead of the intra-group and inter-group inequality to quantify the contribution of identification and alienation to polarization. Indeed, from a statistical point of view, the intra-group variance and the inter-groups variance are the most appropriate approaches to evaluate the homogeneity within a group and the heterogeneity across groups respectively, when the representative magnitude of each group is the mean of the variable of interest, in our case the mean income (see among others Fisher, 1958). Moreover the concept of polarization, on the contrary to the inequality indices, is not linked directly to welfare. For this reason we think that positive measures, as the variance, are more appropriate for the computation of alienation and identification.

[7] Although Esteban and Ray (1994) made an attempt of normalization of their measure, using log income and replacing the population weights by the population frequencies, it is easy to show that this measure can take values higher than one.

[8] The index of Theil can be broken down in a similar way as the variance. That is, the overall inequality is equal to the inter-groups inequality plus the intra-group inequality. This property is also verified by the Gini index if the groups do not overlap.

3. EMPIRICAL RESULTS

Israel's society is highly heterogeneous both culturally and also with respect to the standard of living of the various population groups. Heterogeneity is driven mainly by nationality with four fifth of the population being Jewish and one fifth Arab. A further strong force of heterogeneity exists within the Jewish population, in which there is a significant cultural divide between orthodox (henceforth Haredi) Jews, who account for about 11% of the Jews, and the others. Heterogeneity is driven mainly by Haredi preference to let the men concentrate on theological studies, rather than earning a living, leaving this task to the wives. This tendency is underlined by the de facto exemption of the young Haredi from army service. Marriage at an early age, large family size and low labor market participation create large (equivalized) income differences. Important cultural differences as well as differences in opportunities for the Arabs create a further possible source for polarization between Jews and Arabs. However, the Arab society is in a process of rapid change, such as for example a decline in family size.

A further source of polarization is government policy and the economic environment. The Israeli economy being a small and open economy has been subject to significant shocks during the observation period. These shocks may affect the various groups differently, for example, depending on their involvement in the labor market. During the second half of the 1990's the Israeli economy had become an increasingly open economy, not only due to its high and rising share of imports and - largely hi-tech oriented - exports, but also due to the increasingly liberal regime of international capital flows[9]. Economic vulnerability and polarization may have been enhanced by the Israeli-Arab conflict which brought about repeated outbursts of violence, thus exposing the Israeli economy to significant shocks. During the observation period such a shock occurred from the last quarter of 2001 to early 2003. Another cause of sharp changes in the income distribution could be the radical mix of macroeconomic and socio-economic policies during the years 2002 to 2004 and a previously started de facto liberal policy towards the influx of foreign workers, coupled with a policy of low compliance and enforcement of labor laws among employers of foreign workers.[10] This indeed caused a significant influx of foreign workers since 1993, affecting negatively the employment prospects of low skilled Israeli workers. A fiscal policy led by a tax reform which reduced income tax rates mainly for the well-to-do, and was coupled with severe cuts in social benefits - particularly in child benefits, income support of families whose head of household was in working age, and in the eligibility

[9] See Gottlieb and Blejer (2001).

[10] The government has undertaken several attempts over recent years to regulate foreign workers' influx but until now without much success (see for example Bank of Israel Annual Reports of recent years and Gottlieb, 2002).

criteria for unemployment. The main goal of these cuts in welfare budgets which occurred mainly between 2002 and 2004, was aimed at raising labor market participation of income support receivers and at reducing the budget deficit through a reduction in social expenditure, which in the past was characterized by a higher degree of solidarity.[11] The worldwide economic crisis of 2008/9 was not significantly felt in Israeli data until the last two months of the year of 2008, such that it is hardly felt in the data.[12] The Israeli income survey during the period of 1997 to 2008 thus presents a unique opportunity for studying polarization.

3.1 Description of the survey

The data is from the annual income surveys for the years 1997 to 2008, collected by the Israeli Central Bureau of Statistics (CBS).[13] The number of households surveyed each year varies between 12,946 and 14,636. The mean net equivalized income varied between 2,588 NIS and 4069 NIS per month and the corresponding median income varied between 2078 and 3483, which implies a real growth rate of that income by 2.3% p.a.

Table 1: Basic data[14]

Total population	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of households in sample	12,834	13,332	13,323	13,473	13,675	14,051	14,194	14,415	14,291	14,333	13,922	13,916
Mean income	2,577	2,758	3,128	3,250	3,359	3,387	3,409	3,504	3,715	3,971	4,143	4,222
Income Variance	22,601	25,086	32,608	41,703	33,442	36,505	42,905	31,050	46,394	47,829	39,612	40,344
Average number of school years*	12.3	12.4	12.6	12.4	12.6	12.7	12.7	12.8	12.9	13.0	13.1	13.2
Average family size	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Average number of earners in household	1.4	1.4	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3

3.2 Analysis and results

To model the equivalized net income distribution the MRA pdf given by (1) is used. The coefficients of the MRA model given by expression (1) are estimated by the maximum

[11] See National Insurance Institute, Annual Surveys, 2004 to 2008.
[12] See Annual Survey, 2008, National Insurance Institute, p. 15-18.
[13] The CBS began to topcode the highest incomes since 2006. In a first analysis the non-topcoded data which are not publicly available were analyzed by Daniel Gottlieb in the present framework, but eventually we concluded that the topcoding had no significant effect on the analysis.
[14] In order to be able to analyze polarization over time we had to exclude the Jerusalem Arabs from our data set, since they had not been surveyed in the years 2000 and 2001.This was necessary to ascertain a consistent, though incomplete measurement of polarization for Israel. Their population has been growing rapidly from somewhat more than 10% to nearly 20% of Israel's Arab population. They mostly belong to the poorest class of the income distribution, thus possibly biasing the overall results for polarization.

likelihood procedure using the EM algorithm (Hartley, 1958; Dempster et al., 1977; McLachlan and Krishman, 1997). Different approximations, to the theoretical distribution, are performed by increasing the resolution level m. Attending to the parsimony principle, the model with minimum m which is non-rejected by the test of Kolmogorov-Smirnov fits well to the pdf and will be used to apply the measure of polarization.

After estimating the MRA pdf, the number of groups and their location are obtained by applying the algorithm described in Section 2.

The results presented in table 2 reveal that the number of groups shrank during the observation period. In the first year the algorithm suggests that there were 4 groups.[15] In the following years up to 2007 the number of significant income groups was reduced to three and in 2008 the number of groups seems to have dropped further to only two groups. The estimated group sizes and mean incomes are given in Tables 2 and 3.

The lowest group, which includes the poor, reached a low point by year 2002 with a parallel increase in the size of the middle class. This development was abruptly changed, coinciding with the severe cuts in social security benefits, increasing again the size of the lower class at the expense of the middle class.

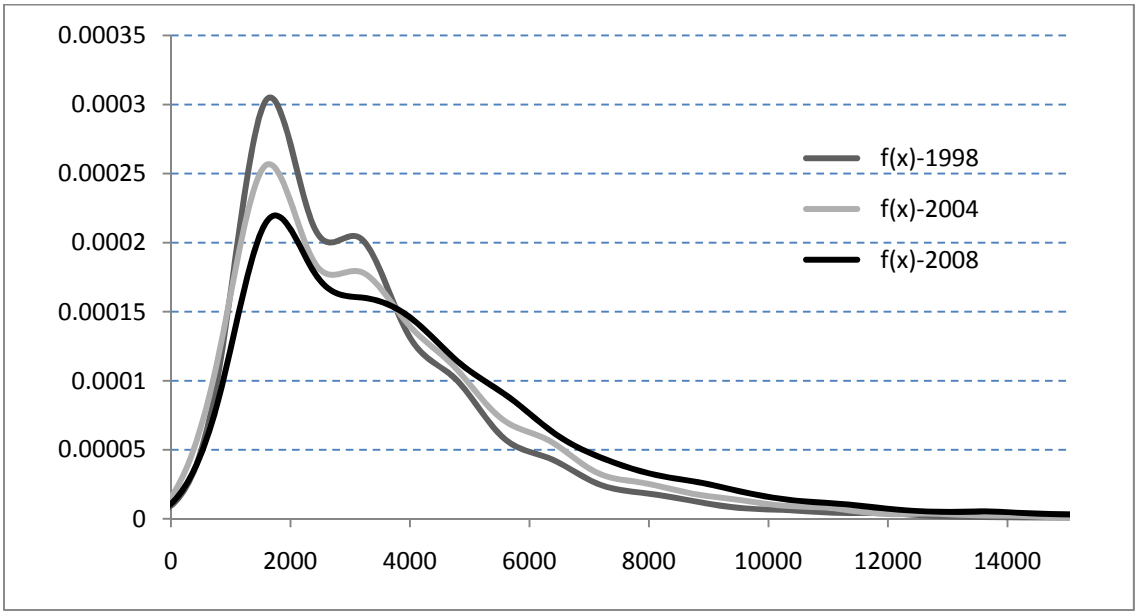
Table 2. Group sizes and means of net equivalized incomes by groups from 1997 to 2008

	Mean net equivalized incomes by groups						Relative sizes of groups (percent)					
	Poor	Middle	Poor and Middle	Upper Middle	Upper Middle and Rich	Rich	Poor	Middle	Poor and Middle	Upper Middle	Upper Middle and Rich	Rich
1997	1,181	2,124	2,768	4,044	4,824	9,266	25.2%	23.9%	92.4%	43.3%	51.0%	7.6%
1998	1,535	4,007	2,784	#N/A	#N/A	10,300	41.0%	53.8%	94.8%	#N/A	#N/A	5.2%
1999	1,571	3,981	2,632	#N/A	#N/A	9,925	43.1%	49.1%	92.2%	#N/A	#N/A	7.8%
2000	1,540	4,149	2,920	#N/A	#N/A	10,940	38.3%	56.2%	94.5%	#N/A	#N/A	5.5%
2001	1,635	4,243	2,872	#N/A	#N/A	10,565	40.1%	52.2%	92.3%	#N/A	#N/A	7.7%
2002	1,455	4,021	2,866	#N/A	#N/A	10,536	35.3%	58.5%	93.8%	#N/A	#N/A	6.2%
2003	1,463	4,245	3,030	#N/A	#N/A	11,850	37.6%	58.4%	96.0%	#N/A	#N/A	4.0%
2004	1,482	4,256	2,930	#N/A	#N/A	10,850	37.8%	55.7%	93.5%	#N/A	#N/A	6.5%
2005	1,590	4,686	3,242	#N/A	#N/A	13,496	40.9%	55.3%	96.2%	#N/A	#N/A	3.8%
2006	1,605	4,785	3,394	#N/A	#N/A	14,170	37.4%	58.4%	95.8%	#N/A	#N/A	4.2%
2007	1,650	4,560	3,106	#N/A	#N/A	11,744	36.6%	54.9%	91.4%	#N/A	#N/A	8.6%
2008	#N/A	#N/A	3,371	#N/A	11,218	11,218	#N/A	#N/A	88.8%	#N/A	11.2%	11.2%

[15] Possibly the sample of 1997, being the first to be united from its two sources of information – the employment survey and the consumer expenditure survey, was of lesser quality, concerning the net income variable, thus implying that the results from 1998 onwards are more consistent.

Figure 1 displays the overall probability density function of net incomes and reveals that over the three years compared – 1998, 2004, 2008 – the shape of the overall distribution underwent an important change: while in 1998 there were clearly two modes to the distribution, the second mode was flattened over time, and more or less disappeared in 2008.

Figure 1: The overall probability density function of the equivalized net income distribution



This may be observed also in figures 5-16 in appendix , in which the estimated MRA pdfs of the overall population as well as those for each group from 1997 to 2008.

Economic growth, as manifested in the average real annual growth rate of net equivalized median income was 2.3% and was probably a major force pushing the first group's pdf to the right. This can be seen by the gradual flattening over time of the initial bimodal overall distribution. Concurrently this flattening process was accompanied by an increase in dispersion as can be observed by the outward shift of the right hand side of the distribution, suggesting a movement within the middle class to its upper part. This development may well be linked to the increase in the return on education that occurred with the strengthened demand for knowledge in an increasingly globalized economy. Further possible causes are discussed in the section below on the probit equations.

Figure 2: The relative sizes of the groups

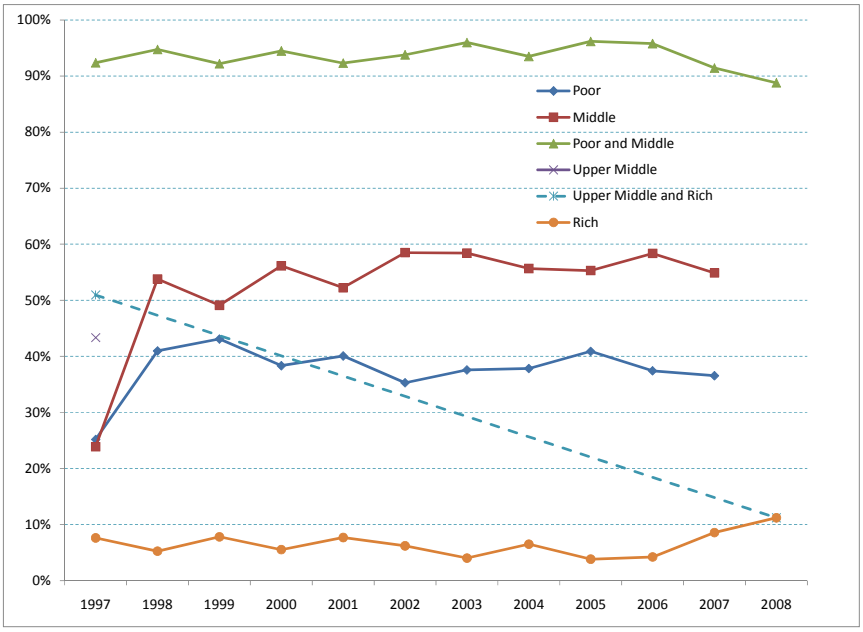
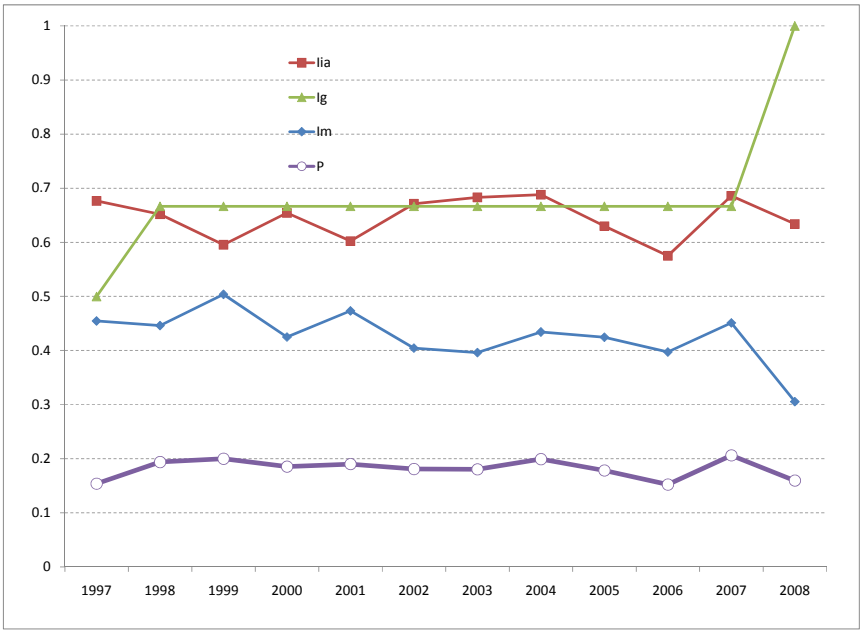


Figure 2 and the right hand side of table 2 show that during the tri-polar period (1998 to 2007) the middle class was the biggest, accounting for half to 60% of the population, and the lower class, which includes the poor, was around 40%. It shows a slight downward trend, diverted in the years 2002 to 2005 by the harsh social policy. In 2006 and 2007 the size of the lowest class began again to shrink. By 2008 the lower and middle classes converged into one, more dispersed class, which was smaller than the combined size of the two classes in the year before. The class of the rich fluctuated at around 3 to 10% until 2007. In 2008 the rich class was strengthened by an influx from the upper middle class and exceeded 11%. The polarization index is presented in Figure 3 and Table 3 (in the Appendix).

Figure 3 The PG-Polarization index and its components



The components or factors of the index reveal an interesting aspect of the proposed polarization measure:

I_{ia}: At the heart of any polarization measure is the measure of identification and alienation. This measure fluctuated around about 0.6 to 0.7. Two sub-periods can be distinguished - the first, showing an increase in identification-alienation from 2001 to 2004, a period which coincides with harsh socio-economic policy, that began in 2002 and culminated in 2004 and the second, showing a sharp decline in the period of rapid economic growth (2005 to 2007). Overall this component remained quite stable over time.

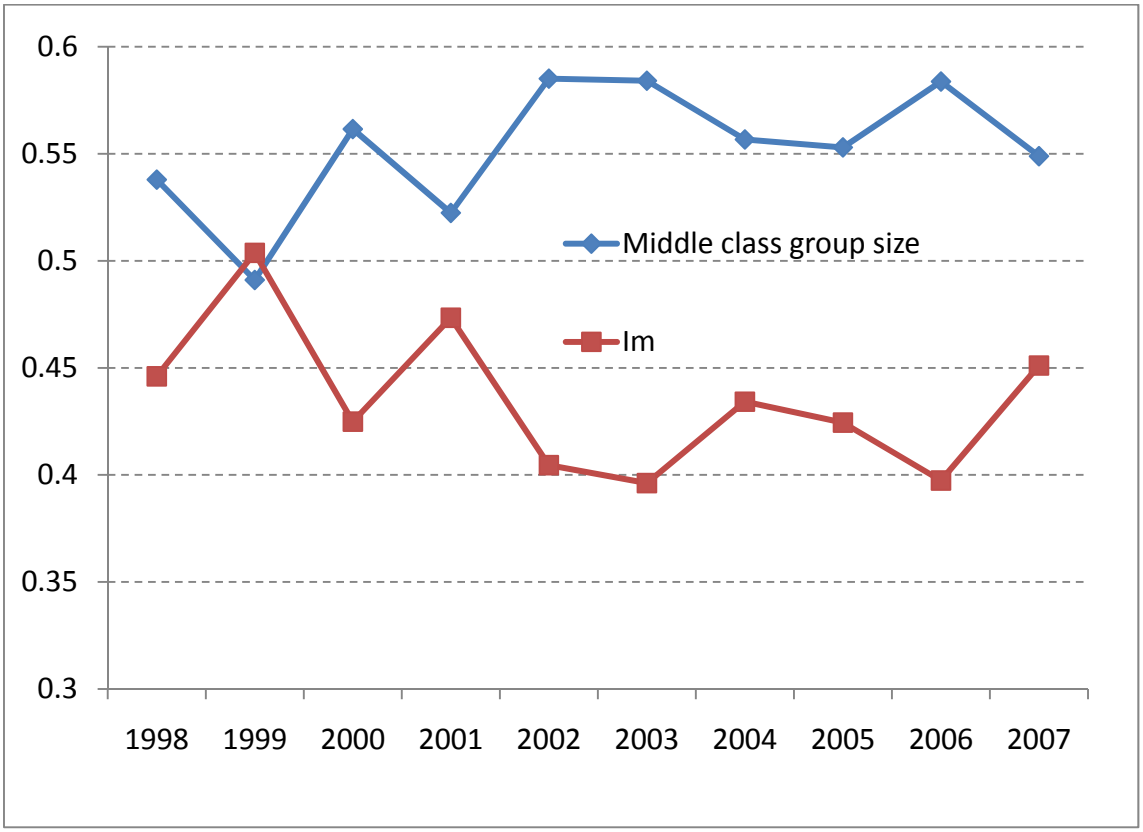
I_g: As explained above an increase in the number of groups tends to reduce polarization, though for a given variance this reduction is partly offset by the polarization-increasing effect of a fall in the within group variance.[16] This offset can be observed by the downward direction of the identification-alienation component in 2008.

I_mI: The size of the middle class has had an upward trend over time, thus implying a decrease in that component of the index, since the factorI_m behaves inversely to the size of the middle class (figure 4).

[16] For any given total variance the within variance must decrease since an increase in the number of groups squeezes the subgroup probability density functions.

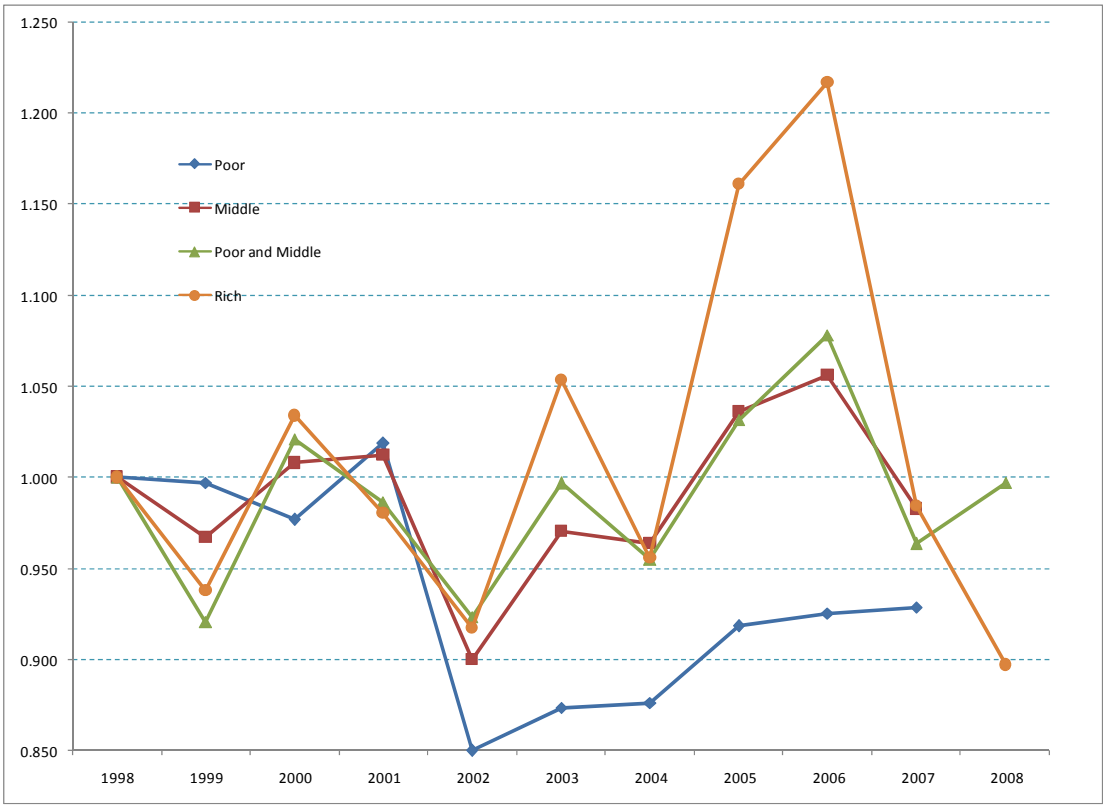
The overall polarization index has been relatively stable over the observation period, though in 3 out of the 4 last years the polarization index has been below its previous long term average.

Figure 4: The PG-polarization component of group size and the size of the middle class



It shows that during most of the observation period the polarization index according to PG was close to 0.2 and only in the years 1997 and 2006 and 2008 did it significantly drop below that level.

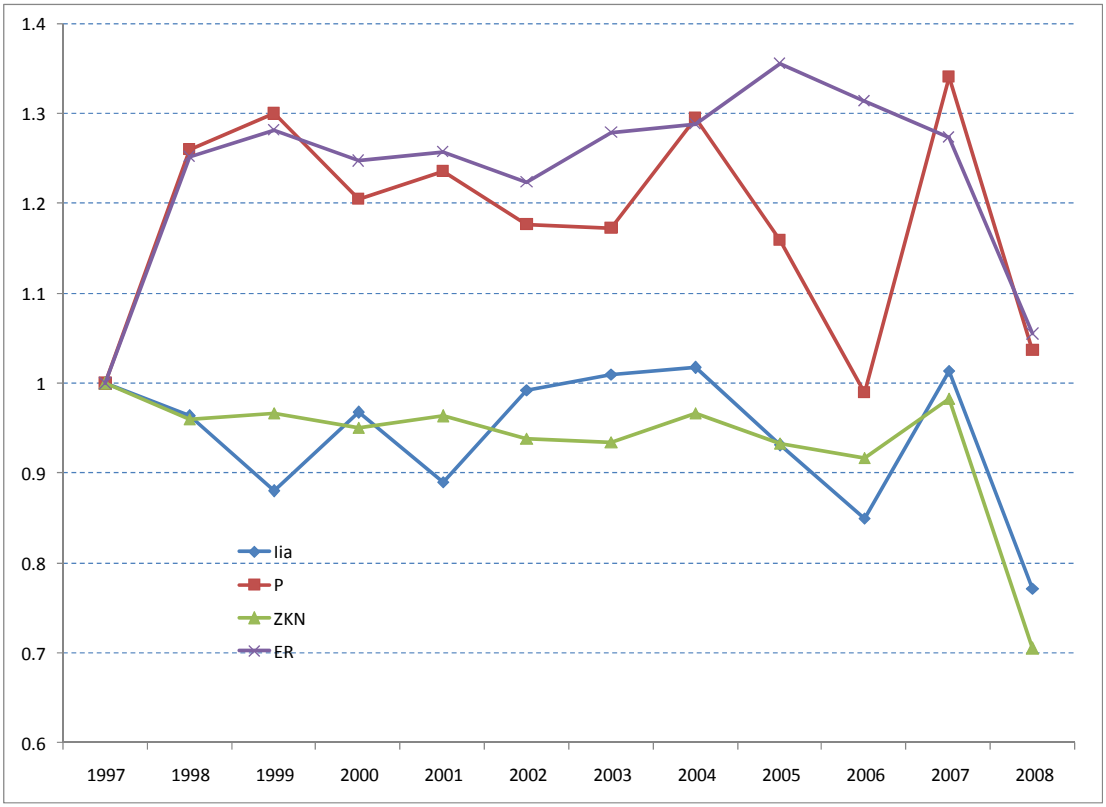
Figure 5: Average incomes of the classes resulting from PG



The development of the average income in each of the empirically determined classes reveals that the socio-economic facts are well captured by the polarization measure: The poor indeed experienced a sharp drop in incomes due to harsh social policies from 2001 to 2002 and 2003. In the following years economic growth and some pro-poor social policy actions improved incomes of the lowest class, but not enough to catch up with the level that had prevailed before the cuts. The drop of middle class incomes due to the cuts in social policy reduced their incomes by less and the ensuing growth period benefited their incomes more than those of the lower class. The income of the rich behaved similarly to that of the middle class but the swings are much more pronounced. The fall in incomes in 2008 of the rich is consistent with the merge of the upper middle class and the rich. Further research is needed to establish whether it reflects also the effect of the World economic crisis on Israeli assets.

3.2.1 A comparison of PG with other polarization measures

Figure 6: PG and other Tri-polarization measures



As can be seen from figure 6 and tables 3a and 3b (in the appendix) during the years from 2004 to 2008 the PG index behaved similarly to the normalized Zhang-Kanbur measure (ZKN), mainly due to the similarity of the Zhang-Kanbur measure with the identification-alienation component (I_{ia}). However the measure also moves along with the Esteban-Ray measure. Interestingly, all the measures considered show an improvement in polarization for 2008.

3.2.2 A probit analysis

In order to analyze demographic and other characteristics of belonging to a specific income class we ran an ordered probit analysis. From repeating the regression in three different years we conclude that the regression coefficients are robust and stable over time.

Table 4. Ordered Probit Model

Model: Ordered Probit	coefficient		
Year	1998	2004	2007
Arab	-0.56767	-0.73878	-0.81779
Haredi	-0.98888	-1.14368	-1.07102
New immigrant	-0.48266	-0.44	-0.44062
South	-0.1438	-0.15317	-0.24264
North	-0.16367	-0.14917	-0.13006
0-8 years of schooling	-0.90603	-0.7127	-0.7033
9-12 years of schooling	-0.46354	-0.4381	-0.46701
Age to 30	-1.48416	-1.43272	-1.52441
Age 31 to 45	-1.16579	-1.14349	-1.24917
Age 46 to Retirement	-0.88882	-0.8295	-0.99472
Earners-family size ratio	1.28222	1.32449	1.18196
Social benefits-net monetary income ratio	-2.01376	-1.91673	-2.29658
cut1	-1.86105	-1.85173	-2.0873
cut2	0.783539	0.771794	0.387234
Number of observations	13333	14415	13922
Missing observations dropped	66	82	46
data n=	13267	14333	13876
Mean dependent var	1.642798	1.686737	1.720236
S.D. dependent var	0.578408	0.587421	0.610536
Log-likelihood	-7550.59	-8342.43	-8454.07
Akaike criterion	15129.18	16712.86	16936.13
Schwarz criterion	15234.08	16818.84	17041.66
Hannan-Quinn	15164.2	16748.1	16971.28
Likelihood ratio test: Chi-square(12)	7553.06 [0.0000]	8293.24 [0.0000]	8277.19 [0.0000]
Number of cases 'correctly predicted' observations	10036 (75.6%)	10906 (76.1%)	10306 (74.3%)

The results of the probit analysis are reported in table 4. The regression shows that being Haredi (Jewish Ultra-orthodox) is associated with a highly negative coefficient, thus associating them to the low income group. The Haredi coefficient being the most negative, is consistent with the results known from the poverty analysis for Israel, according to which they belong to the poorest population groups.[17] This effect is further enhanced by the combination of the low participation in employment by Haredi men and the typically very large family size (see ratio of earners to family size).[18] Being Arab yields a similar though less pronounced result, the coefficient being somewhat less negative. The Arabs' income performance has been improving, especially since their average family size has been decreasing lately. For the

[17] See official poverty reports at www.btl.gov.il

[18] Distinctly from other poor groups, their low labor force participation rate as well as their high number of children reflect to some extent a self-conscious choice.

Bedouin there's an additional negative coefficient at work, the geographic coefficient for the south, thus making Bedouin Arabs from the south particularly vulnerable. As expected, risk is also negatively associated with age and exposure to welfare funds. On the other hand, labor force participation and small family size (as a ratio) increase the chances of belonging to a higher income group. The coefficient estimates are remarkably stable during the years 1998, 2004 and 2007.

4.CONCLUSIONS

An important question is whether to use a purely statistical measure built on the variance or a measure satisfying the transfer axiom and other axioms typically required in inequality and poverty analysis. We view polarization as a positive rather than normative measure, that should therefore remain unweighted. In a political economic context for example it is important to capture small classes of super rich people just as it is important to capture the poor. Increasing the weight of the poor such as by use of the Gini-index might obscure an increase in polarization due to an increase in the mean income of the super-rich, threatening democratic decision making through their impact on policy making to their advantage. We thus view it as an advantage that changes at the top and the bottom of the distribution are equally reflected by the alienation-identification component in the polarization index.

Another advantage of the present index is that it is able to capture changes in the size and mean incomes of the income groups, when they are statistically significant.

Furthermore the present index, being bounded between 0 and 1, makes it scale free and suitable for comparisons over time and space.

We found the Israeli economy to be a useful example for the analysis of polarization, given its sharp economic fluctuations during the observation period – from rapid growth to a severe recession in 2002/3 followed by a harsh and mostly permanent shift in social policy and back to renewed rapid growth during four and a half years thereafter. The analysis suggests that economic growth played a significant role in pushing the poorest group's pdf to the right as can be seen by the gradual flattening over time of the initial bimodal overall distribution. Concurrently this flattening process was accompanied by an increase in dispersion as can be observed by the outward shift of the right hand side of the distribution. This suggests that there has been a movement within the middle class to its upper part. Two opposing trends had offsetting effects on the polarization measure – the increase in the size of the middle class reducing polarization and the decreasing number of classes raising it.

The identification-alienation index, which is at the heart of any polarization measure, fluctuated around two distinct sub-periods - the first, showing an increase in identification-alienation from 2001 to 2004, which coincided with the harsh socio-economic policy, that began in 2002 and culminated in 2004, and the second, showing a sharp decline, during the period of rapid economic growth (2005 to 2008). The Probit analysis reveals that the conclusions from the polarization analysis can be importantly enriched by extending it beyond mere income class membership, to include ethnic-cultural demographic, family and individual characteristics. Belonging to the Haredi (Jewish Ultra-orthodox) community sharply raises their probability of belonging to the low income group, as expected from the poverty analysis for Israel. Being Arab yields a similar though less pronounced result. The Arabs' income performance has been improving, especially since their average family size has been decreasing lately. For the Bedouin there's an additional negative coefficient at work, the geographic coefficient for the south, thus making Bedouin Arabs from the south particularly vulnerable. As expected, risk is also negatively associated with age and exposure to welfare funds. On the other hand, labor force participation and small family size (as a ratio) increase the chances of belonging to a higher income group.

5. REFERENCES

Abu Bader S. and D. Gottlieb, 2009, "Poverty in the Bedouin Society", ECINEQ Working papers

Bank of Israel, Annual Reports, http://www.bankisrael.gov.il/publeng/publeslf.php?misg_id=12

Burtless G., 2007, "Globalization and Income Polarization in Rich Countries", Issues in Economic Policy, Brookings Institution, April, 1-36.

D'Ambrosio C. 2001, "Household characteristics and the distribution of income in Italy: an application of social distance measures", Review of Income and Wealth, 47(1), pp. 43-63.

Duro J. A., 2005, "Another look to income polarization across countries", Journal of Policy Modeling 27, 1001–1007.

Dempster, A., Laird, N., and Rubin, D. ,1977, "Maximum likelihood for incomplete data via the EM algorithm", Journal of the Royal Statistical Society, Series B, 39(1):1-38.

Duclos, J. Y., Esteban J.M., and Ray D. ,2004, "Polarization: Concepts, Measurement, Estimation" , Econometrica, 74 pp1337-1772.

Esteban J.M., and Ray D. ,1994, "On the Measurement of Polarization", Econometrica, 62 (4), pp. 819-851.

Esteban J.M., Gradín C. and Ray D., 1999, Extensions of a Measure of Polarization OCDE Countries, Luxembourg income Study, Working Paper, 218, New York.

Esteban J. M., 2002, Economic Polarization in the Mediterranean Basin. CREI, (10), Universitat Pompeu Fabra.

Fisher W. D. ,1958, " On Grouping for Maximum Homogeneity", Journal of the American Statistical Association, 53 (284), pp. 789-798.

Foster J.E. and M.C. Wolfson, 2009, "Polarization and the decline of the middle class: Canada and the U.S.". This paper appeared first in 1992, mimeo, Vanderbilt University.

Gottlieb, D. ,2000, *Globalization and World financial Turmoil - A Test for Israel's Economic Policy;* in: *Small Economies Adjustment to Global Tendencies (2000)*: pp. 213-244; or http://mpra.ub.uni-muenchen.de/3150/.

Gottlieb D., 2002, "The Effect of Migrant Workers on Employment, Real Wages and Inequality", The Case of Israel - 1995 to 2000", http://ideas.repec.org/p/pra/mprapa/3148.html.

Gottlieb D., 2007, "Poverty and Labor Market Behavior in the Ultra-Orthodox Population in Israel" (Hebrew), July, 1-56, www.vanleer.org.il/econsoc/pdf/1_research_mdiniut4.pdf

Gottlieb D. and L. Kushnir, 2009, "Social Policy Targeting and Binary Information Transfer between Surveys", Economics, The Open-Access, Open Assessment E-journal; http://www.economics-ejournal.org/economics/journalarticles/2009-28

Gottlieb D. and M. Blejer, 2001, "Liberalization in the Capital Account of the Balance of Payments," in "From Government Intervention to a Market Economy: The Israeli

Economy 1985-1998", in Memory of Michael Bruno" ed: Avi Ben-Bassat, English, MIT Press, 291 - 340.

Gradín C., 2000, "Polarization by sub-populations in Spain, 1973-91" , Review of Income and Wealth, 46 (4), pp. 457-474.

Hartley, H.,1958, "Maximun likelihood estimation form incomplete data", Biometrics, 14, pp.174-194.

Mallat, S.,1999, A Wavelet Tour of Signal Processing. Academic Press Cambridge.

McLachlan, G. and T. Krishnan, 1997, The EM algorithms and extensions. Wiley series in probability and statistics. Jonh Wiley &Sons.

McLachlan G and Peel D ,2000, Finite Mixture Models, New York, Wiley.

National Insurance Institute, 2004-2008, Annual Surveys, Jerusalem, Israel.

National Insurance Institute, 2008, Poverty and Social Gaps, Annual Report, November, Jerusalem, Israel, 1-54.

OECD, 2010, OECD Reviews of Labour Market and Social Policies, Israel, 1-288.

Shubhasree Seshanna, Stephane Decornez, 2003, "Income polarization and inequality across countries: an empirical study", Journal of Policy Modeling, January,25, 335-358.

Palacios-González, F, and García-Fernández R., 2009, "A multiresolution analysis of income polarization", European Journal of Economic and Social Systems, 119-142.

Palacios-González, F, and García-Fernández R., 2008, Polarization in a mixture of density functions. Paper presented in the Research Workshop of the Israel Science Foundation on Income Polarization: Measurement, Determinant, Implications.

Palacios-González, F, and García-Fernández R., 2010, An intra-group variance based polarization measure (under review).

Rubinstein, Ariel, 2009, *Economic Tales*, (in Hebrew), Kinneret, Zmora-Bitan, Dvir. See also

Tsui, K and Wang, Y. ,2000, Ordering and New Classes of Polarisation Indices, Journal of Public Economic Theory, 2 (3), pp. 349-363.

Silber, J., J. Deutsch, and M. Hanoka, (2007) .On the Link between the Concepts of Kurtosis and Bi-polarization. Economics Bulletin, Vol. 4, No. 36 pp. 1-5

Wolfson, M. C. 1994, When Inequalities Diverge?, American Economic Review, 84, pp.353-58.

Zhang X., Kanbur R. ,2001, " What difference Do Polarization Measures Make? An Application to China", The Journal of Development Studies, 3/37, 85-98.

APPENDIX

Figure 5. Global pdf and group pdfs for 1997

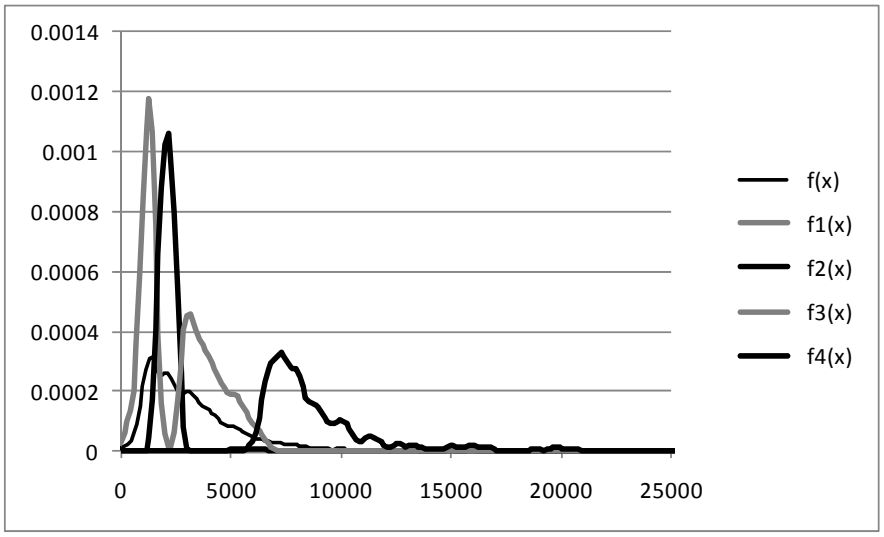


Figure 6. Global pdf and group pdfs for 1998

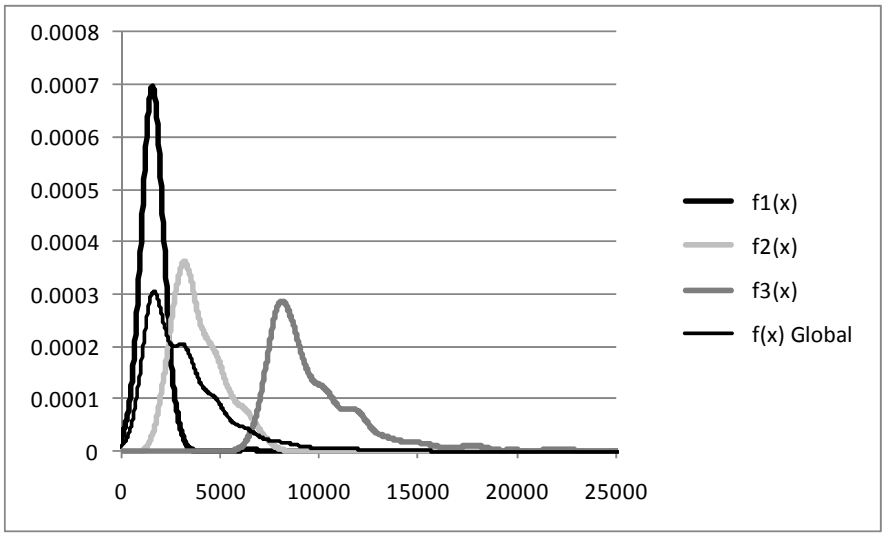


Figure 7. Global pdf and group pdfs for 1999

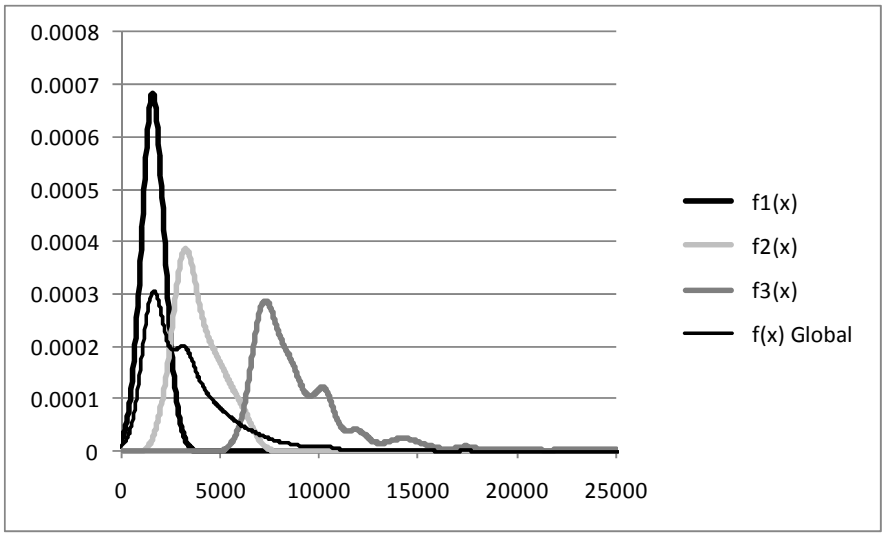


Figure 8. Global pdf and group pdfs for 2000

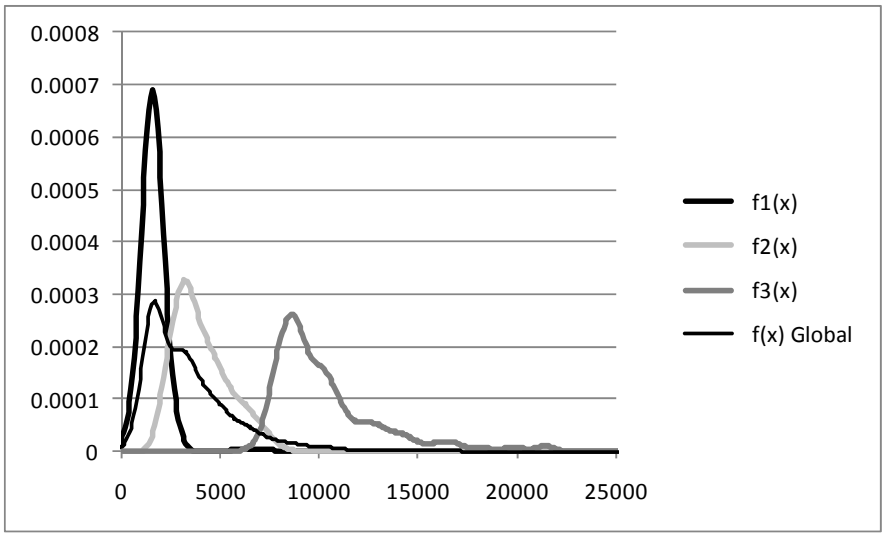


Figure 9. Global pdf and group pdfs for 2001

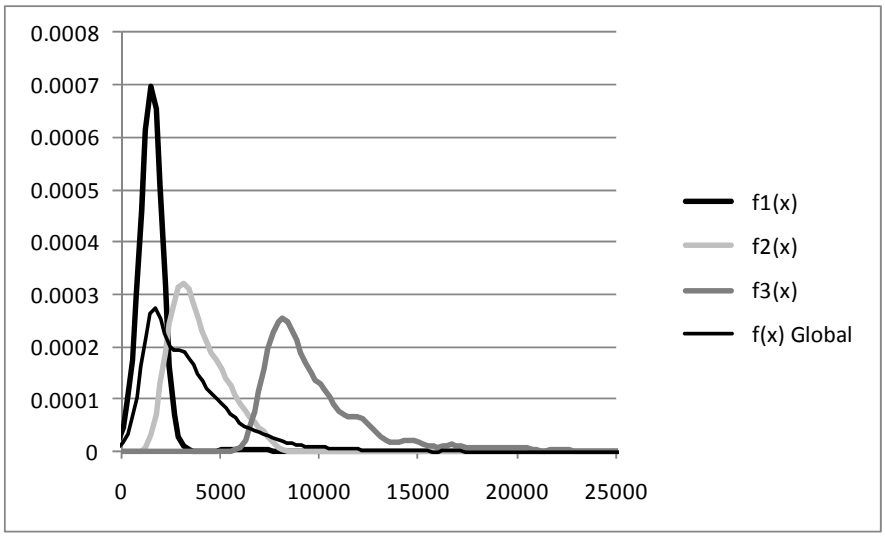


Figure 10. Global pdf and group pdfs for 2002

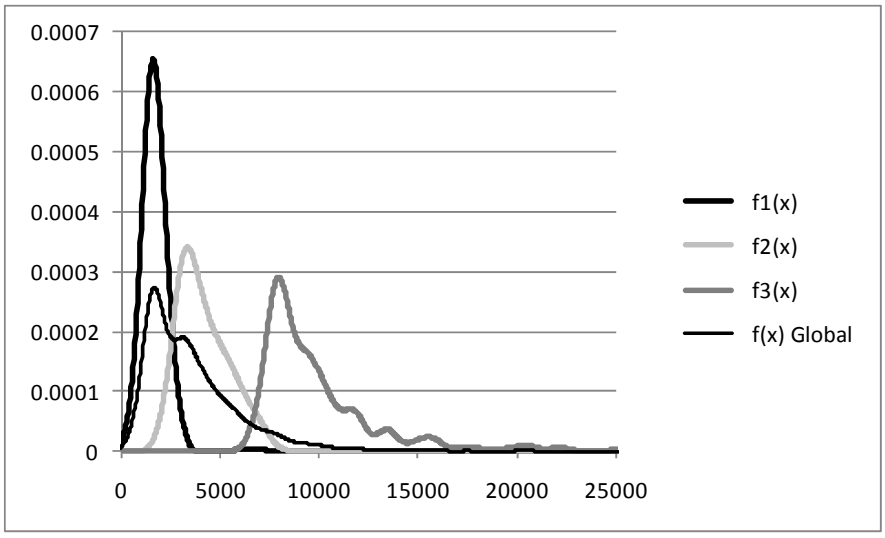


Figure 11. Global pdf and group pdfs for 2003

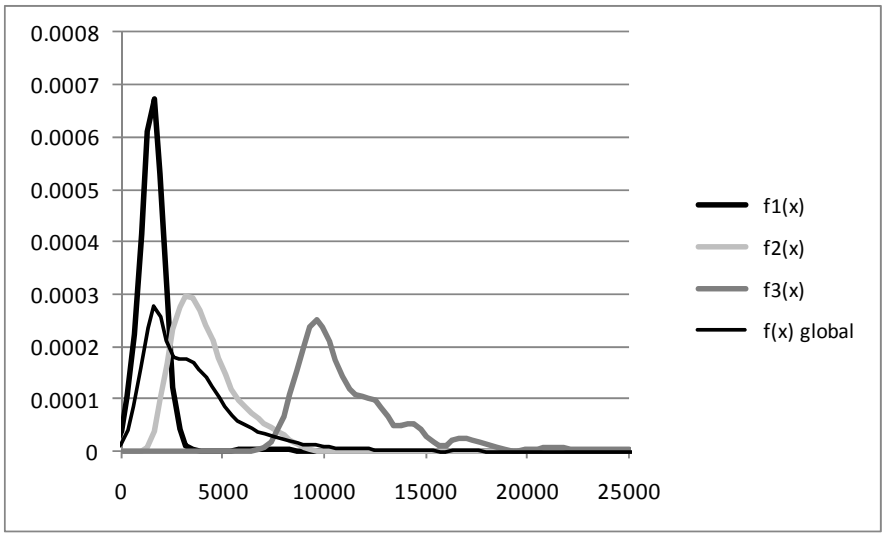


Figure 12. Global pdf and group pdfs for 2004

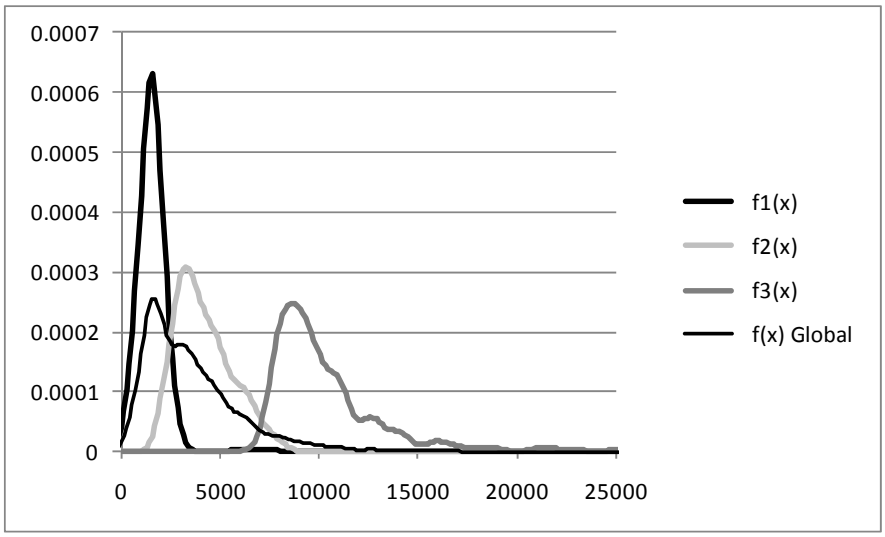


Figure 13. Global pdf and group pdfs for 2005

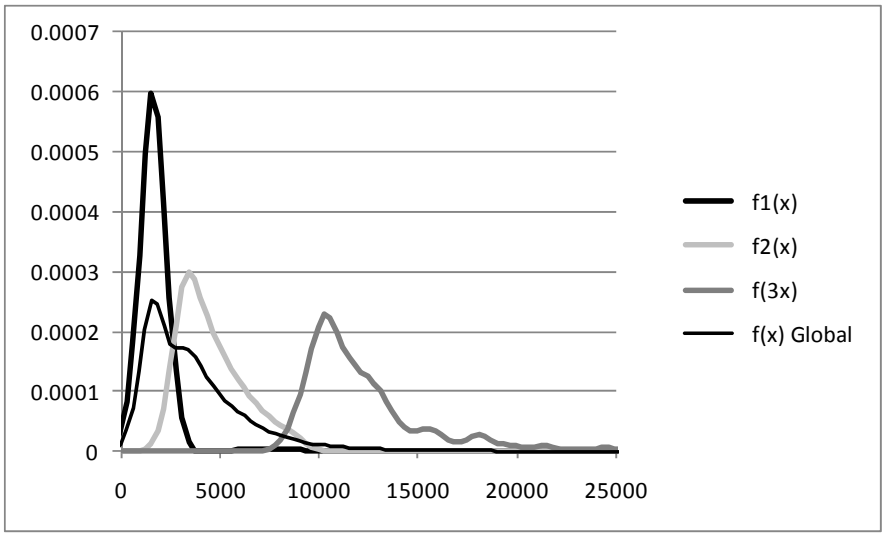


Figure 14. Global pdf and group pdfs for 2006

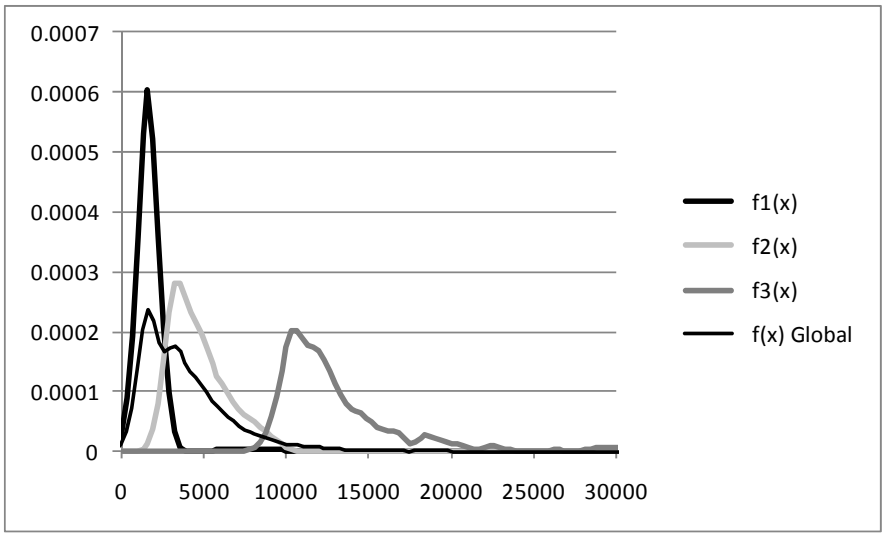


Figure 15. Global pdf and group pdfs for 2007

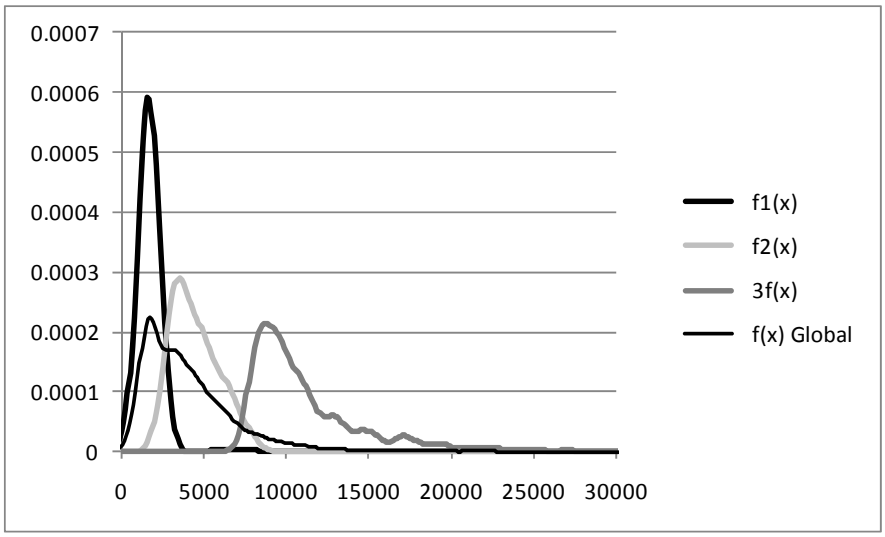


Figure 16. Global pdf and group pdfs for 2008

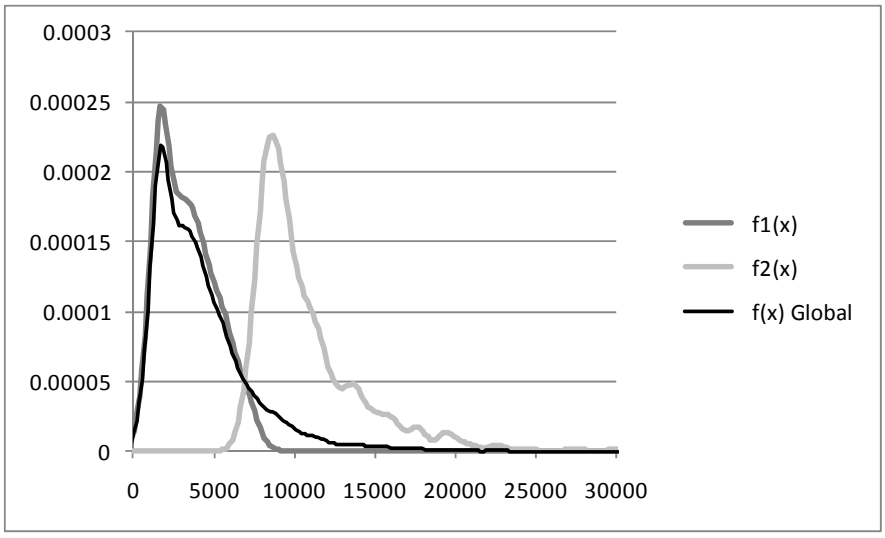


Table 3a: The PG-Polarization measure and other tri-polar measures

	Im	Iia	Ig	P	ZK	ZK normalized	ER	Theil index
1997	0.455	0.677	0.500	0.154	3.714	0.788	0.170	0.220
1998	0.446	0.652	0.667	0.194	3.107	0.757	0.213	0.210
1999	0.504	0.596	0.667	0.200	3.199	0.762	0.218	0.235
2000	0.425	0.655	0.667	0.185	2.983	0.749	0.212	0.218
2001	0.473	0.603	0.667	0.190	3.149	0.759	0.214	0.228
2002	0.405	0.671	0.667	0.181	2.834	0.739	0.208	0.219
2003	0.396	0.683	0.667	0.180	2.789	0.736	0.218	0.222
2004	0.434	0.688	0.667	0.199	3.203	0.762	0.219	0.232
2005	0.424	0.630	0.667	0.178	2.773	0.735	0.231	0.243
2006	0.397	0.575	0.667	0.152	2.604	0.723	0.224	0.248
2007	0.451	0.686	0.667	0.206	3.427	0.774	0.217	0.240
2008	0.306	0.552	1.00	0.160	1.250	0.555	0.179	0.242

Table 3b: An Index (1997=1) of the measures in table 3a

	Iia	P	ZK normalized	ER	Theil
1997	1	1	1	1	1.
1998	0.964	1.260	0.960	1.252	0.951
1999	0.880	1.300	0.967	1.282	1.064
2000	0.967	1.205	0.951	1.248	0.990
2001	0.891	1.236	0.963	1.257	1.032
2002	0.992	1.177	0.938	1.224	0.994
2003	1.010	1.173	0.934	1.279	1.009
2004	1.017	1.295	0.967	1.289	1.050
2005	0.931	1.159	0.933	1.356	1.104
2006	0.850	0.990	0.917	1.314	1.126
2007	1.014	1.341	0.983	1.274	1.088
2008	0.772	1.037	0.705	1.055	1.096