FEMISE RESEARCH PROGRAMME

On the Impact of Economic Development, Trade and Investment Openness on Income Inequality

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A Synthesis of the Findings of the Research Project on the Impact of Euro-Mediterranean Agreements on Poverty in the Mediterranean Basin

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I) Overall Synthesis

"Competition markets may be the best guarantee of efficiency but not necessarily of equity. Liberalization and privatization can be a step to competitive markets - but not a guarantee of them. And markets are neither the first nor the last word in human development. Many activities and goods that are critical to human development are provided outside the market - but these are being squeezed by the pressures of global competition. There is a fiscal squeeze on public goods, a time squeeze on care activities and an incentive squeeze on the environment. When a market goes too far in dominating social and political outcomes, the opportunities and rewards of globalization spread unequally and inequitably - concentrating power and wealth in a select group of people, nations and corporations, marginalizing the others."

These sentences are drawn from the introduction to the 1999 Human Development Report and the title of this introductory overview was *Globalization with a Human Face.* The overall goal of the research project on *The impact of Euro-Mediterranean Agreements on poverty in the Mediterranean Basin* was precisely to determine what impact openness to international trade and international investment had on economic inequality, a term which refers not only to income inequality but also to the inequality of a broader concept of standard of living such as that which is measured by the Human Development Index.

The original research proposal had suggested that three types of investigations would be conducted. In a first stage an international cross-section of data on income inequality at the country level in both urban and rural areas would be examined and the impact of openness to international trade and investment on overall inequality as well as on inequality between and within urban and rural areas would be determined. In a second stage a time series of country specific data, more precisely of Israeli data, would be analyzed in order to understand what may be the effect over time of an increasing degree of openness to international trade. In a third and final stage an attempt would be made to combine cross-section and time series data by focussing on panel data giving for three different periods the value of the Human Development Index in various countries. This last phase of our investigation would thus give us a better idea of the impact of openness to international trade and investment on development in general but also on the inequality of the distribution of the Human Development Index since the data at our disposal allowed us to take account of country-related fixed effects.

The findings of these three types of studies have been reported in three different papers and the purpose of the present summary is just to give an overall review of the main conclusions of our investigation. This synthesis will focus on the impact of the openness to international trade and investment although, depending on the study considered, other variables such as the per capita G.D.P., the inflation or unemployment rates have been taken into account.

The impact of openness to international trade and investment on the level of development

The panel data we worked with showed very clearly that both openness to international trade and openness to international investment had a positive effect on the level of development of a country when the latter is measured by the United Nations Human Development Index.

The impact of openness to international trade on inequality

There seems to be a contradiction between findings based on a cross-section of countries and conclusions derived on the basis of a time series. Whereas the cross-section analysis seemed to indicate that inequality decreases with openness to international trade, the study based on the time series showed that openness to international trade had no effect on overall income inequality. A closer look at the results showed however that openness to international trade did not affect the

income shares of the rich or of the poor but did lead to a deterioration of the income share of the middle class, especially the lower middle class. Note that such a contradiction between findings based on cross-section and those derived from a time series analysis is not unique as it is well known that the first studies on the consumption function in the 1940's had also indicated that the conclusions depended on whether one was analyzing time series or cross-section data.
Note also that our panel data analysis showed that variations in the degree of openness to international trade could explain part of the dispersion of the values of the Human Development Index which is observed in different countries, though the contribution of this variable amounted to only 2.4% to 3.5% of the overall mean difference of these indices.

The impact of openness to international investment

The cross-section analysis showed a very significant and positive effect of openness to international investment on overall income inequality but also on the between (urban and rural) areas inequality and on the within areas (in fact mainly within rural areas) inequality.

The Impact of Trade Agreements

We had no way of testing directly the effect of such agreements. The only case where such an investigation could have been conducted was that of our time series analysis which examined Israeli data during the past thirty years but once openness to international trade was included in the regression, the implementation of trade agreements per se (agreements between Israel and the European Union) had no significant additional effect. It should be clear however that the various agreements that have been signed over the years between Israel and the European Union were probably one of the main causes for the increasing degree of openness to international trade so that there should be no doubt that indirectly these agreements had an effect on inequality.

II) Summary of each specific study

The cross-section study: On the Impact of Economic Development, Trade and Investment Openness on Income Inequality

This research tried to determine the links that may exist between the level of development, the degree of openness to international trade and investment on one hand and income inequality on the other hand. As a whole it appears that overall inequality as measured by the Gini index decreases with the level of development (measured by the per capita G.D.P.) and the degree of trade openness but increases with the level of investment openness.
Inequality therefore decreases with the level of development, once the degree of openness to international trade and investment is kept constant. This negative net effect of the level of development is however the consequence of several influences. First an increase in per capita G.D.P. decreases the between groups (urban and rural areas) inequality as well as the overlapping component. Second the effect of the level of development on the within groups inequality is less clear. It seems that as the per capita G.D.P. increases, the within groups inequality increases but at a decreasing rate. A closer look at these results shows however that the net effect of the per capita G.D.P. on the within groups inequality is in fact the consequence of two opposite impacts. An increase in per capita G.D.P. increases the within urban areas inequality but decreases the within rural areas inequality. One could summarize all these influences by saying that as a whole as the level of development increases, differences in per capita G.D.P. between urban and rural areas as well as inequality within rural areas decrease but inequality within the urban areas increases, the latter being probably the consequence of a relative increase in high incomes in urban areas
If we now take a look at the pure (that is for a given level of per capita G.D.P. and of international investment openness) impact of openness to trade, we observe that, ceteris paribus, trade decreases

the between and within groups inequality but has no significant effect on the overlapping component. Concerning this net effect of trade on within areas inequality, note that this negative effect seems to be significant only in rural areas. To summarize we may therefore say that the main impact of openness to international trade is, other things constant, to decrease inequality between urban and rural areas and eventually also within rural areas.
Finally concerning the effect of openness to international investment we observe that this impact is positive for all the components of the decomposition of overall inequality but the overlapping component in which case the coefficient is not significant. Concerning the effect of openness to international investment on within areas inequality, we may observe that here again the coefficient is significant for rural areas but only when the variable (1/GDP) is added to the regression.
If we want to shortly synthesize all these results we could say first that as the level of development of a country increases, one observes, for a given level of openness to international trade and investment, a decrease in the income gap between urban and rural areas, an increase in inequality within urban areas and a decrease in inequality within rural areas. Second, as the degree of trade openness increases, it appears that for a given level of development and investment openness, inequality between urban and rural areas as well as within rural areas decreases. Finally, as the degree of openness to international investment increases, one observes, for a given level of development and trade openness, an increase in income inequality between urban and rural areas and within rural areas.

The policy implications of these different results seem therefore to be that trade openness which has a positive effect on development seems also to have a significant effect on inequality in so far as the greater the degree of trade openness, the smaller income inequality. Trade openness should thus be encouraged. Openness to international investment however, which has been already criticized by certain economists because of its destabilization effects on macroeconomic equilibria, might be put also into question because it increases income inequality, though the influence seems to be more on inequality within rural areas than on inequality within urban areas or between urban and rural areas. Naturally it would be good to strengthen these conclusions by extending the sample of observations but compatible data in this field are difficult to obtain. Moreover it would be interesting, again once data become available, to analyze the more specific effect of regional integration agreements.

The time series analysis: Income Inequality and Openness to International trade - The case of Israel

In this paper an attempt has been made to analyze the impact of the openness to international trade on income inequality in Israel during the period 1967-1997. In order to do so we regressed either the Gini index of income inequality or the share of various income deciles on the three variables which were assumed to have a possible impact on inequality: the rate of inflation, the rate of unemployment and the degree of openness to international trade. A quick look at the annual values of these three variables shows that the degree of openness to international trade almost doubled in a period of 30 years, that unemployment was very high at the beginning of the period considered as well as in the early 1990's. Finally, as is probably well known, Israel experienced almost hyperinflation during this period of thirty years since in 1984 the annual inflation rate was close to 500%. In the regression analysis we tried also to make a distinction between expected and unexpected inflation. The expected inflation rate in a given month was assumed to be a function, in a sixth order autoregressive process, of the inflation rates experienced during the past sixth month. Then an annual expected inflation rate was estimated on the basis of the monthly expected inflation rates. Unexpected inflation was finally defined as being equal to the difference between actual and expected inflation.
The regression results indicate first that expected inflation had no significant on inequality (on the Gini index) as well as on the income share of any income decile. We also observed that unemployment and unexpected inflation had as a whole similar effect in so far as they tended to increase the income shares of the rich and decrease that of the poor and of the middle class. Finally

the degree of openness to international trade had no effect on the rich or on the poor but had a significant negative impact on the income share of the middle class, essentially of the lower section of the middle class.
These results as a whole tend to confirm that in a developed country like Israel the rich have usually the means to protect themselves against the dangers of inflation or unemployment. They may even benefit from a situation of high inflation or high unemployment. The poor on the contrary seem to suffer in periods of higher inflation or unemployment (remember that our data refer to gross income so that we did not take into account the impact of the tax and transfer system). As to the main concern of our study, the role that openness to international trade may play, our analysis has shown that it has no significant impact on the poor or on the rich but it has a negative effect on the income share of the lower middle class. Naturally such conclusions are at this stage specific to the Israeli case. Additional national studies based on time series are needed before one may derive strong conclusions as to the impact of openness to international trade on income inequality.

The panel data analysis

This paper attempted to study the impact of the degree of openness to international trade and investment of the level on human development. The analysis was based on a decomposition technique borrowed from the literature on the breakdown of income inequality by income sources, an approach which may also be applied to regression results to estimate the impact of each exogenous variable on the dispersion of the dependent variable. The panel data which were used included information on at least 49 countries for each of the years 1975, 1985 and 1985. Using a fixed effect model we found that both indices of openness (to international trade and to international investment) had a positive but non linear effect on human development but that the degree of openness to international trade explained a higher percentage of the dispersion of human development levels than the degree of openness to international investment

As indicated previously we have used a fixed effect model by assuming a fixed effect for each country. The dependent variable was the Human Development Index HDI_{jt} for country j in year t while the exogenous variables were respectively the degree of openness to international trade for country j in year t, the square of this variable, the degree of openness to international investment for country j in year t and the square of this variable. It appears that the Human Development Index increased on average over time and this is also true for the average degree of openness to international trade. For the degree of openness to international investment the fluctuations seem to have been important since even the average value of this index decreased between 1975 and 1985 but subsequently increased to reach in 1995 a higher level than in 1975.

On the basis of these panel data we have run three types of regressions: in the first case we allowed where the number of observations to vary from one year to the other, in the second case we took into account only those countries for which observations were available for both 1975 and 1995 while in the third case we included only those countries for which observations were available for each of the three years: 1975, 1985 and 1995.. Whereas the magnitude of the coefficients varies from one regression to the other, the signs are consistent and show similar effects. It appears that the degrees of openness to international trade and to international investment have a positive effect on human development. This impact is however not linear in so far as the Human Development Index increases at a decreasing rate with the degrees of openness to international trade and investment.

In a second stage we have attempted to determine which factors have an influence on the overall dispersion of the Human Development Index, when this dispersion is measured by the Mean Difference of this Human Development Index. It appears then that the degrees of openness to international trade and investment explain only 3.3% in 1975 and 4.4% in 1995 of the mean difference of the Human Development Index. The openness to international trade accounts in fact

for most of this contribution (2.4% in 1975 and 3.5% in 1995) as the non-linear term of the openness to international investment practically cancels the impact of the linear term.

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1) Introduction

The rapid economic growth of developing countries which opened their markets to free international trade during the past two decades has stimulated a large empirical and theoretical literature on the impact of trade on growth. There seems now to be overwhelming evidence of a link between openness and growth, at least in the 1970s and 1980s. There have been however fewer studies analyzing the impact of international trade on income inequality within countries. Although there is an important literature, both theoretical and empirical, which has looked at the link between the level of economic development and overall income inequality (what is usually called the Kuznets Curve or the inverted-U relationship between per-capita G.D.P and inequality) most of the studies first did not integrate the potential impact of international trade, second looked mainly at the impact of development on total inequality, without analyzing in details the impact economic growth has on inequality between and within different sectors, such as urban and rural areas.
There is therefore a need for detailed and careful work on the impact of economic growth and international trade on inequality between and within specific sectors of the economy and this is precisely the purpose of the present study. More precisely we attempt to analyze the specific impact of the level of development (measured by the real per capita G.D.P.) and of the degree of openness to international trade and investment flows, on the overall level of income inequality as well as on the within and between areas (urban versus rural) inequality.
The paper is organized as follows. Section 2 reviews the literature, both theoretical and empirical, on the link between inequality and development as well as that on the impact of trade on inequality. Section 3 and 4 describe respectively the methodology and the data sources while section 5 presents the results of the regressions that analyze the effect of the level of development and of the degree of openness to international trade and to international investment on overall inequality as well as on the inequality between and within urban and rural areas. A short conclusion summarizes the main findings of the study.

2) A Review of the Literature:

Un) The Impact of Development on Inequality:

* Theoretical Studies

Following Kuznets' (1955) pathbreaking study numerous authors in the 1960s and 1970s attempted either to formalize Kuznets' hypothesis or to check its empirical validity. In the early 1980s interest in the link between income inequality and development declined. In recent years, however, there has been a clear resurgence of research in this field, essentially for three reasons: the appearance of the so-called "new growth" theories, the application of the theory of public choice to new areas and the availability of more sophisticated data sets. This section presents a quick and non-exhaustive review of the various theoretical explanations for the existence of the Kuznets Curve while references to empirical studies on this subject will be mentioned later on.

We will successively examine three types of approaches. The first one draws on Kuznets' work and emphasizes the implications for inequality and development of the existence of a dual economy. The second type of studies belongs to the "new growth" school and stresses mainly imperfections in the capital market, the role of investment in human capital and the so-called demographic transition. There is, finally, a third category of models which emphasizes either the role of social choices as consequences of the political system or the effect of institutional constraints which are essentially the product of history.

Kuznets' Approach and Dual Economy Models

The earliest model of this type was proposed by Kuznets (1955) who showed that "even if within-sector inequality is constant and the ratio of mean sectoral incomes is also constant, the shift of population between sectors at first produces a widening in inequality and then a narrowing" (Adelman and Robinson, 1989). While Kuznets (1955) used a numerical example, Robinson (1976) provided a more rigorous proof of Kuznets' hypothesis and his demonstration was based on the existence of intersectoral difference in mean income and did not require a higher average income or a greater level of inequality in the growing sector.

Fields (1980) considerably extended this approach by making a distinction between a sector enlargement effect, a sector enrichment effect and an interaction terms. More details on this type of model are given in Adelman and Robinson (1989) in their survey of income distribution and development.

Bourguignon (1990) proposed an interesting extension of the dual model of development in so far as the latter is stated in general equilibrium terms and hence takes into account changes in internal terms of trade (e.g., as the proportion of the population employed in the traditional sector decreases, the relative price of traditional goods is likely to rise). Moreover, in Bourguignon's analysis the emphasis is put on the Lorenz Curve and not on a specific inequality index as two indices may yield different conclusions as to the link between inequality and development.

The paper by Bourguignon and Morrisson (1990) is also an interesting contribution to the literature on the Kuznets Curve although it is not a dual economy model. In it the empirical investigation is based on a consistent theoretical framework stressing the importance of factor endowments, their ownership structure and foreign trade distortions: "Developing countries which are comparatively well endowed with mineral resources and land (climate) tend to be less egalitarian than others, although the effect of the agricultural comparative advantage may be offset by the distribution of land" (Bourguignon and Morrisson, 1990, pages 1127-28). Trade protection is another crucial variable and it leads to a worsening of the income distribution. The most important conclusion, however, is that it is the presence of exporTable resources rather than GDP per capita which is an essential determinant of the income distribution, the reason being, evidently, that natural resources of this type have usually been concentrated among a few owners. In more recent periods, however, these resources have often been publicly appropriated, hence the changing level of income inequality over time.

New Growth Models and the Kuznets Hypothesis

In recent years numerous papers have attempted to analyze the implications of the so-called new growth theories for the link between inequality and development.

Aghion and Bolton's (1992) for example emphasize the impact of declining interest rates as the economy accumulates capital (and grows). The idea is that at some stage it may be possible for the poor to obtain loans, a process which ultimately may lead to a decrease in inequality.

Other models stress the role of investment in human capital. Thus, Dahan and Tsiddon (1996) argue that the original decrease in mortality rates in the demographic transition implies a decrease in the cost of child rearing per living child. This in itself leads to an increase in the number of children both among the poor and rich people but the number of rich increases at a slower rate so that the wage of the poor declines and that of the rich increases. At some stage the wage gap between rich and poor becomes large enough to encourage investment in human capital among some of the poor and income distribution becomes less unequal and this change occurs at the same time as fertility declines.

Social Choices and the Kuznets Curve

In this type of model the emphasis is on the interaction between the economic structure and the political mechanism. Most of the early models of this type assumed that political participation was exogenous. It should be stressed also that in these models the causality runs from redistribution to growth rather than from per capita GDP to income inequality.

In Persson and Tabellini's (1994) study taxes are only used for redistributive purposes. A higher tax rate depresses the after-tax return to private investment and hence growth so that income inequality is negatively correlated with subsequent growth.

In St-Paul and Verdier (1993) taxes are used for public education, the main determinant of growth, so that there is a positive correlation between growth and public expenditures on education and at the same time the income distribution becomes more equal.

More recently some models have attempted to endogenize political participation. Thus Gradstein and Justman (1997) present a model where, in the early stages of development, a small fraction of the upper income classes controls the political process so that a regressive redistributive policy occurs. Later on economic growth leads to an expansion of political participation and ultimately a progressive redistributive policy will take place and inequality will be reduced.

In Milanovic (1994) the emphasis is more on institutional constraints related to historical developments such as the extent of regional inequality in per-capita income or the importance of the state sector. The latter, for example, will tend to reduce inequality because there exists, usually, less dispersion in wages in the public than in the private sector.

**** Empirical Studies of the Relationship between Inequality and Development**

Most of the empirical literature on the Kuznets Curve has been based on cross-country estimations of the relationship between inequality and per capita national income (e.g., Adelman and Morris, 1973; Paukert, 1973; Ahluwalia , 1974, 1976a, 1976b; Ahluwalia et al, 1979; Anand and Kanbur, 1993a, 1993b; Tabatabai, 1974). Several measures of income inequality have been used in these empirical investigations (the percentage income share of the poorest 40%, Theil's two entropy indices, the squared coefficient of variation, the Gini Index or its logit transform, the Atkinson Index or one of its decomposable transforms, the variance of the logarithm of income).

These empirical studies have also used various kinds of functional forms to test for the Kuznets hypothesis, the inequality measure being regressed on per capita income and its inverse or on per capita income and the inverse of the logarithm of income, etc. In a recent study Anand and Kanbur (1993a) have shown that each inequality index generally had a corresponding functional form of the inequality-development relationship. When they used the Gini Index, Anand and Kanbur (1993a) found that the turning point of the Kuznets curve corresponded to a per capita GDP of $421 (1970 US dollars), on the basis of a sample of 60 countries including both developing and developed counties. In 1985 this turning point would correspond to a per capita GDP of $1168, on the basis of the US consumer price index.

Tabatabai (1994) used as dependent variable the logit transform of the Gini Index and his results give, at the turning point, a per capita GDP at 1985 international prices of $1,565 when the Gini Index measures the inequality between households and of $2,422 when it measures the inequality between persons. The first case is based on 98 observations, the second on 52.

Fields and Jakubson (1994) use a combination of cross-section and panel data which includes thirty-five countries with one to nine observations per country. They first present a "pooled model" where all the data are treated as a single cross-section while in a second stage they present a "fixed effects model", the idea being that different countries may lie on Kuznets curves which have the same shape but different intercepts. They find out that in the pooled model inequality rises in the early stages of economic development while the fixed effects model always shows a negative relationship between income inequality and the level of development. These results remain robust enough not to be affected by changes in the definitions of the level of development or of the recipient unit (households versus

individuals), by the addition of other countries or by several modifications of the econometric specifications. Fields and Jakubson (1994) believe that their findings may be related to the fact that in Latin American countries inequality is usually high while their per capita GDP lies in the middle of the range of countries usually included in such studies. This might explain why the inverted *U* curve does not show up in their fixed-effects model.

Bruno et al. (1996) present a careful review of the empirical evidence on the link between inequality and growth. They argue that it is an error to rely on cross-country data sets to draw conclusions concerning the existence of the Kuznets Curve. First, such data ignore country-level determinants of inequality. For example, past inequality is likely to be correlated with current inequality and this in itself is a source of biased estimates. Bias could also arise from differences in the type of data. Some studies, for example, combine income and consumption data. However, because of consumption smoothing, income inequality is usually higher than consumption inequality. Since for Latin American countries one had usually income data while for Asian countries, in the sixties, one had consumption data, one should not be surprised to derive an inverted *U*-curve linking inequality and per capita income. Bruno et al. (1996) indeed stress that, when using cross-section data covering the 1980s, that is, once Asian countries had, on average, a much higher per capita income, there was no more evidence of an inverted *U*-curve.

Concerning the evidence from time series, Bruno et al. (1996) argue that no clear trend emerged from a careful analysis of Indian data which included 33 household surveys covering the period 1951 to 1991. There was, eventually, a downward trend until the mid-1960s. Finally, when combining time series and cross-section data, Bruno et al. (1996) found that 92 percent of the variance in Gini indices by country and date is a consequence of cross-section variations while only 7 percent is accounted for by variation over time.

Whereas all these studies looked at the link between the Gini Index of total income and per capita GDP or income, it might be worthwhile to see whether international trade has an independent impact on income inequality.

b) The Impact of Trade on Inequality:

The rapid economic growth of developing countries which opened their markets to free international trade during the past two decades has stimulated a large empirical and theoretical literature on the impact of trade on growth. There seems to be overwhelming evidence of a link between openness and growth, at least in the 1970s and 1980s although no correlation has been observed in any of the earlier decades, except for a negative correlation in the 1930s (Vamvakidis, 1998; for a somehow different point of view, see Williamson, 1996). In fact international trade seems not only to have a positive impact on growth but also to facilitate the kind of convergence between the economies which is predicted by neoclassical growth models Williamson,1996).

Most of the literature on trade and growth however did not examine the impact of regional integration on growth. In a recent symposium on regionalism and development, the empirical evidence brought forth by Vamvakidis (1998) seems to show that countries with open, large and more developed neighboring economies grow faster than those with closed, smaller and less developed neignboring economies. Examining the impact of five Regional Integration Arrangements, he concluded also that South-South agreements among small, closed developing countries are unlikely to have a positive impact on growth while North-South agreements are more likely to have a positive growth effect on the southern partner, although this is not at all certain. Clearly more work is needed before firmer conclusions may be drawn concerning the impact of Regional Integration Agreements on economic growth.

Research on the impact of international trade on inequality within countries has been much less popular. One may cite however the work of Bourguignon and Morrisson (1990), mentioned earlier, who stressed that, ceteris paribus, inequality seems to be higher in countries endowed with exportable resources (probably because such resources are concentrated in the hand of a few owners)

Research on the impact of Regional Integration Agreement on Inequality has been even more scarce, although there has been some work (see Bradley et al., 1995) on the effect of the European Union on regional inequality in Europe.
Given the limited amount of research on the impact of international trade on income inequality, the present study should be a useful contribution and improve the understanding of the combined effect of growth and trade on income inequality**.**

3) The Methodology:

As indicated earlier the idea is to use a relatively new set of data collected by the International Labour Office which includes detailed information on the income distribution in various countries. The summary tables are presented in several versions. There is first an interesting breakdown of the income data by source of income and these figures have been recently studied by Deutsch and Silber (1998) who suggested a new approach to the analysis of the link between inequality and development (the so-called Kuznets Curve hypothesis). But the I.L.O. data give also an alternative decomposition of household (or individual) income inequality, one where the income shares corresponding to the different quantiles (these are not always deciles) of the income distribution are given separately for urban and rural households. This type of table allows us to extend our analysis of the Kuznets hypothesis, by decomposing income inequality, not by income source but by population subgroups, as will now be explained.
Let TOTG, BETG, WITHG, OVERL refer respectively to the overall value of the Gini Index of income inequality in a given country, to the between groups inequality in this country, to the within groups income inequality and finally to the residual term of the decomposition of overall inequality (this residual, also called interaction term, measures in fact the degree of overlap between the income distributions of the different population subgroups analyzed). We may then write (see, Silber, 1989) that

$$TOTG = BETG + WITHG + OVERL \qquad (1)$$

Since, as indicated also in Silber (1989), the within groups inequality WITHG may be written as

$$WITHG = \sum_i P^i S^i WITHG_i \qquad (2)$$

where P^i ,S^i and $WITHG^i$ denote respectively the shares of population subgroup i in the total population and total income of the country and the within group i Gini index, we may combine (1) and (2) to derive

$$TOTG = BETG + \sum_i P^i S^i WITHG^i + OVERL \qquad (3)$$

On the other hand we can run the traditional type of regression analyzing the impact of per capita G.D.P on inequality (as it has so often appeared in the literature on the Kuznets Curve), but adding now variables measuring the effect of international trade. More specifically we will write that:

$$TOTG_h = a_0 + a_1 GDP_h + a_2 (1/GDP_h) + a_3 TROP_h + a_4 INVOP_h + u_h \quad (h=1 \text{ to } n) \qquad (4)$$

where h refers to a given country, n to the total number of countries, GDP_h. is the per capita Gross Domestic Product, $TROP_h$ a measure of trade openness and $INVOP_h$ an indicator of investment openness of country h.[1].

[1] Since the link between per capita GDP and inequality is often non linear (the basic idea of the concept of Kuznets curve) we have introduced in addition to the G.D.P. per capita a variable equal to the inverse of the G.D.P. per capita, a formulation suggested by Anand and Kanbur (1993)

Combining (3) and (4) we may also estimate the following set of regressions:

$BETG_h = b_0 + b_1 GDP_h + b_2 (1/GDP_h) + b_3 TROP_h + b_4 INVOP_h + v_h$ (h=1 to n) (5)

$WITHG_h = c_0 + c_1 GDP_h + c_2 (1/GDP_h) + c_3 TROP_h + c_4 INVOP_h + w_h$ (h=1 to n) (6)

$OVERL_h = d_0 + d_1 GDP_h + d_2 (1/GDP_h) + d_3 TROP_h + d_4 INVOP_h + z_h$ (h=1 to n) (7)

with $a_j = b_j + c_j + d_j$ for j = 0 to 4 (8)

and $u_h = v_h + w_h + z_h$ for h= 1 to n. (9)

Moreover combining (2) and (6) way may also write that

$WITHG^i_h = e^i_0 + e^i_1 GDP_h + e^i_2 (1/GDP_h) + e^i_3 TROP_h + e^i_4 INVOP_h + x^i_h$ (10)

for h=1 to n and i =1 to 2 (urban and rural areas) and with

$c^i_k = \sum_{i=1 \text{ to } 2} e^i_k$ for k=1 to 4

and $w_h = \sum_{i=1 \text{ to } 2} x^i_h$ for all h.

In other words we are able to analyze the specific impact of development on inequality between rural and urban areas, on inequality within urban and rural areas and finally on the degree of overlap between the income distributions of urban and rural areas. This will give us a much finer picture of the so-called Kuznets process, if it exists.
Moreover by including trade and investment openness variables in the regressions we are also able to estimate the impact of this openness not only on overall income inequality but also on each of the various components mentioned previously (inequality between urban and rural areas, inequality within each of these areas, and overlap between the income distributions of these two areas).

4) The Data Sources:

Data on the per capita G.D.P. were taken from Summers and Heston's (1991) study and refer to the year 1988. Data on the distribution of income in urban and rural areas in various countries were obtained from a comparative study conducted by the I.L.O. (see, International Labour Office, 1992). These data allowed us to compute the overall Gini Index in each country and to derive its various components when inequality is decomposed by population subgroups, the groups referring here to urban and rural areas.
Data on the degree of openness of various countries to international trade and to international investment were borrowed from Low et al. (1999). These indices of openness are in fact corrected indices and were constructed by Low et al. (1999) in the following way. Concerning the Trade Openness Index they computed in a first stage an index defined as the ratio of the sum of imports and exports over the G.D.P. In a second stage Low et al. (1999) corrected this basic trade openness indicator to account for differences in country size and levels of development. The idea is that large countries in terms of G.D.P. and/or population tend to trade less, as most of the trade takes place within these countries. It has been similarly argued that countries with high levels of per capita G.D.P. may be biased towards having a lower level of trade to G.D.P. ratio, because as countries develop, the share in G.D.P. of the services, which are largely non-tradable, increases. Therefore, to account for differences in country size and development levels, Low et al. (1999) run a regression in a panel of 2540 observations, where the dependent variable is the logarithm of the basic trade openness indicator while the exogenous variables are respectively the logarithms of the G.D.P., of

the square of the G.D.P., of population size and of the square of the per capita G.D.P. On the basis of such a regression the author derived for each country and year the expected value of the trade openness indicator. Then in a final stage they constructed what they called the corrected trade openness index which is defined as the ratio of the actual over the expected trade openness indicator.

The corrected investment openness index was estimated in a similar way. Low et al. (1999) started by computing a basic investment openness indicator defined as being equal to the ratio of international investment flows over G.D.P.. These investment flows are equal to the sum of inward and outward Foreign Direct Investment and inward and outward Portfolio Investment Abroad. Then again they run a regression to control for the size of the country and the level of its development to finally compute a corrected investment openness index defined as the ratio of the actual over the expected investment openness indicators.

The raw data on per capita G.D.P., the Gini Indices, the indices of Trade and Investment Openness are presented in Table 1. One may observe that the richest country for which data were available is the United States (per capita G.D.P. of 18,339 dollars at 1985 prices) while the poorest country was Sri Lanka (per capita G.D.P. of 1,959 dollars). Mexico is the country with the highest overall Gini Index (0.425) while Germany is that with lowest (0.1275). Inequality between urban and rural areas is generally not very high, Mexico being the only country in our sample where the index is above 0.1.

If we now take a look at the openness indices we observe that Netherlands is the country with the highest level of trade openness (2.11), this index being also high for Ireland and Germany. On the contrary trade openness is lowest in the United States (0.43), Mexico (0.53) and Costa-Rica (0.57). Finally the international investment openness index is highest for Ireland (2.91) and the Netherlands (2.87) and lowest for Poland (0.05) and Italy (0.35).

Table 2 gives information on the population and income shares of urban and rural areas as well as on the Gini index in each area, for each country. It appears the share of rural areas in total population is high in countries like Sri Lanka (80%), Costa Rica (49%) or Turkey (42%). If we now take a look at the Gini index in urban and rural areas, we may observe that in urban areas the Gini index is highest in the United States and Mexico (.40) and in Turkey (.38) and lowest in Denmark (.17). In rural areas Ireland (.41), the United States (.41) and Turkey (.39) show the highest values of the Gini index while Denmark (0.17) has again the lowest value of the Gini index.

In Table 3 we present for the different countries included in the sample the value of the various components of the decomposition of the overall Gini index. It appears that the main contribution comes from the within areas inequality, the latter being highest for the United States (.32) and lowest for Jordan (.12). The between areas inequality is highest for Mexico (.13) and lowest for Denmark (.002) and Costa Rica (.001). Finally, the overlapping component is highest for Ireland (.14) and lowest for Denmark (0.02).

We can also analyze the importance, in relative terms, of the different components of the inequality breakdown (see, Table 4). Then it appears that the contribution of the between areas inequality is highest for Mexico (31.1%), Sri Lanka (22.5%) and Turkey (21.7%) and lowest for Costa Rica (0.4%) and Denmark (1.3%). Similarly the within areas inequality is highest for Denmark (86.1%) and lowest for Costa-Rica (50%) and Mexico (52.7%). Finally, always in relative terms, the overlapping component is highest for Costa-Rica (49.6%) and Poland (41.4%) and lowest for Denmark (12.6%).

5) The results of the empirical analysis:

Tables 5 to 7 present the results of the regression analysis. In Table 5 we present the results of regressions where the dependent variables are respectively the overall Gini index, the between and within groups inequality and the overlapping component and the exogenous variables are the per capita G.D.P., the inverse of the per capita G.D.P. and the corrected indices of trade and investment openness. In Table 6 we present the same regressions but without the exogenous variable measuring the inverse of the per capita G.D.P. as the coefficient of the latter was generally not significant.
As a whole it appears that overall inequality as measured by the Gini index decreases with the level of development (measured by the per capita G.D.P.) and the degree of trade openness but increases with the level of investment openness.
Inequality therefore decreases with the level of development, once the degree of openness to international trade and investment is kept constant. This negative net effect of the level of development is however the consequence of several influences. On one hand an increase in per capita G.D.P. decreases the between groups (urban and rural areas) inequality as well as the overlapping component. On the other hand the effect of the level of development on the within groups inequality is less clear. In Table 5 which includes a non linear term, the coefficients of both G.D.P. and (1/G.D.P.) are positive and significant. This indicates that as the per capita G.D.P. increases, the within groups inequality increases but at a decreasing rate. This explains also why in Table 6 which does not include any non linear term, the effect of the per capita G.D.P. is not significant.
A closer look at these results shows however that the net effect of the per capita G.D.P. on the within groups inequality is in fact the consequence of two opposite impacts, as shown by the results of Table 7 in the case where no non linear term is included. An increase in per capita G.D.P. increases the within urban areas inequality but decreases the within rural areas inequality.
We could summarize all these influences by saying that as a whole as the level of development increases, differences in per capita G.D.P. between urban and rural areas as well as inequality within rural areas decrease but inequality within the urban areas increases, the latter being probably the consequence of a relative increase in high incomes in urban areas[2]
If we now take a look at the pure (that is for a given level of per capita G.D.P. and of international investment openness) impact of openness to trade, we observe (see Tables 5 and 6) that, *ceteris paribus*, trade decreases the between and within groups inequality but has no significant effect on the overlapping component. Concerning this net effect of trade on within areas inequality, note that this negative effect seems to be significant only in rural areas (see Table 7). To summarize we may therefore say that the main impact of openness to international trade is, other things constant, to decrease inequality between urban and rural areas and eventually also within rural areas.
Finally concerning the effect of openness to international investment we observe that this impact is positive for all the components of the decomposition of overall inequality but the overlapping component in which case the coefficient is not significant. Concerning the effect of openness to international investment on within areas inequality, we may observe (see Table 7) that here again the coefficient is significant for rural areas but only when the variable (1/GDP) is added to the regression.
If we want to shortly synthetize all these results we could say first that as the level of development of a country increases, one observes, for a given level of openness to international trade and investment, a decrease in the income gap between urban and rural areas, an increase in inequality within urban areas and a decrease in inequality within rural areas. Second, as the degree of trade openness increases, it appears that for a given level of development and investment openness, inequality between urban and rural areas as well as within rural areas decreases. Finally, as the degree of openness to international investment increases, one observes, for a given level of

[2] Otherwise it would be difficult to understand that the combined result of a decrease in between groups inequality and of no change in the within groups inequality is a decrease in the degree of overlapping.

development and trade openness, an increase in income inequality between urban and rural areas and within rural areas.

6) Conclusions

The policy implications of these different results seem therefore to be that trade openness which was already known (see the studies mentioned in section II) to have a positive effect on development seems to have also a significant effect on inequality in so far as the greater the degree of trade openness, the smaller income inequality. Trade openness should thus should be encouraged. Openness to international investment however, which has been already criticized by certain economists because of its destabilization effects on macroeconomic equilibria, might be put also into question because it increases income inequality, though the influence seems to be more on inequality within rural areas than on inequality within urban areas or between urban and rural areas. Naturally it would be good to strengthen these conclusions by extending the sample of observations but compatible data in this field are difficult to obtain. Moreover it would be interesting, again once data become available, to analyze the more specific effect of regional integration agreements.

Table 1: Basic data on various countries

Country	Per Capita GDP	Corrected Trade Openness Index	Corrected Investment Openness Index	Overall Gini Index
Canada	16272	0.87308	1.62	0.2345
Costa Rica	3800	0.5668	0.77	0.3707
Cyprus	7858	1.41099	1.13	0.2518
Denmark	12089	1.10561	0.65	0.1673
Spain	7406	0.83605	0.85	0.2258
Finland	12360	0.9645	0.99	0.2596
Greece	5857	0.78968	0.71	0.2530
Ireland	6239	1.82391	2.91	0.3994
Italy	11741	0.96833	0.35	0.1982
Jordan	2356	1.34743	0.46	0.2082
Sri Lanka	1959	0.66893	0.52	0.3578
Mexico	4996	0.52833	1.22	0.4250
The Netherlands	11468	2.10971	2.87	0.2612
Norway	14976	1.27885	1.55	0.2782
Poland	4086	0.77703	0.05	0.2524
Turkey	3598	0.91362	0.97	0.3994
United States	18339	0.42535	0.68	0.4053

Table 2 : Population Shares, Income Shares and Gini Index of Inequality in Urban and Rural Areas

Country	Gini index in urban areas	Gini index in rural areas	Income share of urban areas	Income share of rural areas	Popu-lation share of urban areas	Popu-lation share in rural areas
Canada	.2362	.2183	.8392	.1608	.8241	.1759
Costa Rica	.3699	.3716	.5084	.4916	.5098	.4902
Cyprus	.2555	.2180	.7383	.2617	.6924	.3076
Denmark	.1671	.1688	.9268	.0732	.9246	.0754
Spain	.2239	.2162	.7553	.2447	.7235	.2765
Finland	.2538	.2572	.6553	.3447	.6138	.3862
Greece	.2503	.2456	.6954	.3046	.6556	.3444
Ireland	.3912	.4064	.6716	.3284	.6305	.3695
Italy	.1976	.1990	.7324	.2676	.7270	.2730
Jordan	.2103	.1993	.6767	.3233	.6598	.3402
Sri Lanka	.3481	.3369	.2759	.7241	.1953	.8047
Mexico	.3978	.3897	.7578	.2422	.6257	.3743
The Ne-therlands	.2705	.2324	.6972	.3028	.7206	.2794
Norway	.2735	.2851	.8199	.1801	.7930	.2070
Poland	.2481	.2587	.6451	.3549	.6321	.3679
Turkey	.3826	.3931	.6668	.3332	.5801	.4199
United States	.4023	.4102	.8933	.1067	.8717	.1283

Table 3: Decomposition of Overall Inequality into a Between Groups, a Within Groups and an Overlapping Component

Country	Overall Gini Index	Contribution of the between urban and rural areas inequality	Contribution of the within urban and rural areas inequality	Contribution of the overlapping component
Canada	0.2345	0.0151	0.1695	0.0499
Costa Rica	0.3707	0.0014	0.1854	0.1839
Cyprus	0.2518	0.0459	0.1482	0.0577
Denmark	0.1673	0.0022	0.1441	0.0210
Spain	0.2258	0.0318	0.1370	0.0569
Finland	0.2596	0.0414	0.1363	0.0818
Greece	0.2530	0.0398	0.1399	0.0733
Ireland	0.3994	0.0411	0.2150	0.1433
Italy	0.1982	0.0054	0.1197	0.0730
Jordan	0.2082	0.0169	0.1158	0.0755
Sri Lanka	0.3578	0.0806	0.2151	0.0622
Mexico	0.4250	0.1321	0.2239	0.0690
The Netherlands	0.2612	0.0235	0.1555	0.0821
Norway	0.2782	0.0268	0.1884	0.0630
Poland	0.2524	0.0130	0.1349	0.1045
Turkey	0.3994	0.0867	0.2030	0.1097
United States	0.4053	0.0215	0.3189	0.0650

Table 4: Decomposition of Overall Inequality into a Between Groups, a Within Groups and an Overlapping Component (in percent)

Country	Overall Gini Index	Contribution of the between urban and rural areas inequality	Contribution of the within urban and rural areas inequality	Contribution of the overlapping component
Canada	100	6.4	72.3	21.3
Costa Rica	100	0.4	50.0	49.6
Cyprus	100	18.2	58.9	22.9
Denmark	100	1.3	86.1	12.6
Spain	100	14.1	60.7	25.2
Finland	100	15.9	52.5	31.5
Greece	100	15.7	55.3	29.0
Ireland	100	10.3	53.8	35.9
Italy	100	2.7	60.4	36.8
Jordan	100	8.1	55.6	36.3
Sri Lanka	100	22.5	60.1	17.4
Mexico	100	31.1	52.7	16.2
Netherlands	100	9.0	59.5	31.4
Norway	100	9.6	67.7	22.6
Poland	100	5.2	53.4	41.4
Turkey	100	21.7	50.8	27.5
United States	100	5.3	78.7	16.0

Table 5: Regression Results[3] with four exogenous variables

Exogenous Variables	Dependent Variable: Overall Gini Index	Dependent Variable: Between Groups Inequality	Dependent Variable: Within Groups Inequality	Dependent Variable: Overlapping Component
Intercept	0.339 (3.6983	0.078 (1.63)	0.118 (1.99)	0.143 (2.56)
Per Capita Gross Domestic Product	-0.000002 (-0.48)	-0.000003 (-1.12)	0.000006 (1.82)	-0.000005 (-1.74)
Trade Openness Index	-0.189 (-4.15)	-0.054 (-2.19)	-0.105 (-3.44)	-0.030 (-1030)
Investment Openness Index	0.119 (4.40)	0.033 (2.23)	0.061 (3.36)	0.025 (1.49)
(1/Per Capita Gross Domestic Product)	210.3 (1.04)	25.0 (0.23)	254.5 (1.89)	-69.2 (-0.55)

Table 6: Regression Results[4] with three exogenous variables

Exogenous Variables	Dependent Variable: Overall Gini Index	Dependent Variable: Between Groups Inequality	Dependent Variable: Within Groups Inequality	Dependent Variable: Overlapping Component
Intercept	0.420 (9.94)	0.088 (4.00)	0.216 (7.00)	0.116 (4.50)
Per Capita Gross Domestic Product	-0.000007 (-2.367)	-0.000004 (-2.39)	0.000001 (0.43)	-0.000004 (-2.34)
Trade Openness Index	-0.191 (-4.17)	-0.054 (-2.29)	-10788 (-3.21)	-0.029 (-1.04)
Investment Openness Index	0.114 (4.27)	0.032 (2.31)	0.055 (2.81)	0.027 (1.66)

[3] t-values in parentheses.
[4] t-values in parentheses.

Table 7: Regression results[5] for the two components of the within groups inequality

Exogenous Variables	Within urban areas inequality	Within urban areas inequality	Within rural areas inequality	Within rural areas inequality
Intercept	0.143 (1.87)	0.105 (2.96)	-0.025 (-0.54)	0.112 (3.77)
Per capita G.D.P.	0.000005 (1.06)	0.000007 (2.77)	0.000001 (0.57)	-0.000007 (-2.88)
1/Per capita G.D.P.	-98.1.2 (-0.56)		352.6 (3.33)	
Corrected Trade Openness Index	-0.063 (-1.59)	-0.062 (-1.61)	-0.043 (-1.77)	-0.045 (-1.42)
Corrected Investment Openness Index	-0.033 (-1.42)	-0.036 (-1.58)	0.028 (1.95)	0.020 (1.04)

[5] t-values in parentheses.

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Income Inequality and Openness to International Trade: The Case of Israel

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1. **Introduction**

During the past twenty years numerous papers have attempted to analyze the effect of macroeconomic variables on income inequality (see, Slottje, 1994, for a detailed analysis of this issue). Following a pioneering study by Blinder and Esaki (1978), most of these studies tried to look at the impact of inflation and unemployment on income inequality. In recent years however, because of the phenomenon of globalization, there has been also a growing literature attempting to look at the impact openness to international trade may have on economic growth. Much scarcer however are the studies which try to analyze the impact of such an openness on income inequality and poverty. This paper is an attempt in this direction in so far as its goal is to determine the impact which the increasing degree of openness to international trade had on income inequality in Israel. In order to implement such a study we have collected data covering a period of thirty years (1967-1997). Since however this was a period during which Israel at some stage was close to experiencing hyperinflation we had to take into account inflation when analyzing the impact of openness on inequality. Moreover during this same period there was, during a very short period, a huge inflow of immigrants, coming mainly from the former U.S.S.R., so that Israel experienced also, for a while at least, relatively high levels of unemployment. We decided therefore to include also the unemployment rate in our analysis.

Our study therefore combines in a way two strands of analyses: a first type which focuses more on the short term effect of macroeconomic variables, such as inflation and unemployment, on inequality and a second type which is rather more interested by the long run effect of openness to trade on income inequality. In order to implement our analysis we have also tried to make a distinction between unexpected and expected inflation, following here an earlier study by Silber and Zilberfarb (1994). To examine the relationship between inequality and the three or four exogenous variables introduced in this study we have used vector autoregressions as it was clear to us that there were lagged effects.

The results of our empirical analysis indicate that the various variables which have been introduced had a significant effect on inequality, so that inflation, at least unexpected inflation, unemployment and openness to international trade do not affect equally all the income deciles. Naturally additional studies based on time series collected in other countries are needed before more definitive conclusions may be drawn as to the impact of openness to international trade on income inequality.

The paper is organized as follows. Section two summarizes the main measurement issues we had to deal with while section 3 gives a short survey of the macroeconomic conditions in Israel during the years 1967-1997. In section 4 we look into more details at the degree of openness of Israel to international trade, emphasizing in particular the various agreements which have been signed over the years between Israel and the European Union. The econometric model is described in section 5, while section 6 gives the results of our empirical analysis and concluding comments are given in section 7.

2. Measurement Issues

Size distributions of incomes are usually constructed by assigning incomes to income units and classifying these units by increasing or decreasing income size. Such an operation assumes that income has been chosen as the variable which is most appropriate to analyze inequality, that an agreement has been reached concerning the most relevant income concept as well as the most suitable income unit. One also has to make sure that the data collected over time or across areas cover the same type of population. Finally if one desires to use an index summarizing the extent of inequality, one also has to make a choice among various possible inequality measures.

a) The definition of income

Income may be limited to labor income or it may include additional income sources such as property income, capital gains or pensions. It may be measured before taxes in which case it is called gross income or be a net after-tax income. One may also define a before taxes but after transfers income or an after tax and transfers income. Sometimes one may have to decide whether income in kind should be included, provided such data are available. Another question concerns the inclusion of imputed income such as the potential rent an owner of an apartment or a house could obtain, if
she would rent her apartment (house). The same kind of problem arises concerning the ownership of a car. Finally if a concept of net of taxes income is adopted one may also consider deducting local and not only national taxes (see, Menirav, 2000, for an interesting comparison of all these income concepts, and the implications concerning the measurement of income inequality).

b) Inequality of incomes or of consumption expenditures?

Another dilemma involves the choice between income and consumption as the basis of inequality analysis. Although most studies of inequality use one or another of the various possible definitions of income, it has been argued that consumption is more relevant than income to study inequality. The idea is that current income fluctuates more than permanent income and since consumption depends more on permanent than on current income, consumption may be a better variable if the idea is to analyze permanent inequality. The results one obtains when basing the analysis on some concept of income may be often quite different from those derived from a study using consumption data (see, Menirav, 2000, for a comparison of the extent of poverty in Israel when income or consumption are used to derive poverty measures).

c) The selection of the appropriate income unit:

Here also caution is required. Whereas the basis of most consumption surveys are data collected at the household level, in which case the data will include the consumption of all the individuals living in the household, some consumption surveys preferred to use the concept of family which refers to all the individuals living in the same household, who are related by blood, marriage or adoption. The first consumption surveys which were conducted in Israel used for example the concept of family rather than that of household.
Another issue concerns the choice between, say, household income or per capita income. Often one also introduces a variable called income per standardized person, a concept that takes into account the size of the household and sometimes even the age of its members. The selection of one of these notions may be explained in terms of the
relative importance one wishes to give to “private” versus “public” goods in the household. If one assumes for example that all the goods and services acquired by the household are ultimately appropriated by a given member of the household, then the relevant concept is evidently income per person since to measure the actual standard
of living of a household member, one has to divide total household income by the number of its members. If on the contrary one were to assume that all the goods and services which one finds in a household may be considered as “public” goods, that is goods which may be shared by several members of the household at the same time (e.g., a refrigerator, a living room, etc...), then evidently total household income is the appropriate measure of the welfare level of the different household members. An intermediate and probably more appropriate solution is to assume that some goods and services are “ private” whereas some others are “public”, so that one may want to compute an “equivalized income”, or what is often known as income per “standardized person” (see, Buhmann

et al., 1988, for an interesting presentation of these ideas, or Cowell and Mercader-Prats, 1999, for a survey of the issue of equivalence scales and inequality).

d) The population surveyed:

Income or consumption surveys may be conducted in the whole population, whether the household lives in a urban or a rural area, or it may be limited, as is often the case, specially in developing countries, to urban areas. It may cover only households whose head participates in the labor force or only household whose head is employed (and hence will exclude households whose head is unemployed) or only wage earners, in which case self-employed heads of households are not taken into account. One has therefore to be extremely careful when making international comparisons. In Israel for example the longest time series available refers to urban households whose head is employed.

e) The selection of an inequality measure:

An index of inequality may be considered as a summary statistic of the dispersion of incomes. Since there exist many measures of inequality, the ranking of various income distributions may often depend on the inequality index which has been selected. There are various ways of choosing between inequality measures. One may want to relate an inequality index to some social welfare function, and this is not possible for all indices, and then select an inequality index on the basis of the properties that the implicit social welfare function that it implies, fulfils. Another possibility is to specify a set of properties which one would like an inequality index to possess and select the index that has the most desirable properties. Finally it should be stressed that it is also possible to use an ordinal rather than a cardinal approach to inequality, in which case one would be only able to rank income distributions but not say how much more unequal one distribution is compared to another. More details on these various issues may be found in Blackorby et al., 1999, Chakravarty, 1999, and Moyes, 1999.

3. Macroeconomic Conditions in Israel during the Period Analyzed

a) Inflation:

We have analyzed a period covering the years 1967 to 1997. Macroeconomic conditions have varied considerably during such a period as is evident from Table 1 which gives the annual inflation and unemployment rates. Inflation was for example very low during the 1967-1969 period and it took more than thirty years for inflation to reach again similar levels (the inflation rate in 1999 was equal to 3.3%). Growing aggregate demand, following the Six Day War, put pressure on prices, and inflation increased to 13% a year in 1971-1972. The Yom Kippur War and the first oil shock in October 1973 raised inflation to a new annual level of 30-40% which prevailed in 1974-1977. In October 1977 a new economic policy was adopted that liberalized the foreign exchange market and instituted a flexible exchange rate system. Due to inadequate monetary and fiscal measures, the new policy led to an increase in the annual inflation rate to about 120 % during the years 1979-1983 (see, Zilberfarb, 1990, for an analysis of this new policy). A run of foreign exchange led to the collapse of the Israeli stock market in the last quarter of 1983 and forced the government to devaluate the Israeli shekel by 23%. This led to another jump in inflation to a level of more than 400% per year in 1984 and in the first half of 1985.
In July 1985 a national unity government introduced a new anti-inflation program. Its
main elements were a major cut in the deficit of the government, a move to a regime of fixed exchange rates and temporary wage and price controls (see, Bruno, 1986, for a description and an analysis of this program). The new economic program was very successful and inflation went down to approximately 18% during the 1987-1991 period. As indicated earlier, it took another eight years

and a very restrictive monetary policy to bring down inflation to levels similar to those which existed at the beginning of the period we analyze.

b) Unemployment:

The path of unemployment was quite different. If one excludes the period of massive immigration during the late 1940s and early 1950s (see, Neuman, 1999, for an extensive survey of immigration waves in Israel), unemployment was not a major problem in Israel until the second half of the 1960s. The unemployment rate was relatively low in 1965 (3.6%) but rose sharply in 1966 (7.4%) and 1967 (10.4%), two years during which there was a major recession in Israel. Unemployment decreased rapidly after the Six Day War and was less than 4% throughout the 1970s. The rising inflation rates in the early 1980s seem to have had negative effects on output growth and the unemployment rate reached 6.7% in 1985. The successful anti-inflation program reduced inflation and renewed economic growth but unemployment remained relatively high (6.4 to 7,1%). Mass immigration from the former Soviet Union in the early 1990s pushed unemployment rates to record levels after 1989 (the unemployment rate was equal to 11.2% in 1992). Unemployment decreased somehow after 1992 to reach 6.7% in 1996 but afterwards it increased again reaching 8.9% in 1999.

4) Openness to Trade and Trade Agreements between Israel and the European Union:

Europe, specially Western Europe, has always been in several respects a natural trading partner for Israel, not only because of proximity and Israel's restricted commercial relations with her geographical neighbors, but also because of the structure of Israeli exports, whether one refers to agricultural products which for climatic reasons should be of interest to countries in Northern Europe, or to the type of manufactured goods produced in Israel which are often of great interest to countries with the kind of standard of living prevailing in Western Europe. This explains why Israel has always attempted to promote close trade relations with European countries. Such a policy was made easier by the decision taken by Israel to liberalize her own trade policies, at least during the period which is analyzed in this paper, so that reciprocal concessions in the form of improved access to Israeli markets for European exports were made possible.

A first commercial agreement was signed in 1964. It implied reductions in the European Community's most favored nation tariff on some goods of special interest to Israel.

In 1970 a preferential trade agreement was signed with Israel which reduced by 50% the tariffs of the European Community on Israeli manufactured exports and by 40% those imposed on some agricultural exports. There was however an exception list for sensitive industrial exports (corresponding more or less to one third of the Israeli manufactured exports to the European Community) for which full duties were to be levied. Moreover most agricultural exports were not covered by the agreement. The impact of this agreement is not easy to evaluate since similar preferential agreements were signed by the European Community with other Mediterranean countries and because the United Kingdom, an important trading partner for Israel, joined the European Community in 1974.

In 1975 a free trade agreement was signed between the European Community and Israel. This agreement led to the abolition of all trade barriers on Israeli manufactured exports by July 1977, subject to ceilings on some goods until the end of 1979. Israeli tariffs on manufactured exports by the European Community were removed progressively, those on the most sensitive imports being removed by the end of 1989. More details on the various agreements signed between Israel and the European Community may be found in Greilsammer and Weiler, 1988, (see also Berrebi and Silber, 1988, for an analysis of the impact of the 1975 Free Trade Agreement on Israeli exports).

One should add that in 1978 a trade agreement was signed between Israel and the United States which removed duties on the most important items that Israel was exporting to the United States.

Finally on November 20 1995 Israel signed an Association Agreement with the European Union. This "Association Agreement" replaces the earlier Cooperation Agreement of 1975. The main

features of this Agreement include regular political dialogue, provisions on freedom of establishment and liberalization of services, the free movement of capital, competition rules with, in particular, a request for transparency in state aid and adjustment in state monopolies, the strengthening of economic cooperation, cooperation on social matters and cultural cooperation.
An Agreement has also been signed on Scientific and Technical Cooperation which provides for the participation of Israel research entities in European scientific
programs. Finally there is also an Agreement on Procurement by Telecommunications
Operators and on Government Procurement which provides for a mutual opening of procurement by telecommunications operators through granting an exchange of national treatment.
Since the period covered in the present analysis ends in 1997, it is too early to attempt to detect the impact of such an agreement but, needless to say, future analyses will have to take it into account.
These agreements as well as Israel's deliberate policy of openness to international trade have had an important impact on the degree of Israel's openness to international trade. We present in Table 1 the yearly data on openness to international trade, this variable being equal to the ratio of the sum of imports and exports to the Gross Domestic Product.
It appears clearly that there was a tremendous increase in the degree of openness to international trade during the past 40 years. The index more than doubled, since it was equal to 0.33 in 1959 and to 0.79 in 1999. There were naturally fluctuations over the years in its value (e.g. the index was higher in 1996 than in 1999) but the upward trend is clear.

5. The Econometric Model

In accordance with Blinder and Esaki (1978) who were probably the first to attempt to analyze the impact of macroeconomic variables on income inequality, we have first estimated the following equations:

$$S_i(t) = a_i + b_i\ U(t) + c_i\ \Pi(t) + d_i\, O(t) + \varepsilon_i(t) \qquad (1)$$

where $S_i(t)$, $U(t)$, $\Pi(t)$ and $O(t)$ measure respectively for each year t the share of decile i in total income, the unemployment rate, the actual inflation rate and the degree of openness to international trade. To solve the problems of autocorrelation we used the method of feasible generalized least squares and adopted the Prais-Winsten (1954) estimator (see Appendix A and Green, 1993, for more details on this estimation technique).
The only variable which did not appear in Blinder and Esaki (1978) study is the openness to trade variable and we added it because it is evidently the central element
of our inquiry.
We have also run a regression where the dependent variable was not the share of some decile i at time t but the Gini index of inequality G(t) at time t, the exogenous variables being the same as those which appear in (1).
Since, as indicated earlier, inflation, during the period covered, reached at some stages (between 1980 and 1985) very high levels, we have also attempted to decompose the actual inflation rate into an expected and an unexpected inflation rate, the idea being
first that it may be easier for individuals to protect themselves against expected than against unexpected inflation, second that it might be easier for richer individuals to protect themselves against unexpected inflation. Given that $E\Pi(t)$ and $U\Pi(t)$ denote respectively the expected and unexpected rates of inflation and time t, the second type of regressions we have run may be expressed as

$$S_i(t) = a_i + b_i\ U(t) + c_i\ E\Pi(t) + d_i\ U\Pi(t) + e_i\, O(t) + \varepsilon_i(t) \qquad (2)$$

Here also we ran an additional regression where the dependent variable was the Gini index of inequality G(t) at time t.

To compute the expected rate of inflation EΠ(t) during year t we have used monthly data on the inflation rates and proceeded as follows. We first regressed the actual rate of inflation during month τ , M$\pi(\tau)$, on past monthly rates, assuming an autoregressive process of the sixth order AR(6) (see, Green, 1993, for more details on the estimation technique to be adopted in such a case).We were thus able to estimate for each month τ the expected monthly rate of inflation E M$\pi(\tau)$. This allowed us to compute for each month the expected (predicted) price index EP(τ).

We then regressed, separately for each year, that is on the basis of the monthly observations EP(τ) of the corresponding year, the logarithm of the expected price index EP(τ) on the time variable τ by writing that

$$\ln EP(\tau) = a + b\tau$$

The estimate b' of b derived on the basis of such a regression was then used to compute the expected annual rate of inflation for year t, Eπ(t), by writing that

$$E\pi(t) = 12b'$$

6. The Empirical Results

The results for the regressions of the type presented in expression (1) are presented in Table 2. We did not give the results for each decile preferring to show what happens at the lower and at the higher end of the distribution as well as in its middle so that we would be able to find out whether a given variable had a greater impact on the poor, the rich or on the middle class.

If we look first at the determinants of overall income inequality when the latter is measured by the Gini index it appears that inflation and unemployment increase inequality while the degree of openness to international trade had no significant

impact. These results are confirmed when we analyze the effect of these three variables on the two poorest and two richest deciles since inflation and unemployment tend to increase the share of the richest and decrease that of the poorest in total income, the openness to international trade having, here also, no significant impact. Similar effects are obtained when we define the poor as the five poorest deciles and the rich as the five richest deciles.

To analyze the impact of inflation, unemployment and openness to trade on the "middle class" we successively looked at the effect these variables have on groups which included all the deciles from the third to eighth, the fifth to the eighth, the sixth to the eighth or the fifth to the seventh. The results given in Table 2 indicate that whatever the way we define the middle class, inflation and unemployment have a negative effect on the share of the middle class. As to the impact of openness to international trade it appears that it has a negative and significant effect on the income

share of the middle class if we define the latter as including either the fifth to eighth deciles, the fifth to seventh deciles or the sixth to eighth deciles. In other words it seems that openness to trade has a negative impact on the lower section of the middle class while it has no effect on the poor or on the rich deciles.

In Table 3 we have extended our analysis by making a distinction between expected and unexpected inflation, using the estimation method described previously. On one hand it appears that expected inflation does not have any impact on inequality, whether we take as dependent variable the Gini index or the share of any income decile or of any grouping of deciles. Unexpected inflation on the other hand has a positive effect on inequality when the latter is measured by the Gini index. One may also observe that unexpected inflation increases the share of the two or even five richest deciles. Note however that its effect on the richest decile is not really

significant. Similarly unexpected inflation decreases the income share of the two or five lowest deciles but does not seem to have a significant impact on the poorest decile. Finally one should also observe that unexpected inflation decreases the share of the middle class, whatever the way we define the latter (third to eighth deciles, fifth to eighth deciles, sixth to eighth deciles or fifth to seventh deciles).

The effect of unemployment is similar to that of unexpected inflation since it raises the income share of the rich and decreases that of the poor as well as of the middle class. Note however that it has no significant effect on the poorest decile.
Finally when we look at the impact of openness to international trade the results are very similar to those observed in table 2 in so far as this openness has no significant
effect on the rich or on the poor but it decreases the income share of the middle class, specially of the lower middle class.

7. Concluding Comments

In this paper an attempt has been made to analyze the impact of the openness to international trade on income inequality in Israel during the period 1967-1997. In order to do so we regressed either the Gini index of income inequality or the share of various income deciles on the three variables which were assumed to have a possible impact on inequality: the rate of inflation, the rate of unemployment and the degree of openness to international trade. A quick look at the annual values of these three variables shows that the degree of openness to international trade almost doubled in a period of 30 years, that unemployment was very high at the beginning of the period considered as well as in the early 1990's. Finally, as is probably well-known, Israel experienced almost hyperinflation during this period of thirty years since in 1984 the annual inflation rate was close to 500%. In the regression analysis we tried also to make a distinction between expected and unexpected inflation. The expected inflation rate in a given month was assumed to be a function, in a sixth order autoregressive process, of the inflation rates experienced during the past sixth month. Then an annual expected inflation rate was estimated on the basis of the monthly expected inflation rates. Unexpected inflation was then defined as being equal to the difference between actual and expected inflation.
The regression results indicate first that expected inflation had no significant on inequality (on the Gini index) as well as on the income share of any income decile.
We also observed that unemployment and unexpected inflation had as a whole similar effect in so far as they tended to increase the income shares of the rich and decrease that of the poor and of the middle class. Finally the degree of openness to international trade had no effect on the rich or on the poor but had a significant negative impact on the income share of the middle class, essentially of the lower section of the middle class.
These results as a whole tend to confirm that in a developed country like Israel the rich have usually the means to protect themselves against the dangers of inflation or unemployment. They may even benefit from a situation of high inflation or high unemployment. The poor on the contrary seem to suffer in periods of higher inflation or unemployment (remember that our data refer to gross income so that we did not take into account the impact of the tax and transfer system). As to the main concern of our study, the role that openness to international trade may play, our analysis has
shown that it has no significant impact on the poor or on the rich but it has a negative effect on the income share of the lower middle class. Naturally such conclusions are at this stage specific to the Israeli case. Additional national studies based on time series are needed before one may derive strong conclusions as to the impact of openness to international trade on income inequality.

Appendix A: The Prais-Winsten Estimation Method

Let us assume a regression where the dependent variable is the value y_t of a variable y at time t whereas the exogenous variable is the value x_t of the variable x at time t. We may therefore write that

$$y_t = \alpha + \beta x_t + \mu_t \qquad (1)$$

Let us also assume that the errors are first-order autoregressive so that we may write that

$$\mu_t = \rho \mu_{t-1} + \varepsilon_t \qquad (2)$$

where ε_t is a normal random variable fulfilling the conditions:
$E\varepsilon_t=0$, $V(\varepsilon_t)=\sigma^2$ and $E\varepsilon_t\varepsilon_{t-1}=0$.
In a first stage we regress equation (1), using ordinary least squares, and obtain estimates $\hat{\alpha}$ and $\hat{\beta}$, as well as the estimated errors $\hat{\mu}_t$.
We then estimate ρ as being equal to the expression

$$\hat{\rho} = \sum_t \hat{\mu}_t \hat{\mu}_{t-1} / \sum_t \hat{\mu}_t^2 . \qquad (3)$$

and compute the values of new variables y_t^* and x_t^* where

$$y_t^* = y_t - \hat{\rho} y_{t-1} \qquad (4)$$
$$x_t^* = x_t - \hat{\rho} x_{t-1} \qquad (5)$$

The first observations y_0 and x_0 are estimated on the basis of the expressions

$$y_0 = \sqrt{1-\hat{\rho}^2}\, y_1 \qquad (6)$$

and

$$x_0 = \sqrt{1-\hat{\rho}^2}\, x_1 \qquad (7)$$

In a second stage we regress the transformed variables y_t^* on x_t^*, and estimate the regression:

$$y_t^* = \alpha(1-\rho) + \beta x_t^* + \varepsilon_t \qquad (8)$$

The new estimates of α and β can be substituted in equation (1) to obtain new estimates of $\hat{\mu}$ and $\hat{\rho}$ using equation (3). Substituting in equations (4)-(7) we regress again equation (8) and the process is repeated until the estimate $\hat{\rho}$ obtained in round *s* differs from the one obtained in round *s+1* by less than an arbitrary value δ.
Naturally the same procedure may be applied when there is more than one exogenous variable x_t, which is in fact our case since we have three exogenous variables, the rates of inflation and unemployment as well as the degree of openness to international trade.

Table 1: Basic data for the period analyzed

Year	Inflation Rate	Unemployment rate	Gini Index	Openness to International Trade
1959	0.006	5.5		0.338
1960	0.049	4.6		0.377
1961	0.067	3.6		0.411
1962	0.096	3.7		0.433
1963	0.05	3.6		0.429
1964	0.033	3.3		0.427
1965	0.057	3.7		0.407
1966	0.057	7.3		0.416
1967	¯0.007	10.4	0.359	0.444
1968	0.003	6.1	0.327	0.496
1969	0.028	4.5	0.315	0.494
1970	0.119	3.8	0.306	0.527
1971	0.121	3.5	0.292	0.545
1972	0.109	2.7	0.298	0.513
1973	0.241	2.6	0.3	0.604
1974	0.403	3	0.313	0.586
1975	0.214	3.1	0.289	0.583
1976	0.4	3.6	0.281	0.593
1977	0.47	3.9	0.29	0.596
1978	0.479	3.6	0.304	0.619
1979	1.152	2.9		0.608
1980	1.357	4.8	0.32	0.583
1981	0.976	5	0.32	0.602
1982	1.364	5	0.324	0.597
1983	1.81	4.5	0.324	0.61
1984	4.967	5.9	0.353	0.625
1985	2.228	6.7	0.327	0.621
1986	0.223	7.1		0.645
1987	0.143	6.1	0.319	0.701
1988	0.157	6.4	0.315	0.662
1989	0.166	8.9	0.33	0.647
1990	0.197	9.6	0.325	0.646
1991	0.215	10.6	0.337	0.658
1992	0.093	11.2	0.345	0.682
1993	0.099	10	0.336	0.742
1994	0.157	7.8	0.359	0.774
1995	0.09	6.9	0.356	0.783
1996	0.102	6.7	0.352	0.81
1997	0.076	7.7	0.353	0.8
1998	0.098	8.6		0.79
1999	0.033	8.9		

Note: Some data were missing for the years 1979, 1986, 1998 and 1999.

Table 2: Regression results with actual inflation rate among the exogenous variables

Dependent Variable	Inflation rate	Unemployment Rate	Openness to trade	Constant	R-Square and Durbin-Watson
Gini Index	0.0074 (2.8)	0.0060 (4.3)	0.045 (1.0)	0.256 (8.9)	0.95 (1.63)
Share of first (richest) Decile	-0.084 (-1.47)	0.469 (4.8)	3.012 (1.0)	19.4 (10.2)	0.95 (1.92)
Share of tenth decile	-0.084 (-1.47)	-0.045 (-1.46)	0.751 (0.80)	2.44 (3.83)	0.63 (1.33)
Share of two richest deciles	0.515 (2.56)	0.513 (4.71)	3.80 (1.13)	34.3 (15.1)	0.98 (1.82)
Share of two lowest deciles	-0.207 (-2.21)	-0.132 (-2.59)	-0.024 (-0.015)	7.94 (1.07)	0.84 (1.34)
Share of five richest deciles	0.540 (3.09)	0.380 (4.16)	4.01 (1.45)	67.7 (36.7)	0.99 (1.58)
Share of five lowest deciles	-0.540 (-3.09)	-0.380 (-4.16)	-4.01 (-1.45)	32.3 (17.6)	0.96 (1.58)
Combined share of third to eighth deciles	-0.299 (-1.96)	-0.377 (-4.67)	-3.948 (-1.61)	57.8 (35.2)	0.99 (1.98)
Combined share of fifth to eighth deciles	-0.375 (-3.04)	-0.303 (-4.90)	-4.73 (-2.60)	34.4 (28.9)	0.98 (1.87)
Combined share of sixth to eighth deciles	-0.317 (-3.22)	-0.239 (-4.97)	-4.197 (-3.02)	24.5 (27.2)	0.97 (1.80)
Combined share of fifth to seventh deciles	-0.280 (-2.97)	-0.233 (-4.50)	-3.15 (-2.09)	27.2 (27.0)	0.99 (1.90)

Note: The number in parentheses are t-values, except in the last column where they refer to the Durbin-Watson statistic.

Table 3: Regression results with expected and unexpected inflation rates among the exogenous variables

Dependent Variable	Expected Inflation	Unexpected Inflation	Unem-ployment	Openness to trade	constant	R-square and Durbin Watson
Gini Index	0.0047 (1.07)	0.0076 (2.85)	0.0060 (4.32)	0.043 (1.01)	0..259 (9.09)	0.95 (1.70)
Share of first (richest) decile	0.203 (0.65)	0.312 (1.58)	0.464 (4.76)	2.99 (1.04)	19.5 (10.2)	0.95 (1.93)
Share of tenth (poorest) decile	-0.047 (-0.47)	-0.086 (-1.48)	-0.045 (-1.45)	0.802 (0.84)	2.38 (3.67)	0.63 (1.40)
Share of two richest deciles	0.337 (0.97)	0.519 (2.52)	0.510 (4.73)	3.77 (1.15)	34.5 (15.4)	0.98 (1.85)
Share of two lowest deciles	-0.140 (-0.84)	-0.211 (-2.21)	-0.131 (-2.55)	0.056 (0.035)	7.84 (7.16)	0.84 (1.41)
Share of five richest deciles	0.367 (1.26)	0.558 (3.12)	0.378 (4.14)	3.82 (1.40)	67.9 (36.8)	0.99 (1.66)
Share of five lowest deciles	-0.367 (-1.26)	-0.558 (-3.12)	-0.378 (-4.15)	-3.82 (-1.40)	32.1 (17.4)	0.96 (1.66)
Combined share of third to eighth deciles	-0.072 (0.23)	-0.629 (-2.0)	-0.358 (-4.6)	-3.99 (-1.75)	57.5 (37.4)	0.99 (1.94)
Combined share of fifth to eighth deciles	-0.053 (-0.22)	-0.710 (-2.08)	-0.291 (-4.8)	-4.51 (-2.56)	34.0 (29.0)	0.98 (1.87)
Combined share of sixth to eighth deciles	-0.111 (-0.57)	-0.549 (-2.62)	-0.231 (-4.78)	-4.015 (-2.86)	24.2 (26.0)	0.98 (1.82)
Combined share of fifth to seventh deciles	-0.033 (0.18)	-0.557 (-2.94)	-0.207 (-4.59)	-3.073 (-2.33)	26.9 (30.6)	0.99 (1.88)

Note: The number in parentheses are t-values, except in the last column where they refer to the Durbin-Watson statistic

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Human Development and the Impact of the Openness to International Trade and Investment

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1. Introduction:

"Competition markets may be the best guarantee of efficiency but not necessarily of equity. Liberalization and privatization can be a step to competitive markets - but not a guarantee of them. And markets are neither the first nor the last word in human development. Many activities and goods that are critical to human development are provided outside the market - but these are being squeezed by the pressures of global competition. There is a fiscal squeeze on public goods, a time squeeze on care activities and an incentive squeeze on the environment. When a market goes too far in dominating social and political outcomes, the opportunities and rewards of globalization spread unequally and inequitably - concentrating power and wealth in a select group of people, nations and corporations, marginalizing the others."

These sentences are drawn from the introduction to the 1999 Human Development Report and the title of this introductory overview was *Globalization with a Human Face.* The purpose of the present study is to attempt to check what the exact impact of globalization has been on human development. We have collected data on the levels of human development and on the level of openness to international trade and investment for the years 1975, 1985 and 1995 and tried to estimate how this openness affected human development. Using separate measures for the degree of openness to international trade and the degree of openness to international investment, we found, on the basis of our panel data, that both indices of openness had a significant positive impact on human development, though the degree of openness to international trade plays a greater role. Borrowing decomposition techniques from the literature on income inequality measurement we were also able to determine which percentage of the dispersion in levels of human development (measured by the mean difference of the Human Development Index) could be attributed to the degrees of openness to international trade and investment. The paper is organized as follows. Section 2 recalls how the Gini index of income inequality may be decomposed by income source and how this breakdown may be applied to regression results. Section 3 then applies the technique to the analysis of the impact of globalization on human development while a short conclusion summarizes our findings.

2. The Methodology:

Since the decomposition we use is based on the breakdown of income inequality by income sources we start by summarizing this technique.

a) Decomposing overall inequality by income source:

Let Z_{jk} denote the income from source k in country j. Let $Z_{.k}$ and $Z_{j.}$ be respectively defined as

$$Z_{.k} = \Sigma_{j=1 \text{ to } n} Z_{jk} \qquad (1)$$

and

$$Z_{j.} = \Sigma_{k=1 \text{ to } K} Z_{jk} \qquad (2)$$

where K represents the total number of income sources while n is the number of countries.

Let also P_{jk}, $P_{.k}$ and $P_{j.}$ be defined respectively as

$$P_{jk} = Z_{jk} / Z \qquad (3)$$

$$P_{.k} = Z_{.k} / Z \qquad (4)$$

$$P_{j.} = Z_{j.} / Z \qquad (5)$$

where Z represents the world income (all income sources combined). $P_{.k}$ is therefore the weight of income source k in total world income Z while $P_{j.}$ represents the share of country j in total world income.

Applying Silber's (1989) analysis of the breakdown of income inequality by income source, we may define the overall (for the whole world) Gini Index of inequality as:

$$I_G = [e'] G [Z] \qquad (6)$$

where [e'] is a 1 by n row vector of the shares of the various countries, each equal to (1/n), [Z] is a n by 1 column vector of the shares $P_{j.}$ of the various countries in world income and G is a n by n square matrix, called the G-matrix, (see Silber, 1989) whose typical element g_{fl} is equal to zero if f=l, to -1 if f <l and to +1 if f >l. It should be stressed that in (6) the income shares $P_{j.}$ are ranked by decreasing values of the total income (all sources combined) of the different countries and that in computing the Gini index in (6) we have given each country an equal[6] weight (1/n).

Since the share $P_{j.}$ of country j may also be written as:

$$P_{j.} = \Sigma_{k=1 \text{ to } K} P_{jk} \qquad (7)$$

(6) may be expressed as:

$$I_G = e' G \{ [P_{j1}]+...[P_{jk}] +... [P_{jK}]\} \qquad (8)$$

Note that in (8) the terms $[P_{jk}]$ on the R.H.S. of the G-matrix represent, in fact, column vectors whose typical element is equal to P_{jk}. In other words, (8) may be written as:

$$I_G = [e'] G \{\Sigma_{k=1 \text{ to } K} [P_{jk}]\} \qquad (9)$$

where $[P_{jk}]$ is a n by 1 column vector containing the n shares P_{jk} (= Z_{jk} / Z) of the income source k.

Let now W_{jk} represent the share (Z_{jk} / $Z_{.k}$) of country j in the income source k. Expression (9) may then be written as:

$$I_G = [e'] (G \{ \Sigma_{k=1 \text{ to } K} P_{.k} [W_{jk}]\} \qquad (10)$$

$$I_G = \Sigma_{k=1 \text{ to } K} P_{.k} \{ [e'] G [W_{jk}]\} \qquad (11)$$

where $[W_{jk}]$ represents the n by 1 vector of the shares W_{jk}. Remember that in the vector $[W_{jk}]$ the shares W_{jk} are ranked, not by decreasing values of the shares (Z_{jk} / $Z_{.k}$), but by decreasing values of the shares P_{jk} = ($Z_{j.}$ / Z). The shares W_{jk} may therefore not be monotonically decreasing and the expression

$$H_k = [e'] G [W_{jk}] \qquad (12)$$

is known as the Pseudo-Gini of income source k.

Let $[X_{jk}]$ represent the vector of the shares (Z_{jk} /Z) when the latter are ranked by decreasing values. The expression

$$G_k = [e'] G [X_{jk}] \qquad (13)$$

represents then the Gini Index of inequality between the various countries for income source k .

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[6] We could have also given each country a weight equal to its share in the world population.

The impact of a given income source on the inequality between the countries in the distribution of their total income may be defined in the following way. Calling C_k the contribution of income source k to total inequality, where

$$C_k = P_{.k} H_k \qquad (14)$$

we may then express the overall Gini Index as the sum of the contributions C_k of the various income sources k, that is

$$I_G = \Sigma_{k=1 \text{ to } K} C_k \qquad (15)$$

Such an approach has been used for example by Fei, Kuo and Ranis (1980), Lerman and Yitzhaki (1985) or Silber (1989).

The same kind of decomposition may be used when working with Gini's mean difference Δ rather than with Gini's Concentration Ratio I_G. Recalling that I_G may be expressed as

$$I_G = (1/2)\,(\Delta/yb) \qquad (16)$$

where yb is the average income of the different countries' income y_j, we conclude that

$$\Delta = 2\, yb\, I_G \qquad (17)$$

Similarly, using (13), we may define the mean difference Δ_k for income source k as

$$\Delta_k = 2\, yb_k\, G_k \qquad (18)$$

where yb_k is the average income from source k across countries and G_k is the Gini index of inequality for income source k.

Finally we may define, using (12), a "Pseudo-Mean Difference" $P\Delta_k$ as

$$P\Delta_k = 2\, yb_k\, H_k \qquad (19)$$

Combining expressions (14) to (19) we then conclude, after some algebraic manipulations, that

$$\Delta = \Sigma_{k=1 \text{ to } K}\, P\Delta_k \qquad (20)$$

Let us now call $G\Delta_k$ (Gini-Correlation Coefficient) the ratio ($P\Delta_k$ / Δ_k) between the "Pseudo-Mean Difference" and the actual Mean Difference for income source k.. We may then rewrite (20) as

$$\Delta = \Sigma_{k=1 \text{ to } K}\, [\, (G\Delta_k) \times \Delta_k \,] \qquad (21)$$

b) Applying the decomposition of inequality by income source to regression results:

Let us assume that to explain the determinants of some endogenous variable y we run a regression with k exogenous variables x_k . More precisely let us write that

$$y_j = \Sigma_{k=1 \text{ to } K}\, b_k\, x_{kj} + u_j \qquad (22)$$

where y_j represents the value of the endogenous variable y in country j, x_{kj} is the value taken by the exogenous variable x_k in country j, u_j is the error term for country j and b_k is the estimate obtained for the coefficient associated in the regression with the variable x_k . We may now apply the results derived earlier for the decomposition of the mean difference by income source and conclude, combining (20) and (22), that the mean difference Δ of the endogenous variable y may expressed as

$$\Delta = \Sigma_{k=1 \text{ to } K}\, P\Delta_k + P\Delta_u \qquad (23)$$

where $P\Delta_k$ is the "Pseudo-Mean Difference" of the elements ($b_k x_{kj}$) while $P\Delta_u$ is the "Pseudo-Mean Difference" of the error terms u_j. Since it may be easily proven that the "Pseudo-Mean Difference" of the elements ($b_k x_{kj}$) is equal to b_k times the "Pseudo-Mean Difference" $P\Delta(x_k)$ of the elements of the vector x_{kj}, we conclude that

$$\Delta = \Sigma_{k=1 \text{ to } K} b_k [P\Delta(x_k)] + P\Delta_u \quad (24)$$

Combining then (21) and (24) we finally derive that

$$\Delta = \Sigma_{k=1 \text{ to } K} b_k [G\Delta(x_k) \times \Delta(x_k)] + [G\Delta_u \times \Delta_u] \quad (25)$$

where $\Delta(x_k)$ and Δ_u are respectively the Mean Differences for the variable x_k and the error term u while $G\Delta(x_k)$ and $G\Delta_u$ are respectively the Gini-Correlation coefficients of the variable x_k and of the error term u.

3. An Illustration: The Determinants of the Human Development Index:

As indicated in Appendix 1 the Human Development Index (HDI) is an indicator of development which the United Nations Development Programme estimated each year for most countries during the past ten years. The HDI is a function of the per capita G.D.P., the life expectancy and the educational achievements of each country (see Appendix A for more details on the way the HDI is estimated). In the present section we will attempt to check whether the degree of openness to international trade and to international investment of each country has had an impact on its level of human development (see, Appendix B for a summary of the techniques used in determining for each country the level of openness to international trade and to international investment). We have collected data for the years 1975, 1985 and 1985 so that we have in fact panel data.

a) The data:

Tables 1 to 3 give the values of the Human Development Index and of the degrees of openness to international trade and investment for the years 1975, 1985 and 1995. A close look at these tables shows that the twelve countries with the highest level of human development were always the same countries during this period, but their ranking changed over time. For example while the United States had the first rank in 1975, it had only the second rank in 1985 and 1995 while Canada received the first rank in 1985 and 1995. Finland who had the twelfth rank in 1975 progressed over time to reach the eighth or ninth rank in the following periods Among the countries with low levels of Human Development we may observe that Mali, Burkina Faso and Niger had always the lowest rank (in our sample of countries) but their ranking changed over time.

For the degree of openness the ranking was less stable. For example the Netherlands had the first rank in 1975, Singapore in 1985 and South Africa in 1995. Similar fluctuations may be observed among the countries with relatively low levels of openness to international trade.

Finally for the degree of openness to international investment there seem to have been also important changes over time, in the ranking as well as in the value of the index. For example Egypt had the first rank in 1975 with an extremely high value of the index. It also had the first rank in 1985 and had the third rank in 1995 but there was a very big decrease in the value of the index over time.

b) The regression results:

We have used a fixed effect model by assuming a fixed effect for each country. The dependent variable was the Human Development Index HDI_{jt} for country j in year t while the exogenous variables were respectively the degree of openness to international trade for country j in year t, the square of this variable, the degree of openness to international investment for country j in year t and the square of this variable. The regression results are given in Table 5 while Table 4a and 4b give the mean value of the

different variables used in the regressions. In table 4a we allowed the number of countries in each sample to vary while in Table 4b we used the same number of countries each year. In both cases it appears that the Human Development Index increased on average over time and this is also true for the average degree of openness to international trade. For the degree of openness to international investment the fluctuations seem to have been important since even the average value of this index decreased between 1975 and 1985 but subsequently increased to reach in 1995 a higher level than in 1975.

In the first column of Table 5 we present results of a regression analysis based on our panel data in the case where the number of observations may vary from one year to the other. In the two other columns we present the results of a combined analysis for the years 1975 and 1995 (second column) or of a combined analysis for the years 1975, 1985 and 1995. In these last two columns we took into account only those countries for which observations were available for each of the years analyzed. Whereas the magnitude of the coefficients varies from one regression to the other, the signs are consistent and show similar effects. It appears that the degrees of openness to international trade and to international investment have a positive effect on human development. This impact is however not linear in so far as the Human Development Index increases at a decreasing rate with the degrees of openness to international trade and investment.

c) The Breakdown of the Mean Difference of the Human Development Index:

In Tables 6 and 7 we have applied the decomposition techniques described in Section 1. Table 6 gives the actual decomposition of the overall mean difference of the Human development index while Table 7 presents in percentage terms the contribution of each component. It appears that the degrees of openness to international trade and investment explain together only 3.3% in 1975 and 4.4% in 1995 of the mean difference of the Human Development Index. The openness to international trade accounts in fact for most of this contribution (2.4% in 1975 and 3.5% in 1995) as the non-linear term of the openness to international investment practically cancels the impact of the linear term. Note that the Gini-Correlation of the openness to international investment is negative in both 1975 and 1995 (see Table 8) and since the coefficient of the openness to investment is positive in both years (see, Table 5), one obtains a negative contribution of the openness to international investment to the overall dispersion (as measured by the mean difference) of the Human Development Index (see, Tables 6 and 7). For the square of this openness to international investment, a variable which has also a negative Gini-Correlation (see, table 8), one has a positive contribution (see, Tables 6 and 7) because in the regression the coefficient of this variable is also negative (see, Table 5) and, as indicated earlier, these two contributions more or less cancel out.

The Error Term contributes in 1975 more (4.1%) to the mean difference of the Human Development Index than the degrees of openness to trade and investment. In 1995 however the contribution of the error term is negative because the Gini-correlation of the error term is negative in that year. Note finally that most (92.6% in 1975 and 98.1% in 1995) of the contribution to the overall mean difference of this Human Development Index is a consequence of the country specific fixed effects which are represented in Tables 6 and 7 by the contribution of the constant.

4. Concluding Comments:

This paper attempted to study the impact of openness to international trade and investment of the level on human development. The analysis was based on a decomposition technique borrowed from the literature on the breakdown of income inequality by income sources, an approach which may also be applied to regression results to estimate the impact of each exogenous variable on the dispersion of the dependent variable. The panel data which were used included information on at least 49 countries for

each of the years 1975, 1985 and 1985. Using a fixed effect model we found that both indices of openness (to international trade and to international investment) had a positive but non linear effect on human development but that the degree of openness to international trade explained a higher percentage of the dispersion of human development levels than the degree of openness to international investment, though the contribution of both variables to the mean difference of the Human Development Index was relatively small.

References

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Table 1: Value of the Indices of Human Development, Openness to International Trade and Openness to International Investment for the year 1975

Country	**Human Development Index**	**Index of Openness to International Trade**	**Index of Openness to International Investment**
Canada	0.862	0.83270	1.78
Norway	0.850	1.70939	2.75
United States	0.865	0.40042	0.65
Sweden	0.859	1.20188	0.66
Australia	0.838	0.57167	1.09
Netherlands	0.856	2.03785	3.09
United Kingdom	0.840	1.07477	2.02
France	0.848	1.06847	0.96
Finland	0.834	1.01501	0.50
Denmark	0.861	1.13129	0.33
Austria	0.836	1.06541	0.88
New Zealand	0.843	0.49193	0.44
Italy	0.824	1.06349	0.49
Ireland	0.811	1.59230	1.85
Spain	0.814	0.68593	0.53
Singapore	0.737	3.70724	4.33
Greece	0.792	0.71875	1.17
Portugal	0.735	0.80113	0.22
Korea	0.680	1.80015	0.79
Argentina	0.776	0.23153	0.09
Trinidad and Tobago	0.746	0.29278	1.05
Venezuela	0.740	0.63495	1.03
Malaysia	0.614	1.55964	6.47
Mauritius	0.635	0.41999	0.07
Thailand	0.604	0.94748	0.66
Ecuador	0.645	0.83078	0.10
Saudi Arabia	0.595	1.01401	1.25
Brazil	0.639	0.53023	2.42
Paraguay	0.655	0.57726	1.91
Dominican Republic	0.617	0.64145	1.83
Sri Lanka	0.605	0.62858	0.01
South Africa	0.637	3.82880	0.69
Tunisia	0.510	0.87257	2.40
Bolivia	0.524	0.65068	0.24
Swaziland	0.497	1.71261	2.56

Table 1 (cont.)

Honduras	0.515	1.07413	0.32
Egypt	0.432	1.48309	87.27
Morocco	0.426	0.96501	0.64
Ghana	0.431	0.78960	1.22
Kenya	0.453	1.48566	2.08
Pakistan	0.347	0.62815	0.13
Togo	0.395	0.61588	2.85
Mauritania	0.343	0.99809	7.39
Senegal	0.326	0.86357	1.80
Cote d'Ivoire	0.374	1.27958	1.78
Rwanda	0.323	0.35320	0.92
Mali	0.246	0.69157	1.31
Burkina Faso	0.237	0.63244	0.43
Niger	0.247	0.89189	1.54

Table 2: Value of the Indices of Human development, Openness to International Trade and Openness to International Investment for the year 1985

Country	Human Development Index	Index of Openness to International Trade	Index of Openness to International Investment
Canada	0.901	0.87308	1.62
Norway	0.880	1.27885	1.55
United States	0.897	0.42535	0.68
Sweden	0.880	1.20231	0.88
Australia	0.867	0.59276	1.40
Netherlands	0.883	2.10971	2.87
United Kingdom	0.856	1.08554	3.30
France	0.875	1.06758	1.00
Finland	0.871	0.96450	0.99
Denmark	0.878	1.10561	0.65
Austria	0.863	1.18823	0.94
New Zealand	0.862	0.53635	1.45
Italy	0.852	0.96833	0.35
Ireland	0.839	1.82391	2.91
Spain	0.851	0.83605	0.85
Singapore	0.796	3.53232	3.01
Greece	0.835	0.78968	0.71
Portugal	0.786	0.73883	0.65
Korea	0.761	2.18173	2.10
Argentina	0.798	0.36730	0.80
Trinidad and Tobago	0.784	0.33602	0.35
Venezuela	0.761	0.58773	0.64
Malaysia	0.691	1.72397	4.81
Mauritius	0.692	0.32614	0.79
Thailand	0.678	0.93384	2.07
Ecuador	0.715	0.67986	0.37
Saudi Arabia	0.671	1.61028	2.38
Brazil	0.687	0.46847	1.08
Paraguay	0.695	0.62681	5.32
Dominican Republic	0.685	0.71827	0.52
Sri Lanka	0.671	0.66893	0.52
South Africa	0.671	3.17218	4.51
Tunisia	0.608	0.99569	1.66
Bolivia	0.584	0.46166	0.36

Table 2 (cont.)

Swaziland	0.556	2.27823	2.60
Honduras	0.595	0.99433	0.79
Egypt	0.531	1.04883	31.64
Morocco	0.508	0.81485	0.24
Ghana	0.475	0.44353	0.13
Kenya	0.521	0.95939	0.74
Pakistan	0.414	0.61003	0.63
Togo	0.438	0.89559	0.64
Mauritania	0.386	1.33020	0.53
Senegal	0.369	1.14514	0.95
Cote d'Ivoire	0.415	1.87171	0.75
Rwanda	0.411	0.48185	2.78
Mali	0.289	1.11532	0.53
Burkina Faso	0.280	0.69509	0.83
Niger	0.267	0.94178	1.11

Table 3: Value of the Indices of Human development, Openness to International Trade and Openness to International Investment for the year 1995

Country	Human Development Index	Index of Openness to International Trade	Index of Openness to International Investment
Canada	0.932	1.24513	2.94
Norway	0.927	1.02916	0.87
United States	0.927	0.57796	1.35
Sweden	0.923	1.39886	4.19
Australia	0.922	0.74813	2.05
Netherlands	0.921	2.24471	6.03
United Kingdom	0.918	1.12413	6.47
France	0.918	1.17237	3.79
Finland	0.913	1.07962	3.72
Denmark	0.905	1.14234	4.25
Austria	0.904	1.29713	2.48
New Zealand	0.901	0.68878	3.19
Italy	0.900	1.09505	2.84
Ireland	0.900	1.92433	3.34
Spain	0.894	1.07558	5.62
Singapore	0.888	3.00723	3.77
Greece	0.867	1.39661	1.17
Portugal	0.858	0.91935	2.68
Korea	0.852	1.81722	2.85
Argentina	0.827	0.53471	6.76
Trinidad and Tobago	0.797	0.91407	1.39
Venezuela	0.792	0.68966	1.43
Malaysia	0.768	2.55417	4.91
Mauritius	0.764	0.33199	0.15
Thailand	0.753	1.22363	5.49
Ecuador	0.747	0.84310	1.78
Saudi Arabia	0.740	1.74313	0.58
Brazil	0.739	0.69501	8.00
Paraguay	0.730	1.43914	4.92
Dominican Republic	0.726	0.87324	1.45
Sri Lanka	0.721	0.78501	1.74
South Africa	0.695	3.97928	8.28
Tunisia	0.695	1.08861	1.89
Bolivia	0.652	0.64489	35.11

Table 3 (cont.)

Swaziland	0.644	3.13332	14.70
Honduras	0.641	1.04870	1.88
Egypt	0.616	0.96704	10.90
Morocco	0.582	1.04063	1.94
Ghana	0.544	0.67382	1.32
Kenya	0.519	1.35688	0.36
Pakistan	0.508	0.63109	2.46
Togo	0.469	0.68560	0.19
Mauritania	0.447	0.99987	0.43
Senegal	0.426	1.19922	1.11
Cote d'Ivoire	0.422	2.10144	1.71
Rwanda	0.379	1.22053	2.15
Mali	0.375	1.28735	1.55
Burkina Faso	0.304	0.64900	0.15
Niger	0.298	0.62822	2.53

Table 4a: Mean and Standard Deviation of the Variables Analyzed with a different number of countries each year

Variable	Summary Indicators	1975	1985	1997
Human Development Index	**Number of Observations**	79	93	174
	Mean	0.582	0.629	0.68
	Standard Deviation	0.202	0.193	0.173
Openness to International Trade	**Number of Observations**	110	117	119
	Mean	1.103	1.111	1.206
	Standard Deviation	0.757	0.639	0.689
Openness to International Investment	**Number of Observations**	69	99	107
	Mean	2.499	1.587	3.703
	Standard Deviation	10.364	3.258	4.804
Per Capita GDP	**Number of Observations**	122	146	135
	Mean	3905.877	3930.253	4382.259
	Standard Deviation	5539.095	5529.545	6924.112

Table 4b: Mean and Standard Deviation of the Variables Analyzed (with the same countries each year)

Variable	Summary Indicators	1975	1985	1997
Human Development Index	**Number of countries each year**	49	49	49
	Mean	0.627	0.675	0.724
	Standard Deviation	0.197	0.188	0.189
Openness to International Trade	**Number of countries each year**	49	49	49
	Mean	1.043	1.074	1.244
	Standard Deviation	0.696	0.67	0.713
Openness to International Investment	**Number of countries each year**	49	49	49
	Mean	3.204	2.02	3.895
	Standard Deviation	12.221	4.441	5.318
Per Capita GDP	**Number of countries each year**	49	49	49
	Mean	4650.551	5554.918	6996.98
	Standard Deviation	5179.933	6378.492	7935.099

Table 5: Results of Regression with Fixed Effects (Dependent Variable :Human Development Index)

Variable	Combined Analysis for the years 1975,1985 and 1995 (with a different number of observations for each year)	Combined Analysis for the years 1975 and 1995 (on the basis of a sample including only the countries for which data were available each year)	Combined Analysis for the years 1975, 1985 and 1995 (on the basis of a sample including only the countries for which data were available each year)
Openness to Trade	0.107 (2.89)	0.199 (3.08)	0.134 (3.22)
Square of Openness to Trade	-0.019 (-1.88)	-0.036 (-1.93)	-0.021 (-1.89)
Openness to Investment	0.0087 (2.95)	0.0087 (2.95)	0.0055 (3.05)
Square of Openness to Investment	-0.000086 (4.88)	-0.00012 (-3.66)	-0.000079 (-4.00)
R-square	0.972	0.958	0.964
Number of Observations (countries) for the three years combined	231	98	147

Note: t-values in Parenthesis

Table 6: Decomposition of the Mean Difference of Human Development Index by Components of the Combined Regression for the Years 1975 and 1995

Component	1975: "Pseudo-Mean Difference" for Various Components	1975: Mean Difference of Various Components	1995: "Pseudo-Mean Difference" of Various Components	1995: Mean Difference of Various Components
Openness to trade	0.01396	0.12923	0.00677	0.13916
Square of Openness to Trade	-0.00839	0.06766	0.00060	0.08067
Openness to Investment	-0.01840	0.04165	-0.00070	0.03497
Square of Openness to Investment	0.02025	0.03772	0.00242	0.00899
Error Term	0.00910	0.03461	-0.00521	0.03461
Constant	0.20695	0.21705	0.20483	0.21705
Total: Overall Mean Difference	0.22347	0.22347	0.20870	0.20870

Table 7: Contribution (in percentage terms) of the Various Exogenous Variables to the Mean Difference of the Human Development Index in 1975 and 1995.

Exogenous Variable	Contribution of the Pseudo-Mean Difference of the Variable in 1975	Contribution of the Pseudo-Mean Difference of the Variable in 1995
Openness to International Trade	6.2 %	3.2%
Square of Openness to International Trade	- 3.8%	0.3%
Openness to International Investment	- 8.2%	-0.3%
Square of Openness to International Investment	9.1%	1.2%
Error Term	4.1%	-2.5%
Constant	92.6%	98.1%
Total	100%	100%

Table 8: Gini-correlation and Mean Difference of the Various Exogenous Variables for the Years 1975 and 1995

Variable	Gini-Correlation for the Year 1975	Mean Difference for the Year 1975	Gini-Correlation for the Year 1995	Mean Difference for the Year 1995
Openness to Trade	0.10799	0.64845	0.04652	0.69827
Square of Openness to Trade	0.12399	1.89761	-0.00941	2.26274
Openness to Investment	-0.44184	4.78319	-0.01910	4.01551
Square of Openness to Investment	-0.53693	310.573	-0.26862	73.9958
Error Term	0.26290	0.03461	-0.15050	0.03461
Constant	0.95347	0.21705	0.94418	0.21705
Total	1	0.22347	1	0.20870

Appendix A: The Human Development Index

For the past ten years the United Nations Development Programme has published for numerous countrie sin the world what it has called the Human development Index (HDI). This index is in fact basd on three indicators: longevity, as measured by life expectancy at birth, educational attainment, as measured by a combination of adult literacy and the combined gross primary, secondary and tertiary enrollement ratio and standard of living as measured by real G.D.P. per capita (in dollar terms, using exchange rates based on purchasing power parity).
Let us now recall more precisely how the HDI is estimated. Let le, alr, cger and y denore respectively the life expectancy at birth, the adult literacy rate, the combined gross enrollement ratio and the real per capita G.D.P. . For the first three components of the HDI (let us call them more generally x) one first defines a minimum x_{min} and a maximum x_{max} value and computes then a transformed index Tx which is defined as

$$T(x) = (x - x_{min}) / (x_{max} - x_{min}) \qquad (A.1)$$

For the fourth component (per capita G.D.P.) the transformation is somehow more complex[7] since the transformed index T(y) is defined as

$$T(y) = (\log y - \log y_{min}) / (\log y_{max} - \log y_{min})$$

For the life expectancy at birth for example the minimum value has been chosen to be 25 and the maximum value 85 years. For the adult literacy rate and for the combined gross enrollement ratio the minimum values are 0 % and the maximum value 100 %. For the per capita G.D.P. the United Nations Development Programme has fixed the minimum value at $ 100 and the maximum value at $ 40,000.

In another intermediate stage one estimates the index of educational attainment I_{ea} as

$$I_{ea} = (2/3)\, T(alr) + (1/3)\, T(cger) \qquad (A.3)$$

The Human Devlopment Index HDI is then defined, using the notations introduced previously, as

$$HDI = [\, T(le) + I_{ea} + T(y) \,] / 3 \qquad (A.4)$$

[7] This transformation was introduced for the first time in the 1999 Human Development Report. In previous years the transformation was more complex and was based on a step function whose exact formulation may be found in the Human Development Reports of the previous years.

Appendix B: The Estimation of the Indicators of Openness to International Trade and Investment

Data on the degree of openness of various countries to international trade and to international investment were borrowed from Low et al. (1999). These indices of openness are in fact corrected indices and were constructed by Low et al. (1999) in the following way. Concerning the Trade Openness Index they computed in a first stage an index defined as the ratio of the sum of imports and exports over the G.D.P. In a second stage Low et al. (1999) corrected this basic trade openness indicator to account for differences in country size and levels of development. The idea is that large countries in terms of G.D.P. and/or population tend to trade less, as most of the trade takes place within these countries. It has been similarly argued that countries with high levels of per capita G.D.P. may be biased towards having a lower level of trade to G.D.P. ratio, because as countries develop, the share in G.D.P. of the services, which are largely non-tradable, increases. Therefore, to account for differences in country size and development levels, Low et al. (1999) run a regression in a panel of 2540 observations, where the dependent variable is the logarithm of the basic trade openness indicator while the exogenous variables are respectively the logarithms of the G.D.P., of the square of the G.D.P., of population size and of the square of the per capita G.D.P. On the basis of such a regression the author derived for each country and year the expected value of the trade openness indicator. Then in a final stage they constructed what they called the corrected trade openness index which is defined as the ratio of the actual over the expected trade openness indicator.
The corrected investment openness index was estimated in a similar way. Low et al. (1999) started by computing a basic investment openness indicator defined as being equal to the ratio of international investment flows over G.D.P.. These investment flows are equal to the sum of inward and outward Foreign Direct Investment and inward and outward Portfolio Investment Abroad. Then again they run a regression to control for the size of the country and the level of its development to finally compute a corrected investment openness index defined as the ratio of the actual over the expected investment openness indicators.