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Polarization, Growth and Social Policy in the Case of Israel, 1997–2008

*Rosa María García-Fernández, Daniel Gottlieb,
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Abstract

In this paper we study income polarization by first comparing the efficiency of two statistical models to identify the number of poles in the income distribution empirically. The statistical models used are a multi-resolution analysis (MRA) and a log-normal approach (LNA). We then apply the methodology to Israeli income data over the years 1997–2008 in order to empirically detect the number of income classes as sub-populations of incomes concentrated around an optimally determined number of poles. After that we compute polarization using a multiplicative normalized polarization measure, developed by Palacios-González and García-Fernández (An Intra-Group Variance Based Polarization Measure, 2010), which consists of three interacting components based on well-known axioms of Esteban and Ray (Extensions of a Measure of Polarization OCDE Countries, 1994). Finally we study the causes of the obtained polarization results in a multinomial logit analysis.

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Keywords Polarization; poverty; multiresolution analysis, income distribution

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1 Introduction

Our motivation is to study the partition of the income distribution into income classes. How many income classes exist and how are they best discovered? What affects income polarization? For that purpose we identify the number of poles in the income distribution empirically by use of two competing statistical models. Among 19th century economists the division of income classes in society was a natural issue. In the last two decades the interest in such questions has reappeared, following the contributions of Foster and Wolfson (1992, 2009), Wolfson (1994) and Esteban and Ray (1994). Societies are believed to consist typically of three classes—the poor, the middle class and the rich. However, empirically one may find that the number of classes may vary over time and space. In the recent literature the determination of the number of classes itself has been an issue of interest, especially due to the importance of the middle class in securing social stability. The possibility of the vanishing middle class¹ becomes thus an interesting empirical question.

We focus on detecting empirically the number and sizes of income classes as sub-populations of incomes concentrated around an optimal number of poles by allocating micro data of the Israeli income survey for each of the years 1997–2008 to the groups detected for each year. We proceed by calculating a polarization index as developed by Palacios-Gonzalez and García-Fernández (2008, 2010, henceforth PG). The index is based on (i) the axiomatic approach of the households' identification within and alienation between the estimated income groups, following Esteban and Ray (1994), (ii) their number and (iii) the size of each group. In general the lower identification and alienation and the higher the size of the middle class and the number of groups, the more stable will the income distribution in that society be.

We then identify the variables and characteristics affecting the allocation of households among the classes in a multinomial logit analysis. The Israeli economy is particularly interesting for the study of polarization, due to the cultural

¹ See a discussion of this phenomenon in Esteban and Ray (1994), Duncan et al. (1993), Horrigan and Haugen (1988), Kusters and Ross (1988), and Atkinson and Brandolini, 2011.

heterogeneity of its population, its exposure to various macroeconomic and other shocks, as well as due to its dynamic economic development. The economy experienced sharp economic fluctuations, from rapid growth to a severe recession, back to a growth period of four and a half years, that was interrupted by the global crisis of 2008/9. During the 1990s there was a large influx of temporary migrant workers, allowed to work only in low-skilled occupations, thus putting downward pressure on wages for low-skilled workers and crowding out of low-skilled local workers. This caused many of them to join social welfare. However that economic safety net was radically reduced in a harsh social policy reform during the recession of 2002/3, when cyclical developments would be expected to cause an increase in the number of social benefit receivers. This policy reform included a deep cut into the availability of social benefits to people in working age and their children (especially the size of child benefits and eligibility and size of benefits of unemployment and income support to the young and mid-aged, including a temporary freeze on the indexation of social benefits). This development was accompanied by a small scale pilot project of pro-active labor market policy.² The largely export-led growth period thereafter was mainly concentrated in medium and hi-tech industries, thus benefiting mostly the high-skilled labor force. As is well captured in the official poverty reports³ these forces had a detrimental effect on poverty incidence and particularly on poverty severity. The effect of these developments on polarization and social stability is part of the present analysis.

Distinctly from polarization measures, such as Foster and Wolfson (1992, 2009), Silber et al. (2007), which use the Gini coefficient, the polarization indicator suggested here avoids social weighting by concentrating on positive rather than normative aspects of polarization, such as the variance. Consequently, the alienation-identification component of the PG polarization index, rather than reflecting a welfare measure, should be understood as a mirror of class society, giving an equal relative weight to each class, notwithstanding the ranking of its member's incomes. As shown here this component has some resemblance to a normalized measure of Zhang and Kanbur (2001). This approach views

² According to an OECD (2010) report on the Israeli labor market and social policy, Israeli budgets on active labor market policies (ALP) was only about 0.1% of GDP compared to an average corresponding figure for OECD countries for 2006 of 0.6%.

³ See http://www.btl.gov.il/English%20Homepage/Publications/Poverty_Report/Pages/default.aspx

polarization as a neutral phenomenon, differentiating it from the concept of social weighting which is an important feature of social welfare functions such as the poverty-severity indices of Sen, Foster, Greer and Thorbecke (FGT) or the Gini-inequality index. In these measures the weight of the FGT measure or the rank of the Gini index give a lower weight to households in the social welfare functions the less poor or the richer the households are, respectively. Differently from the welfarist approach a very rich person may considerably threaten social stability through its influence on policy making. In other words, while being a crucial ingredient in poverty and inequality measures, the Pigou–Dalton transfer axiom should be irrelevant in the context of polarization⁴.

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 basic stylized facts about the Israeli economy we compare the various approaches to polarization by use of Israeli data on net equivalised income. In the third section we analyze the allocation of each household to its estimated class, as produced by the algorithms. A multinomial logit analysis is carried out for all relevant years in the sample. The explanatory variables for estimating the class to which the household belongs include personal and demographic characteristics, as well as socio-economic policy variables. Initially we chose the years that best reflected the period prior to the harsh social policy, the period immediately following the policy and thereafter the period of 3 to 4 years of rapid economic growth. We then estimated the same equations also for the remaining years in the sample in order to check the robustness of the coefficients.⁵ Conclusions are drawn in the last section.

2 Statistical Approach

The aim of using a specific statistical model in a polarization exercise is to allocate each household in the sample to its appropriate income class, such that the emerging classes will be more homogeneous in the households' net incomes than

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.

⁵ We thank an anonymous referee for suggesting this improvement.

in the overall distribution. The most frequently used statistical approach is to estimate a mixture of gamma, normal and log-normal distributions, referred to here as the traditional approach. Such an approach may be found in the work of Paap and van Dijk (1998), Pittau and Zelli (2006), Flaichare and Nuñez (2007), Chotikapanich and Griffiths (2008), Pittau et al. (2010), among others. Maximum homogeneity is achieved by having a maximum of unique allocations of households into income groups. Unfortunately, in such exercises statistical models typically provide overlapping results, in which one household has a positive probability to be allocated to more than one group. As is well accepted in the literature (see for instance Esteban and Ray, 1994 and Zhang and Kanbur, 2001), one of the most important characteristics of polarization is the alienation-identification property. Homogeneity-heterogeneity is the statistical interpretation of this property. One of our purposes in this paper is therefore to keep overlapping results to a minimum by choosing a statistical model that enables us to reduce overlapping results to a minimum, in order to provide subpopulations that are as homogeneous as possible and thus less disputable.

In this section we compare two estimations of unknown probability density functions of a given population. The first is a mixture of a log-normal distribution (LNA) and the second is a mixture of densities based on multi-resolution analysis (MRA). The empirical application of the two mixtures is carried out using Israeli income data for the year 2005⁶. The estimated parameters and coefficients of the mixtures of LNAs and of the MRA are given in Figure 1 and Tables 1a and 1b.

Figure 1 shows that in this sample the MRA mixture produces less overlap for each of the subgroups than the log-normal mixture. This has an important economic interpretation, since as mentioned earlier one of the major purposes of a polarization exercise is to allocate each household to a unique income-subgroup. However, in the zones of overlap such uniqueness is violated.⁷ In such cases it is

⁶ We use this year for the analysis because this is the first year in which the full effect of the harsh social policy carried out in the years 2002–2004 is fully reflected in the data, thus providing sufficient variance in the microeconomic information on homogeneity-heterogeneity and making it a good test case. Following an anonymous referee's comment we repeated this test also for the years 1998 and 2011. The results remained robust. They are available upon request from the authors.

⁷In fact this is the case for all households when the model is a mixture of normal, log-normal or gamma pdfs. Although based on an intuitive reasoning, in this paper we have truncated the tails of these distributions for the analysis of overlap and the creation of Table 2.

only possible to assign to these households probabilities of belonging to each of the groups. This is a result to be expected, since we show in Sections 2.1 and 2.2 the components of the MRA mixture are found by a process which optimizes homogeneity whereas the components of the log-normal mixture are a result of maximizing the likelihood function, without including any consideration about the homogeneity of the components.

As is demonstrated in Figure 1 the overlap of the log-normal mixture is particularly high in the third group of high incomes. As a matter of fact it is easy to see that in the LNA there is quite a large overlap between the poor and the rich, a result that is strongly counterintuitive. Furthermore the overlap of the rich and the middle class in the LNA model is almost complete and also highly unsatisfactory for the purpose of the polarization exercise. In contrast, there is no overlap at all

Figure 1. Components of the LNA (left panel) and MRA Mixtures (right panel)

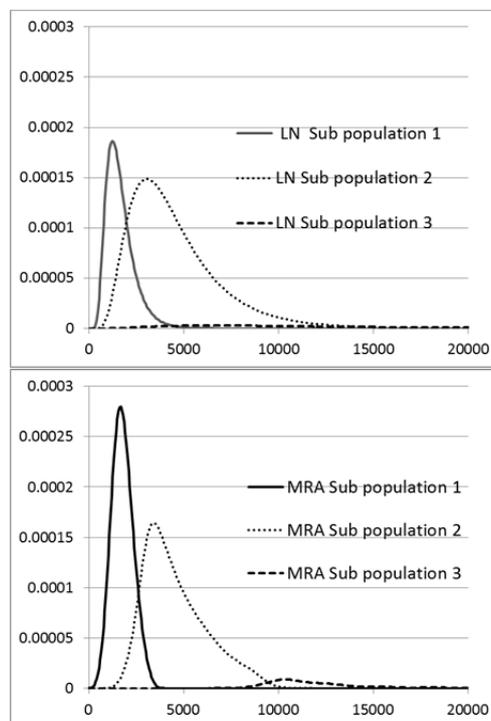


Table 1.a: Parameters of the Mixture of Log-Normal pdf

	Expected values	Expected standard deviation	Parameters of the log-normal mixture		
			$\hat{\mu}$	$\hat{\sigma}$	\hat{p}
Component 1	1658.11253	757.130889	7.31874368	0.43518162	0.27936849
Component 2	4579.03612	2546.53659	8.29450515	0.51911203	0.67728094
Component 3	5203.50434	17689.0709	7.29197697	1.59066692	0.04335057

Table 1.b: Estimation of the Mixture of MRA pdf

	Expected values	Expected standard deviation	\hat{p}
Component 1	1728.6713	2398.93129	0.41010639
Component 2	4599.11435	2553.50559	0.55083056
Component 3	13414.2513	10597.3815	0.03906305

between the poor and the rich in the MRA and the overlap between the rich and the middle class is confined to a relatively limited range of incomes. The considerable overlap between the poor and the middle class at the lower end of the middle class distribution may well reflect the phenomenon of blurred identification and alienation at the high end of the poor class and the lower tail of the middle class.

Overlapping tails have an important economic implication: in these income intervals people find it hard to identify with one or the other group. On the other hand, when overlaps are frequent also at the top end of incomes to which belong also the so-called “tycoons”, i.e., people who often have direct access to decision making in economic policy, one may suspect that they will particularly try to influence policies that affect economic welfare of the rich directly, then the relatively high risk of mis-specification between rich and poor as observed in the case of LNA is particularly disturbing. Since the number of households tends to decline strongly, the richer the households become, their group will typically be very small and hard to identify uniquely in a polarization exercise, while at the same time their economic importance increases. Therefore the homogeneity optimization, characteristic of the MRA procedure, has an inherent advantage,

since the relative efficiency of identification by the MRA seems to increase with the reduction in the size of groups.

Focusing on this problem of overlapping by giving the share out of total observations in the various groups we can see from Table 2 that the share of households allocated uniquely to the lowest class is about twice as big in MRA compared to the comparable group in LNA. The share of overlapping households in the middle and high classes is smaller in the MRA. Overall the share of overlapping allocations is 26.3% in the LNA and only 7.4% in the MRA, thus resulting in an overlap that is 3.6 times higher in LNA than in MRA. Put differently in LNA 73.7% of the households are uniquely allocated to any one class whereas in the MRA the share is 92.6%.

Table 2: Comparison of Overlapping Results in the Log-Normal and MRA Mixtures

Unique and overlapping areas of the components of the mixtures			
Log-normal mixture		MRA mixtures	
G1	0.17266	G1'	0.36767
G2	0.55630	G2'	0.51708
G3	0.00851	G3'	0.04147
G1G2	0.10095	G1'G2'	0.06775
G1G3	0.06379	G1'G3'	0
G2G3	0.03402	G2'G3'	0.00603
G1G2G3	0.06379	G1'G2'G3'	0
Total unique allocations	0.73746		0.92622
Total overlapping allocations	0.26254		0.07378
Total overlaps of LNA/MRA	3.6		

Given the widely accepted view that homogeneity or alienation-identification is a crucial feature of polarization, we may conclude that the MRA approach is

shown in this example to be superior to the traditional approach.⁸ Following this empirical evidence we prefer to use a family of density functions based on MRA as suggested in Palacios-González and García-Fernández (2009).

2.1 The Model

A mixture of MRA probability density functions, at the level of resolution j , is defined as follows

$$f_j(x) = \sum_{k \in S \subset Z}^m a_{jk} \lambda_{jk}(x) \quad (1)$$

where S is a finite subset of integer numbers, $a_k \geq 0 \forall k \in S$; $\sum a_k = 1$ and where $\lambda_{j,k}(x)$ is a pdf with compact support,⁹ $\left[\frac{k-2}{2^j}, \frac{k+2}{2^j}\right]$ that results from making the variable $y = 2^j x - k$ in the Cubic Box Spline $\theta(y)$ given by

$$\theta(x) = \begin{cases} p_1(2+x) & \text{if } -2 \leq x \leq -1 \\ p_2(2+x) & \text{if } -1 \leq x \leq 0 \\ p_2(2-x) & \text{if } 0 \leq x \leq 1 \\ p_1(2-x) & \text{if } 1 \leq x \leq 2 \end{cases}$$

where $p_1(x) = \frac{x^3}{6}$ and $p_2(x) = \frac{-x^3}{2} + 2x^2 - 2x + \frac{2}{3}$.

The mean and the variance of a MRA pdf are given by

$$E_{f_j}[X] = \frac{\mu}{2^j} \quad \text{and} \quad V_{f_j}[X] = \frac{\sigma^2 + 1/3}{2^{2j}}$$

where $\mu = \sum_{k \in Z} a_k k$ and $\sigma^2 = \sum_{k \in Z} a_k (k - \mu)^2$.

The coefficients of the mixture of MRA pdf given by (1) are estimated by the maximum likelihood procedure for a given value of j using the EM algorithm (Hartley 1958; Dempster et al. 1977; McLachlan and Krishnan 1997) and

⁸ We found these results to be robust for the years 1998 and 2011 (which is a more stringent “out of sample” test) since the overlap was again found to be considerably smaller for the MRA, especially for the rich group. These results are available upon request from the authors.

⁹ Note that $x_k = \left\{\frac{k}{2^j}\right\}_{k \in Z}$ is a regular grid of points over \mathfrak{R} equally spaced at distance $\frac{1}{2^j}$.

therefore they are consistent, asymptotically unbiased and asymptotically efficient. After estimating the population density for a given value of j we validate the model using the test of Kolmogorov–Smirnov (KS). If the fitted model is rejected by the test of KS, this is due to the insufficient flexibility of the model or because the level of resolution used is too low. Of all the resolution levels that provide valid estimations for population density, we use the lowest¹⁰ as explained in Palacios-González and García-Fernández (2013).

We refer to any mixture of MRA pdfs as a new MRA pdf. Furthermore it should be clear that any MRA pdf can be broken down in mixtures of MRA pdfs. The decomposition task can be made by multiple forms which allow us to obtain, from the infinite possible decompositions, an optimal decomposition according to the homogeneity of the groups around some selected modes. This is the principle on which is based the algorithm used to obtain the mixture whose components (or subpopulations) are more homogeneous.¹¹

As in any other mixture of pdf, once the MRA pdf model is generated, we can calculate conditional probabilities that a household with a certain level of income comes from a component of the mixture. These probabilities allow us to classify each household into a specific income group. In particular, we cluster data by assigning each household to the level of income to which it has the highest conditional probability of belonging.¹² In the empirical section of the paper we use the classification into income groups provided by the posterior probabilities to estimate a multinomial logit model. In this way we can study the position of the households in the income distribution according to their socioeconomic characteristics and due to policy as reflected in the explanatory policy variables.

2.2 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)

¹⁰ Note that the test of KS is used to validate the model and not for detecting sub-populations.

¹¹ See the algorithm 1 in Palacios-Gonzalez and García-Fernández (2012) for a detailed explanation of this process.

¹² See McLachlan and Peel (2000).

“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.¹³

Since the mid-nineties, several measures of polarization have been defined attending to different approaches [see among others, Esteban et al. (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 developed considering the three contributing polarization factors, suggested by Esteban and Ray (1994): the alienation and the identification felt by individuals, the number of significantly sized groups and the distribution of the size of the groups. The calculation of identification and alienation is somewhat modified (as explained in Palacios-González and García-Fernández 2010). To evaluate the effect that the listed factors have on polarization, three indices, I_{ia} , I_m and I_g , are defined. Since the values of the polarization components I_{ia} , I_m and I_g are defined over the interval $[0,1]$, their product provides a normalized and non-dimensional index of polarization, that is

$$PG = I_{ia}I_gI_m \in [0,1] \quad (2)$$

where

$$I_{ia} = \frac{v_B}{v} = 1 - \frac{v_W}{v}, \quad I_g(k) = \begin{cases} 0 & k = 1 \\ \frac{2}{k} & k = 2, 3, \dots \end{cases} \quad I_m = \begin{cases} \frac{1-2d}{(1+d)} & \text{for } k = 2 \\ \frac{3-2d}{3(1+d)} & \text{for } k = 3, 4, \dots \end{cases} .$$

¹³ Of course one may argue that the higher up in the income distribution one is positioned, the higher the importance of ever small groups become. In an extreme case, a single extremely rich person may exert more power on government decisions and distort democratic decisions than a larger group of people.

V_B, V_W and V are the between groups variance, the intra-group variance and the total variance, respectively. The intra group variance is given by

$$V_W = \frac{1}{n} \sum_{i=1}^k n_i \sigma_i^2$$

that is the average of the within group variances weighted by the group sizes. The expression

$$V_B = \frac{1}{n} \sum_{i=1}^k n_i (\mu_i - \mu)^2$$

is the between groups variance, that is the variance of the means of the groups.

The index k indicates 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 $d = \sum_{j=1}^k (p_j - p^H)^2$, where $p^H = (\frac{1}{2}, \frac{1}{2})$ for $k = 2$ and $p^H = (\frac{1}{2}, 0, \dots, 0, \frac{1}{2})$ for $k \geq 3$.

The index I_{ia} complies with the first and second basic features of Esteban and Ray. We assume that identification increases with 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 positively linked to the distance among the mean incomes of the groups. Attending to the previous arguments we consider, that a global measure of identification should be inversely proportional to the intra-group variance (V_W) and that a global measure of alienation felt by individuals belonging 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 the third feature and is decreasing with the number of groups, in such a way that the higher the number of groups, the smaller is the contribution of this index to polarization. I_m captures the effect of the clustering of population around the extremes of the income distribution, or equivalently the influence of a diminishing middle class on polarization.

Movements of individuals from the middle to the bottom and the top of the income distribution will thus involve a diminution of the middle class and an increase in I_m and hence in polarization.

The measure described above 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 referred to Section 2.1. For the data used, the estimated number of groups is equal to three (excepting the year 1997 in which there are four groups). For this reason, we compare the proposed measure with the measures of Esteban and Ray (1994) and 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

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

in which $|y_i - y_j|$ represents the alienation (distance) felt by individuals of incomes 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 sense of identification increases with the number of people in the group which have the same income level. 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 the 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 is polarization. These authors quantified these tendencies by the ratio of the between groups inequality to the within group inequality, that is

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

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

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

where

$$T_j = \frac{1}{n_j} \sum_{i=1}^{n_j} y_i \ln\left(\frac{y_i}{\mu_j}\right)$$

k is the number of groups; N is the total population; n_j is the population of the j^{th} group; μ is the total sample mean; μ_j is the mean of the j^{th} group and y_j is the j^{th} income.

Our polarization measure has the following advantages with respect to those provided by of ER and ZK. In contrast to ER and ZK, the PG is a normalized measure, taking values between 0 and 1. It can thus be interpreted as a percentage portraying the degree of polarization. The expressions of Zhang and Kanbur (2001) and Esteban and Ray¹⁴ (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 no 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 their measure, using the decomposition property of the Theil index¹⁵, as follows

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

¹⁴Although Esteban and Ray (1994) made an attempt of normalizing 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.

¹⁵The 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.

where $T = T_W + T_B$.

Observe that such a normalized Zhang and Kanbur measure resembles the alienation-identification index (I_{ia}) in PG. 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 the use of the intra-group and the inter-groups variance to that of the intra-group and inter-group inequality to quantify the contribution of identification and alienation to polarization.¹⁶ 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, such as the variance, are more appropriate for the computation of alienation and identification and consequently for polarization.

3 Empirical Results

Israel's society is highly heterogeneous both culturally and also with respect to the standards of living of the various population groups. Cultural heterogeneity is driven mainly by differences based on nationality, religion and religiosity: four-fifth of the population are Jewish and one-fifth Arab and within the Jewish population there is a significant cultural divide concerning religiosity between orthodox (henceforth Haredi) Jews, who account for about 10% of Israeli Jewish population¹⁷, and the rest. Heterogeneity is emphasized by Haredi preference to let

¹⁶As mentioned above, the negative effects of polarization may occur both at the bottom and the top of the distribution. Therefore the higher ranking of lower incomes, as for example in the Gini measure, may diminish the indicator's measurement of the damage caused by the concentration of excessive economic power at top incomes.

¹⁷ In order to identify Haredi Jews a question on religiosity is needed in the survey questions. Since the income survey does not include this information it is imported from the social survey by a special matching procedure designed by Gottlieb and Kushnir (2009).

the men concentrate on theological studies, rather than earning a living, leaving this task to the wives. This tendency is underlined by the exemption of young and mid-aged Haredi pursuing religious studies from army service. This together with their custom of getting married early and having many children lead to low labor market participation with the consequence of creating large (equivalised) income differences in favor of the non-orthodox Jewish majority. Important cultural differences as well as differences in opportunities and occupations for the Arabs create a further possible source for polarization between Jews and Arabs. However, in contrast to the Haredi society the Arab society has been in a process of rapid reduction in family size, thus reducing heterogeneity over time.

A further source of polarization stems from government policy and the economic environment. The Israeli economy being small and open has been subject to significant shocks during the observation period. These shocks may affect various population groups differently, for example, depending on their involvement in the labor market. During the second half of the 1990's with expanding globalization the Israeli economy had become increasingly open, not only due to its high and rising share of imports and—largely high-tech oriented—exports, but also due to the increasingly liberal regime of flows of international capital and of migrant workers.¹⁸ Economic vulnerability and polarization have been enhanced by the Israeli-Arab conflict which brought about repeated outbursts of violence, thus exposing the Israeli economy to politico-economic shocks. Such a shock occurred from the last quarter of 2001 to early 2003. Another cause of sharp changes in the income distribution was the harsh mix of macroeconomic and socio-economic policies implemented during the years 2002–2004 and a previously started de facto liberal policy towards the influx of migrant workers¹⁹, coupled with a policy of weak compliance and enforcement of labor laws among their employers.²⁰ This policy caused a significant influx of migrant workers²¹

¹⁸ See Gottlieb and Blejer (2001).

¹⁹ The migrant workers which started to flow into Israel from 1993 onward in reaction to the gradual closure of the borders for Palestinian workers, due to cycles of political violence, are not to be confounded with Jewish immigrant workers who have been entering Israel for many decades and particularly since 1990.

²⁰ The government has undertaken several attempts over recent years to regulate migrant workers' influx but until now without much success (see various Bank of Israel Annual Reports and Gottlieb, 2002).

since 1993, affecting negatively the employment prospects and salaries of low-skilled Israeli workers and thus possibly exacerbating polarization. A fiscal policy, led by a regressive tax reform (from 2006 onward) which reduced income tax rates mainly for the well-to-do, coupled with the above mentioned 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 criteria for unemployment, particularly towards young unemployed further emphasized the tendency of economic hardship for the low-skilled. The main goal of these cuts in welfare budgets 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.²² The worldwide economic crisis of 2008/9 was not significantly felt in the Israeli economy until the last two months of the year of 2008, such that it is hardly reflected in the observation period.²³ The above mentioned intense economic history of Israel thus presents a unique opportunity for studying polarization during the period of 1997–2008.

3.1 Description of the Survey

The data is from the annual income surveys for the years 1997–2008, carried out by the Israeli Central Bureau of Statistics (CBS)²⁴. The number of households surveyed each year varies between 12,815 and 15,000. The cash income data used in the analysis throughout the observation period are in constant 2006 prices. The mean net equivalised income varied between 2,577 NIS and 4,222 NIS per month, implying a real growth rate of that income by about 2.3% p.a.

²¹ Migrant workers, whose sole aim is to come to work in Israel are not to be confused with new immigrants, who immigrate to Israel by the law of return.

²² See National Insurance Institute, *Annual Surveys (2004–2008)*.

²³ See National Insurance Institute, *Annual Survey (2008, p. 15–18)*.

²⁴ The CBS began to top-code the highest incomes since 2006. At first we analysed the non-top-coded data in the present framework, but eventually concluded that the top-coding had no significant effect on the results derived from income surveys.

Table 3: Basic Data²⁵

Total population	Number of households in sample	Mean net equivalized income in sample	Standard deviation in sample	Average number of school years	Average family size	Average number of earners in household
1997	12,815	3,263	2,554	12.3	3.41	1.41
1998	13,266	3,324	2,512	12.4	3.36	1.37
1999	13,273	3,406	2,876	12.6	3.35	1.24
2000	13,424	3,523	2,697	12.4	3.33	1.25
2001	13,608	3,683	3,016	12.6	3.30	1.19
2002	13,955	3,519	2,647	12.7	3.31	1.18
2003	14,112	3,505	2,618	12.7	3.31	1.18
2004	14,337	3,634	2,788	12.8	3.30	1.20
2005	14,239	3,755	3,088	12.9	3.28	1.21
2006	14,282	3,989	3,452	13.0	3.28	1.24
2007	13,879	4,112	3,265	13.1	3.26	1.26
2008	13,854	4,139	3,285	13.2	3.26	1.27

In order to keep the data set consistent throughout the observation period the Jerusalem-Arabs were at first excluded from the data set for the main analysis. The reason for that was that the outbreak of political unrest (also called the “second Intifada”) late in the year 2000 triggered a low response rate of Jerusalem Arabs to the income survey of the years 2000 and 2001, upon which the Israeli Central Bureau of Statistics decided to exclude Jerusalem Arabs’ responses for these years from the published surveys. Over the years the Jerusalem-Arabs’ population has been growing rapidly from somewhat more than 10% at the beginning of the observation period to nearly 20% of Israel’s Arab population. Most of them belong

²⁵ The data are in real New Israeli Shekel (NIS in 2006 prices). The data in Table 3 are calculated from non-weighted household survey data.

to the lower classes of the income distribution. Their omission may thus seriously understate the overall outcomes for polarization. This issue became particularly pertinent for the analysis of polarization results for 2008. As demonstrated below, their inclusion suggests a reduction in the number of groups from three classes in 2007 to two classes in 2008, thus splitting the previous middle class into the lower (“poor”) and upper (“rich”) classes (see Appendix Figures A.20 and A.21). Such a phenomenon is sometimes referred to as the “vanishing middle class”. In the remaining analysis we therefore analyze the consistent data set for all the years from 1997 to 2008 excluding Jerusalem Arabs (Appendix Figures A.1–A.12). In Section 3.2.2 we analyze polarization outcomes for the case of including them (Appendix Figures A.13–A.21).

3.2 Analysis and Results

To model the equalised net income distribution the MRA pdf is used. The coefficients of the MRA model given by expression (1) are estimated by the maximum likelihood procedure using the EM algorithm (Hartley, 1958; Dempster et al., 1977; McLachlan and Krishnan, 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 1 described in Palacios-González and García-Fernández (2013).

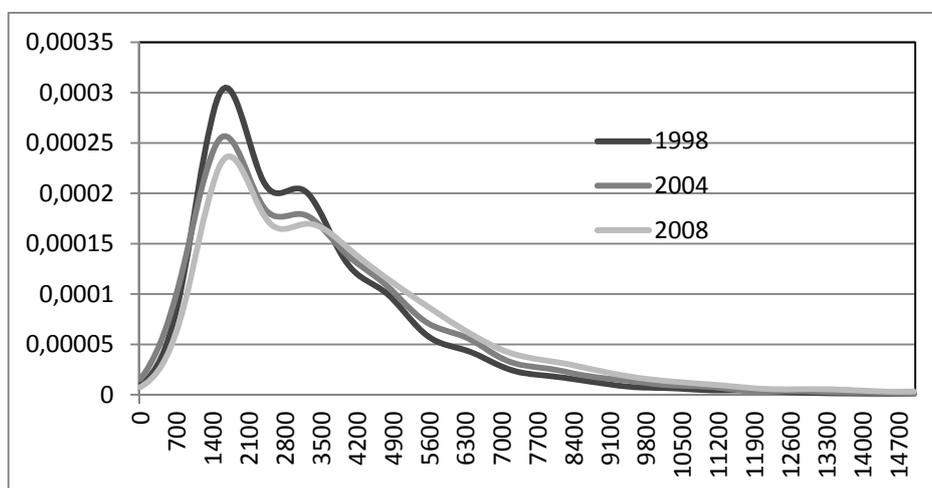
The results presented in Appendix Figures A.1–A.12 reveal that according to the algorithm the number of significant income groups shrank during the observation period from 4 groups in the first year (1997) to 3 groups in the following years.^{26,27}

²⁶ The changes that need to be made to the analysis due to the inclusion of Jerusalem Arabs into the sample turn out to be particularly relevant for the polarization analysis. We therefore added a section on this issue in Section 3.2.2 below.

²⁷ 1997 was the first year for which the Central Bureau of Statistics combined in the income survey information from two sources – the labor force survey and the household expenditure survey. Working with the yearly data one gets the impression that in year 1997 the household’s income was estimated by approximated *ex ante*

Figure 2 displays the overall probability density function of net incomes and reveals that over the three years compared²⁸—1998, 2004 and 2008—the shape of the overall distribution underwent important changes: while in 1998 there were two distinctive modes to the distribution, over time the second mode became more flattened. This flattening process was accompanied by an increase in dispersion as can be observed by an outward shift of the right hand side of the distribution, suggesting a movement within the middle class to its upper part. This (and our extended discussion in 3.2.2) reminds of a similar development for UK data, as reported in Jenkins (1995), reflecting the ‘shrinking middle class’ phenomenon of the income distribution during the 1980s.

Figure 2: Changes in the Overall Probability Density Function of the Equivalised Net Income Distribution over Time: 1998, 2004 and 2008



The estimated MRA pdfs in Appendix Figures A.1–A.12, given for the overall population and for each group from 1997 to 2008 reflect two major forces at work:

standardized income intervals, taking the middle point of the interval as the household’s income. This could be the reason for observing subpopulations in each of the income intervals. From this we conclude that the data for 1997 are less adequate for determining the number of groups, compared to the data for the following years. This year is therefore dropped in most of the empirical section.

²⁸ In response to a comment by an anonymous referee we found that the results were not sensitive to the choice of the years: the figure for the years 1998, 2004, 2005 and 2008 suggest a similar overall development.

(i) a harsh socio-economic policy carried out from 2002 to 2004, with an emphasis on 2003–2004; (ii) a sharp fluctuation in the per capita growth environment of GDP over the observation period of 1.7%, a negative growth rate (–1.9%) during the recession of 2001–2003 and renewed positive growth of 3.2% per capita over the years 2005–2008.²⁹ In these years Israeli per capita GDP growth performance exceeded that of the OECD countries by about 1.7% p.a. on average. In the context of polarization the average per capita growth rate differed for each income group. When splitting the changes into net household income by group, income actually declined during the recession for the lower and middle classes while it increased for the upper class. In the period of enhanced growth from 2005 to 2008, though while all three classes benefitted, the increase was high in the highest class, smaller in the middle class and hardly felt in the low class.³⁰

The polarization indicator as defined in equation (2) is presented in Figure 3 and in Table A.3. This indicator fluctuated considerably around a negative trend. This trend was disturbed in two instances: during the years of harsh social policy (2003/2004) and during the years of rapid growth of net equivalised p.c. income (2005–2008).

Let us focus on the components of the polarization index.

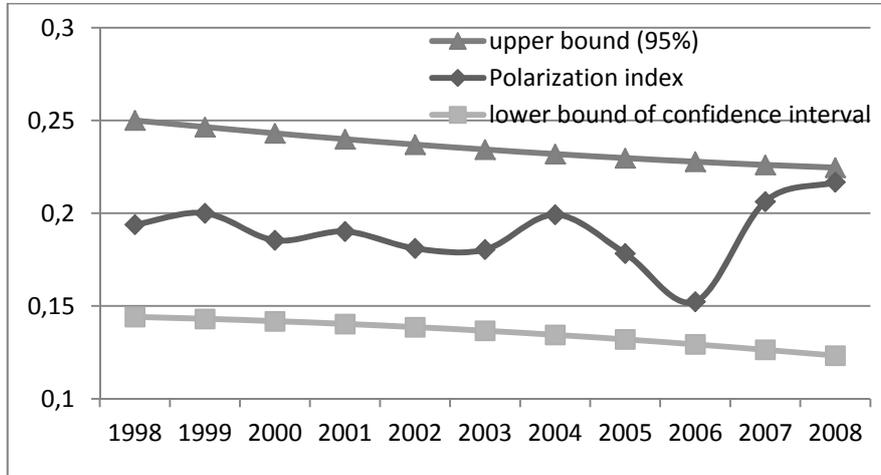
I_{ia} : At the heart of the polarization measure is the measure of identification and alienation. After some fluctuation it increased during 2001–2004, the period of harsh socio-economic policy³¹ (2002–2004), which coincided with a severe recession (late 2001–late 2003). This cut in social expenditure, during an economic downturn not only worsened the economic situation of the low and middle class but probably also deepened the downturn by suppressing the built-in-stabilizer inherent in a cyclical downturn. With growth picking up this effect was

²⁹ We neglect 2004 in the calculation of sub-period p.c. growth because it reflects a year of transition.

³⁰ These results can be calculated from Table A.1. The GDP p. c. calculations are based on data from the Israeli Central Bureau of Statistics.

³¹ Another interesting example of the effect of social policy on income polarization is analysed in Oliver et al. (2010).

Figure 3: The Polarization Index, Its Trend and the Confidence Intervals (95%) (excluding Jerusalem Arabs)



somewhat dampened at first (2004–2006), only to deteriorate again towards the end of the period (2007/8).³²

I_g : As explained above this indicator reflects the number of groups, raising polarization, when the number of groups is falling. The I_g factor compensates for the “squeezing effect” on the intra-group variance of the subgroup probability density functions, when introducing an additional class. This factor becomes important when the Jerusalem Arabs are included in the sample (see discussion below).

I_m : The size of the middle class increased throughout the years 1998–2006, with a temporary drop during the period of harsh socio-economic policy and again towards the end of the enhanced growth period (2007/8). These disturbances (see Table A.2) point at the underlying pressure of a ‘shrinking middle class’.

Comparing our polarization measure with other measures in the tri-polar case (1998–2008) shows a resemblance between our identification-alienation component (I_{ia}) and the normalized expression of the measure of ZK (henceforth ZKN in Table A.4). This obviously stems from the fact that both measures are based on the relationship between income homogeneity within the group and income heterogeneity between groups. Their focus on dispersion is nonetheless different since I_{ia} uses the variance to compute dispersion whereas ZK use concentration indices. The ER measure is different in nature, a fact reflected in Table A.4³³.

3.2.1 A Multinomial Logit Analysis

In order to analyze the effect of various variables on the probability of belonging to a specific income class we use a multinomial logit analysis of households’ group membership, explaining it by three types of variables: (i) demographic variables, such as belonging to a specific cultural group, (ii) characteristics of the household or its head, such as the head’s age group, his number of school years,

³² An econometric test of this hypothesis exceeds the scope of the present paper and will be taken up in future research.

³³ We exclude the important measure of Foster and Wolfson (1992) from our comparison, since it is a bi-polar measure and thus not strictly comparable.

the number of children and the share of employed adults in the household; (iii) a variable of socio-economic policy, measuring the degree of dependence on social benefits as the ratio of benefits out of the family's total income. The multinomial regression procedure includes two equations: The first assesses the probability of a household belonging to the low or the high income class; the second assesses the probability of belonging to the middle or the high income class. From that we derive the probability of belonging to the low rather than the middle class.

The overall robustness of the coefficients was tested by repeating the same regression for the years 1998–2008.³⁴ This period includes besides the harsh social policy in the early 2000's also a strong growth period from 2005 to 2008, during which the Israeli growth rate exceeded that of the OECD by 3% per year. The results are reported in Table 4. As can be judged from the values of the regression coefficients over time they remain stable and can thus be considered robust. In Table 5 we calculate odds-ratios for the major variables. They correspond with ex-ante expectations. Given the robustness of the results, we chose the year 1998 to represent the period preceding the harsh social-policy reform and 2004 as the first year in which the policy results dominated outcomes.

The analysis presented in Table 5 shows for example that being a young, relatively low-educated Haredi male is associated with a high odds ratio of being associated with the low-income group.³⁵ The chances of a Haredi (compared to a non-orthodox Jew) to be in the lowest income group rather than in the middle class are 9 times higher. His chances of being in the top class are almost zero. This effect is mitigated with an increased employment effort.³⁶ For Arabs the result is similar. As expected, low income risk is also negatively associated with age and

³⁴ We skipped that part for 1997 since for that year the data are less qualitative, as explained above.

³⁵ Though many Haredi men may enjoy high education it is typically of religious nature with little applicability in the job market.

³⁶ Distinctly from other poor groups, the Haredis' low labor force participation as well as the high number of children reflect to some extent a self-conscious choice.

Table 4. Multinomial Logit Model: Dependent Variable – Group Memberships

Model: Multinomial Logit		Coefficients										
Variable	Equation no.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Intercept	1	0.8933	0.6327	0.7400	0.0987	-0.2523	0.0050	-0.4412	0.5500	0.9458	0.5066	0.8182
	2	1.9113	1.5306	2.0327	1.2255	1.3067	1.5098	1.1304	1.7548	2.2132	1.7858	1.9604
Arab	1	2.3549	3.4269	2.4167	2.1263	3.0000	2.6111	2.3109	2.7990	2.6499	2.9157	3.6107
	2	1.0061	1.8633	0.8628	0.7385	1.3355	0.9653	0.6759	1.0168	0.7862	1.2253	1.7077
New immigrant, 2000+	1	3.0219	2.6936	2.3936	2.3400	2.4912	2.8261	2.6120	2.7617	2.3193	2.3232	2.0556
	2	2.1366	1.9774	1.6808	1.7357	1.7375	1.9915	1.7481	1.8186	1.5028	1.5166	1.3329
8 years of education	1	4.3554	3.4631	3.6848	3.5837	3.0057	3.5700	3.4644	3.7077	3.6440	3.8577	3.1754
	2	2.8824	1.9744	2.4010	2.2513	1.7900	2.3504	2.2772	2.4555	2.4974	2.7529	2.0288
9-12 years of education	1	2.0734	2.0395	2.0407	2.0550	2.0282	1.9176	1.9883	2.5197	2.2588	2.0300	2.0961
	2	1.2545	1.2521	1.2626	1.3173	1.2256	1.1758	1.2258	1.6938	1.5555	1.3641	1.3943
Age to 30	1	3.1276	3.1432	2.8103	2.7149	2.8953	3.4291	3.1649	2.9372	3.0928	3.0187	3.1423
	2	1.4797	1.3490	1.3213	1.3225	1.3996	1.8011	1.4793	1.3920	1.3435	1.2471	1.2043
Age 31–45	1	2.4628	2.1952	2.0524	2.3686	2.1412	2.8996	2.6222	2.1522	2.4560	2.3768	2.2627
	2	0.9573	0.6432	0.6639	1.0249	0.8536	1.4917	1.1409	0.7317	0.9283	0.8266	0.5699
Age 46 to pension age	1	0.8754	0.7590	0.6309	0.9204	0.6061	1.2150	0.8776	0.8362	0.6549	1.0150	0.8658
	2	0.1253***	-0.0292***	0.0586***	0.2005	0.1073***	0.5399	0.2616	0.1663***	-0.0799***	0.1727***	-0.0496***
Haredi	1	2.7582	3.0575	3.5344	3.4941	3.6606	3.8206	3.2896	2.7680	3.7603	3.6475	3.3314
	2	1.031*	1.2566*	1.4053**	1.4844*	1.846*	2.0914*	1.1475*	0.6664***	1.5557*	1.5811	1.1200
Family size¹	1	1.3192	1.4927	1.5231	1.3852	1.4318	1.6135	1.6184	1.7976	1.7079	1.5522	1.4067
	2	0.9898	1.0532	1.1019	0.9029	1.0290	1.0483	1.1099	1.1631	1.0717	1.0722	0.9494
Employment¹	1	1.5454	1.8629	1.8923	1.8792	1.9909	2.3206	2.3952	1.8552	1.8201	1.9197	2.0063
	2	0.3094	0.4617	0.5752	0.5989	0.6573	0.8181	0.7831	0.4796	0.3583	0.4306	0.4560
Social benefit dependence¹	1	-4.0120	-4.2060	-3.7345	-3.3154	-3.6977	-3.6977	-3.5035	-3.9293	-4.3816	-4.3816	-4.3111
	2	-1.3053	-1.3339	-1.1687	-0.8554	-1.0132	-1.0132	-0.9324	-1.0859	-1.6180	-1.6180	-1.5150

*** insignificant at the 10% level; **significant at the 10% level; *significant at the 5% level; all other coefficients are significant at the 1% level.

¹The value of 'family size' is 1 for families larger than 4 and for the variable of dependence on social benefits the value is 1 if the share of social benefits exceeds half the income.

The value of the employment variable is 1 if the employment of adults is below half the potential.

Table 5. Multinomial Logit Model: Odds Ratios

X₁–X₆ represent combinations of characteristics: the value of 1 in the table indicates the presence of a specific variable in the set of characteristic and 0 indicates the lack of it.

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆
Intercept	1	1	1	1	1	1
Arab	1	0	0	0	1	1
New Immigrant since 2000	0	0	0	0	0	0
8 years of schooling	1	1	1	1	0	0
9 to 12 years of schooling	0	0	0	0	1	1
Age to 30	1	1	1	1	0	0
Age 31–45	0	0	0	0	1	1
Age 46 to pension age	0	0	0	0	0	0
Haredi	0	0	1	1	0	0
Binar_famsize	1	1	1	1	1	1
Potential_bin	1	0	1	0	1	1
SB_net equivalized family inc_real_bin	1	1	1	1	1	0
odds ratio (the ratio of two sets of characteristics)	X ₁ /X ₂		X ₃ /X ₂	X ₄ /X ₂		X ₆ /X ₅
The odds ratio for households with a set of characteristics, X ₁ , compared to households with a set X ₂ for belonging to the lowest (1) rather than to the highest class (3) is exp(beta(1)'x ₁)/exp(beta(1)'x ₂). Similar statements can be made for other combinations of characteristics.	275.1		208.0	28.0		74.5
The odds ratio for households with a set of characteristics, X ₁ , compared to households with a set X ₂ for belonging to the middle (2) rather than to the highest class (3) is exp(beta(2)'x ₁)/exp(beta(2)'x ₂). Similar statements can be made for other combinations of characteristics.	8.7		4.8	3.1		4.5
The odds ratio for households with a set of characteristics, X ₁ , compared to households with a set X ₂ for belonging to the lowest (1) rather than the middle class (2) is exp((beta(1)-beta(2))'x). Similar statements can be made for other combinations of characteristics.	31.6		43.0	0.2		16.4

exposure to welfare funds.³⁷ 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 estimated coefficients are remarkably stable during the years 1998, 2004 and 2008, especially for the first regression (indicated by “1” next to the variable name). The results from this analysis support the consistency of the model’s allocation to income groups.

3.2.2 A Vanishing Middle Class?

Income polarization is importantly affected by the decision whether to include or exclude Jerusalem Arabs into the analysis. Their inclusion strongly accentuates the effect of the shrinking middle class. When they are included polarization worsens beginning in 2003, more or less with the introduction of the harsh social policy. This process culminates in 2008, when the middle class disintegrates into the lower and upper classes.

The inclusion of Jerusalem Arabs into the analysis also emphasizes the fragility of the benefits from economic growth. We find that growth is mainly enjoyed by the mainstream society, leaving aside the Haredi and Arabs, particularly those living in Jerusalem.

4 Conclusions

We use an alternative measure of polarization to the main existing ones. On the one hand it fits easily into the framework suggested by existing measures, since it explicitly includes an identification-alienation index as proposed by the axiomatic approach (Esteban and Ray, 1994). We prefer the use of a purely statistical measure, built on the variance, rather than on measures satisfying axioms in the realm of welfare measures, such as for example the Pigou–Dalton transfer axiom. In a political economic context this is related to the question whether the polarization measure should weigh the rich and the super-rich less than the poor, as is achieved by the ranking characteristic in the Gini-index or the weighting in

³⁷ We found the social benefits policy to affect the Haredi population more strongly than the Arab population, possibly due to their higher dependence on social benefits due to the Haredi men’s low labor force participation.

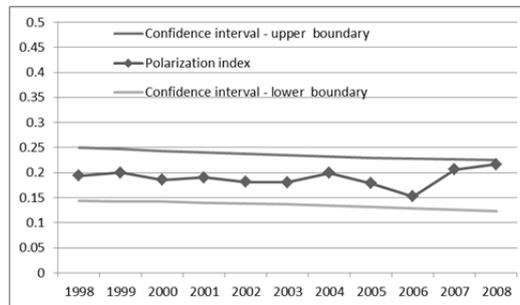
the FGT. Such weighting obscures the detrimental effect that the super-rich often have on democratic decision making due to their direct influence of politicians' decision making through their economic power and financial support during elections. The suggested index, being bounded between 0 and 1, makes it a scale-free and thus suitable index for comparisons over time and space. Furthermore the focus on the number and sizes of significant groups and the use of multi-resolution analysis render the empirical estimation of polarization more sensitive than other measures to the effect of the "shrinking" or "vanishing" middle class.

The Israeli economy is a useful study ground for polarization, given the high heterogeneity of its society. The sharp deterioration in polarization towards the end of the observation period suggests that growth has not been sufficiently inclusive, leaving out the Arabs and Haredi from enjoying the fruits of economic growth. The analysis suggests that the components of identification-alienation and of the number and sizes of groups make the process of polarization more gradual and thus more easily observable. This effect coincides with the flattening of the overall income distribution, observed in the Israeli context. This increase in dispersion is also manifest in the outward shift of the distribution at the high end of incomes.

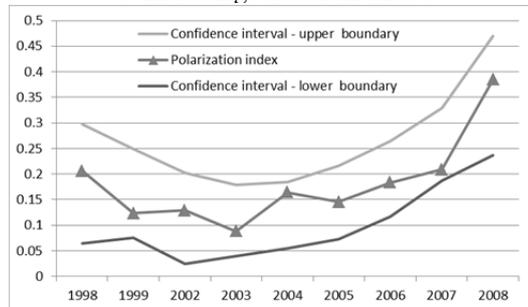
The multinomial logit analysis reveals that polarization analysis can be enriched by explaining income class membership by use of various characteristics, such as ethnic, cultural and other demographic and individual characteristics. Belonging to the Haredi (Jewish Ultra-orthodox) community sharply raises their probability of belonging to the low-income group, as expected also 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. 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 results support the quality of the model's predictions of group membership. Why then is the Israeli social situation not "bursting" as hinted in the breach of the polarization index in Figure 4 when Jerusalem Arabs are included in the analysis and the middle class disappears? A possible answer to this puzzle is found in our multinomial logit analysis, showing that cultural differences remain relevant determinants of class membership, alienating poor Arabs from poor Haredi despite the fact that they share the same income class.

Figure 4: The Polarization Index with and without Jerusalem Arabs

a. Excluding Jerusalem Arabs



b. Including Jerusalem Arabs



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The Editor

APPENDIX

Figures A.1–A.12: Global and Group Probability Density Functions for Israeli Population excluding Jerusalem Arabs

Figure A.1: 1997

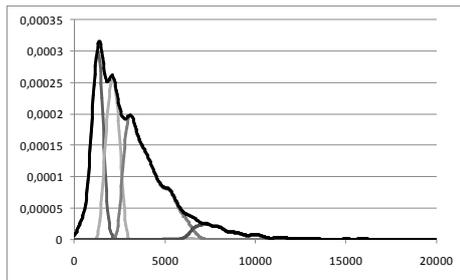


Figure A.2: 1998

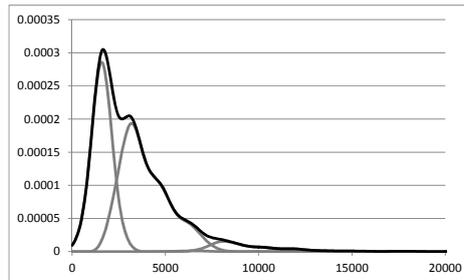


Figure A.3: 1999

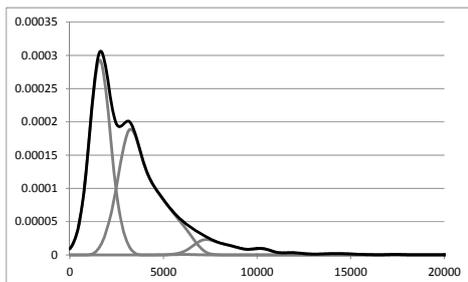


Figure A.4: 2000

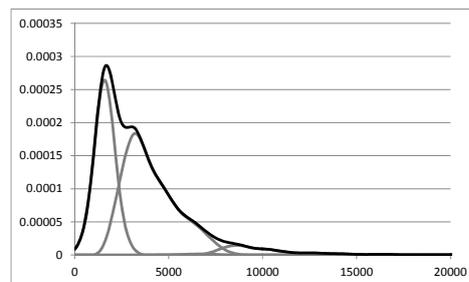


Figure A.5: 2001

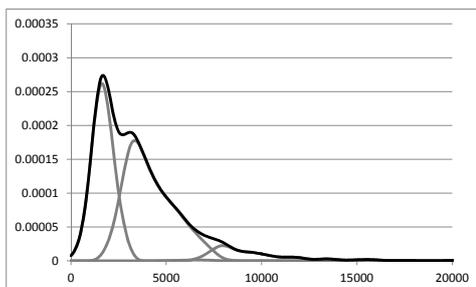


Figure A.6: 2002

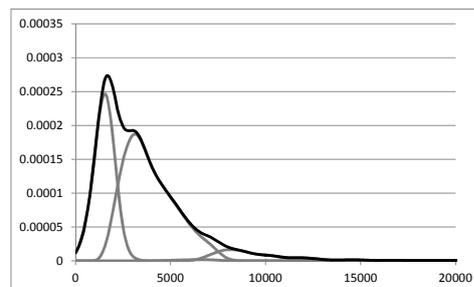


Figure A.7: 2003

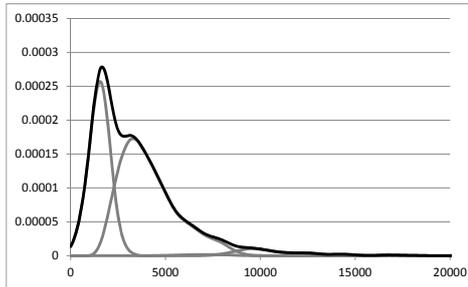


Figure A.8: 2004

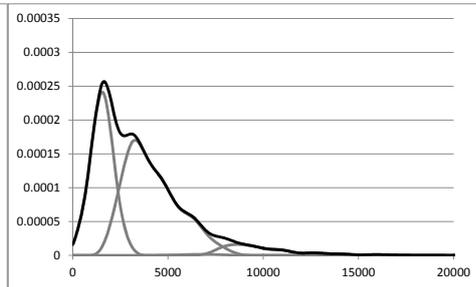


Figure A.9: 2005

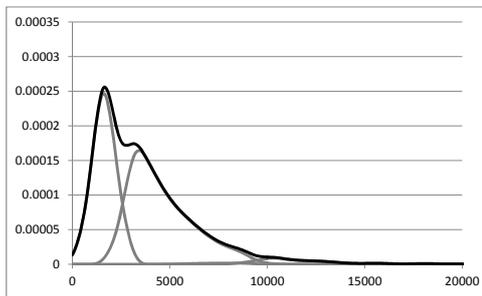


Figure A.10: 2006

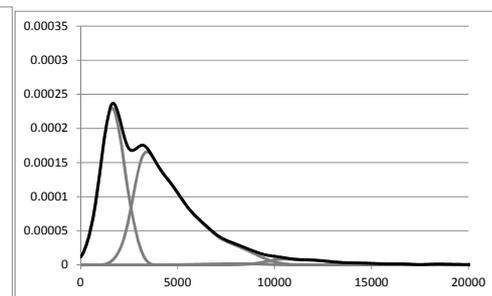


Figure A.11: 2007

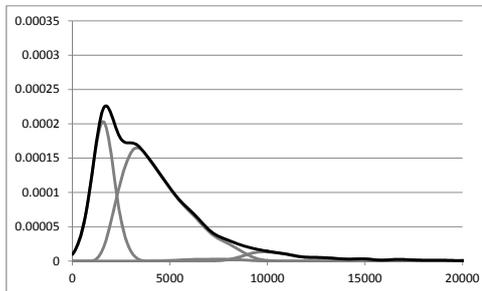
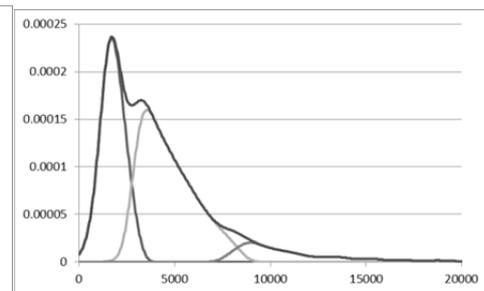


Figure A.12: 2008 (three groups)



Figures A.13–A.21: Global and Group Probability Density Functions for Israeli Population including Jerusalem Arabs

Figure A.13: 1998

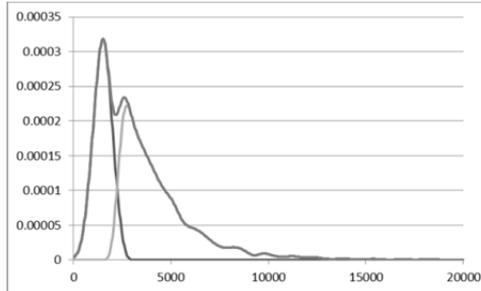


Figure A.14: 1999

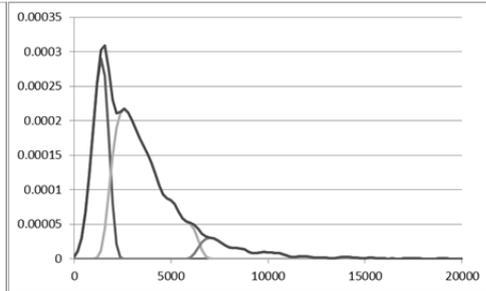


Figure A.15: 2002

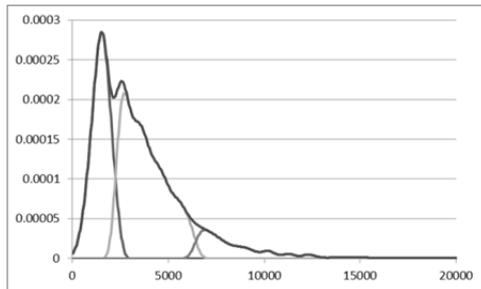


Figure A.16: 2003

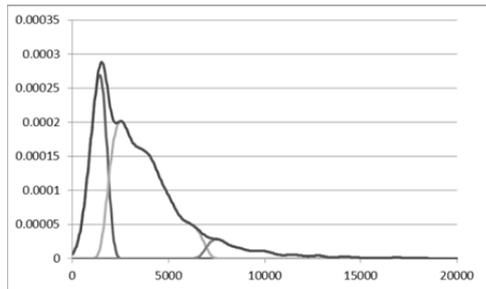


Figure A.17: 2004

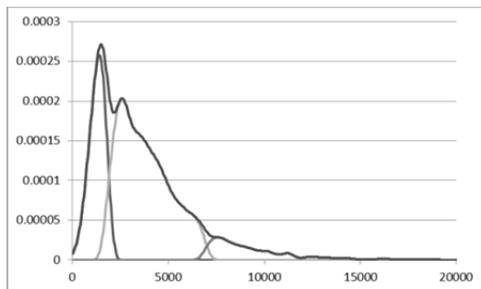


Figure A.18: 2005

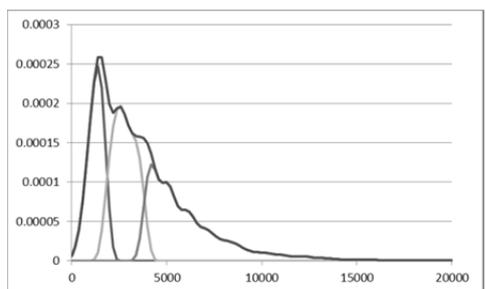


Figure A.19: 2006

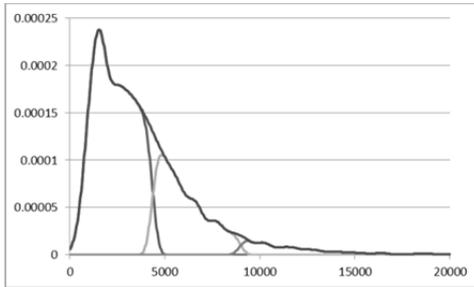


Figure A.20: 2007

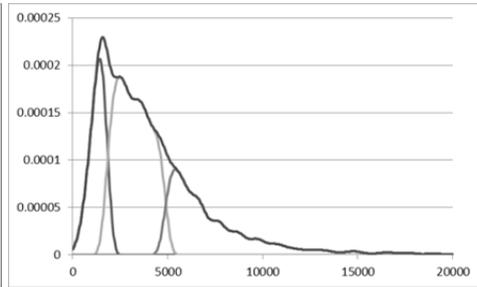


Figure A.21: 2008 (two groups)

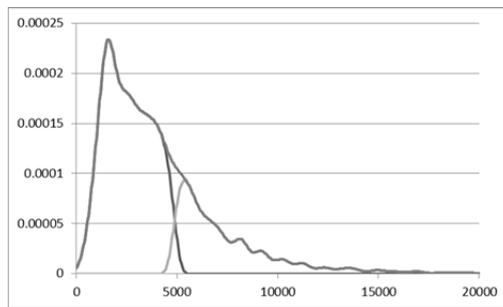


Figure A.22. The components of the polarization index

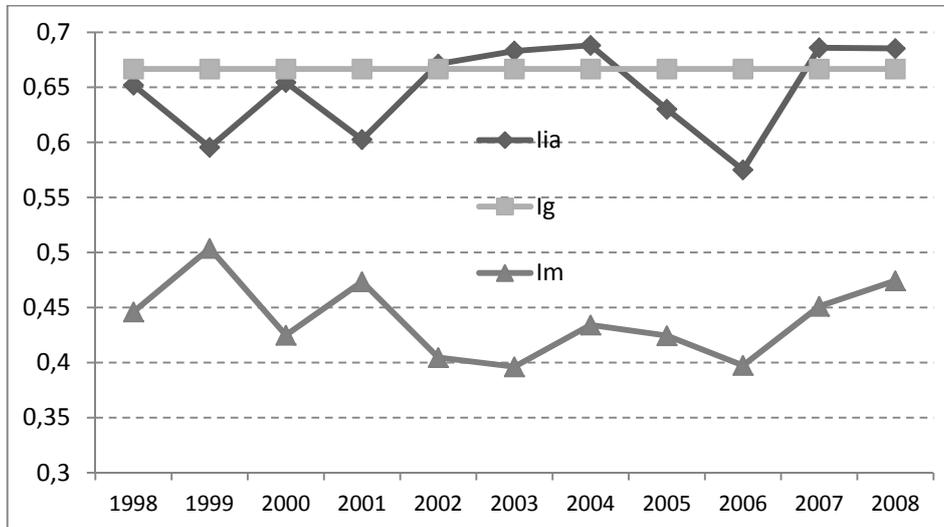


Table A.1: Net Equivalised Mean Income by Income Groups, 2006 Prices

	Lower class	Middle class	Top class	Overall average	Relative income: Upper versus lower class	Relative income: Middle versus lower class
1997	1,181	3,084	9,266	3,263	7.8	2.6
1998	1,535	4,007	10,300	3,324	6.7	2.6
1999	1,571	3,981	9,925	3,406	6.3	2.5
2000	1,540	4,149	10,940	3,523	7.1	2.7
2001	1,635	4,243	10,565	3,683	6.5	2.6
2002	1,455	4,021	10,536	3,519	7.2	2.8
2003	1,463	4,245	11,850	3,505	8.1	2.9
2004	1,482	4,256	10,850	3,634	7.3	2.9
2005	1,590	4,686	13,496	3,755	8.5	2.9
2006	1,605	4,785	14,170	3,989	8.8	3.0
2007	1,650	4,560	11,744	4,112	7.1	2.8
2008	1,728	4,725	11,853	4,139	6.9	2.7
Average of yearly ratios of the means					7.4	2.8

Table A.2: The Size (Weights) of the Classes in the Tri-polar Period (Jerusalem Arabs excluded)

	Lower class	Middle class	Upper class	Sum of weights
1998	0.410	0.538	0.052	1.000
1999	0.431	0.491	0.078	1.000
2000	0.383	0.562	0.055	1.000
2001	0.401	0.522	0.077	1.000
2002	0.353	0.585	0.062	1.000
2003	0.376	0.584	0.040	1.000
2004	0.378	0.557	0.065	1.000
2005	0.409	0.553	0.038	1.000
2006	0.374	0.584	0.042	1.000
2007	0.366	0.549	0.086	1.000
2008	0.393	0.525	0.083	1.000

Table A.3: The Polarization Measure and Its Components (Jerusalem Arabs excluded)

	Iia	Ig	Im	PG
1998	0.652	0.667	0.446	0.194
1999	0.596	0.667	0.504	0.200
2000	0.655	0.667	0.425	0.185
2001	0.603	0.667	0.473	0.190
2002	0.671	0.667	0.405	0.181
2003	0.683	0.667	0.396	0.180
2004	0.688	0.667	0.434	0.199
2005	0.630	0.667	0.424	0.178
2006	0.575	0.667	0.397	0.152
2007	0.686	0.667	0.451	0.206
2008	0.685	0.667	0.474	0.217

Table A.4 The Polarization Measure and Other Tri-polar Measures

	PG	Interval of conf. 95%		ZK	Interval of conf. 95%	
1998	0.194	0.144	0.250	3.107	2.331	4.104
1999	0.200	0.143	0.246	3.199	2.297	4.027
2000	0.185	0.142	0.243	2.983	2.260	3.954
2001	0.190	0.140	0.240	3.149	2.218	3.885
2002	0.181	0.139	0.237	2.834	2.173	3.820
2003	0.180	0.137	0.234	2.789	2.124	3.758
2004	0.199	0.134	0.232	3.203	2.071	3.701
2005	0.178	0.132	0.230	2.773	2.014	3.648
2006	0.152	0.129	0.228	2.604	1.952	3.598
2007	0.206	0.126	0.226	3.427	1.887	3.553
2008	0.217	0.123	0.225	3.163	1.817	3.512

	ZKN	Interval of conf. 95%		ER	Interval of conf. 95%	
1998	0.757	0.703	0.830	0.213	0.198	0.235
1999	0.762	0.700	0.824	0.218	0.198	0.234
2000	0.749	0.697	0.818	0.212	0.198	0.234
2001	0.759	0.694	0.813	0.214	0.199	0.233
2002	0.739	0.690	0.808	0.208	0.199	0.233
2003	0.736	0.686	0.803	0.218	0.199	0.233
2004	0.762	0.682	0.798	0.219	0.199	0.233
2005	0.735	0.677	0.794	0.231	0.199	0.233
2006	0.723	0.672	0.790	0.224	0.199	0.233
2007	0.774	0.667	0.786	0.217	0.198	0.233
2008	0.760	0.662	0.783	0.214	0.198	0.233