School of Economics and Management
TECHNICAL UNIVERSITY OF LISBON

USING DATA ENVELOPMENT ANALYSIS TO SCREEN THE POSSIBILITY OF A FAIR GLOBALIZATION

Sten Thore
The IC² Institute, The University of Texas at Austin, USA (Emeritus)

Ruzanna Tarverdyan
Policy Integration Department, International Labor Office, Geneva

Abstract

The International Labor Office, an arm of the UN based in Geneva, has as its goal to promote opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and human dignity. Since 1999, the ILO has conducted a series of studies of the effects of globalization. In 2004, the organization posed the challenge of tempering the perceived effects of globalization, aiming for A Fair Globalization. Fair rules on trade and finance need to be put in place benefiting men and women in rich and poor countries alike. Using standard economic terms, A Fair Globalization may be seen as the output of a generalized input-output function, dependent upon variables of both economic performance and economic and social policy. Using data envelopment analysis, we fit a piece-wise linear frontier to observations for 72 countries from all continents. Inefficient countries reveal conditions of lacking fairness.

Keywords: globalization, fairness, International Labor Office, data envelopment analysis, Gini index, Pareto efficiency, constant returns to scale, peers, inefficiency, theory of chaos.

Disclaimer: The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the International Labor Office.

Correspondence Address: Sten Thore, e-mail: thore@mail.telepac.pt, Postal address Apt 1284, Carvoeiro LGA, 8400, Portugal

1. MOTIVATION AND BACKGROUND

The International Labor Office (ILO) is a specialized agency of the United Nations, founded in Geneva in 1919. Its goal is to promote opportunities for women and men to obtain decent and productive work, in conditions of freedom, equity, security and human dignity. Working through dialogue with governments, employers and workers, it has set international labor standards that form part of international human rights law and national legal systems.

In February 2002, ILO established the World Commission on the Social Dimension of Globalization to examine the process of globalization and to respond to the needs of people as they cope with the challenges of globalization. The commission formulated the goal of achieving "a fair globalization", tempering the presumed harsh effects of globalization by suitable use of social inputs and policy variables (2002). It called for urgent research in this area. Responding to this challenge, we shall in the pages below propose a format for estimating a generalized input-output relationship striking a balance between globalization and protective measures. Using data for 72 nations from all continents, we determine an efficiency frontier; countries located on the frontier exhibit maximal fairness of globalization while countries falling behind it are inefficient.

For the calculations, we employ a statistical tool called *data envelopment analysis* or DEA for short. For an introductory text, see e.g. Charnes, Cooper *et al.* (1994), Cooper, Seiford, Zhu (2004) or Cooper, Seiford, Tone (2006). The purpose of this technique is to compare and rank the performance of decision-making units in an non-optimal world, where some units reach an idealized performance frontier (characterized by Pareto optimality) whereas others fall short of this ideal. In several studies, DEA has been used to compare and rank the economic and social performance of entire nations; see Land, Lovell and Thore (1994), Lovell (1995) and Golany and Thore (1997a,b,c). In particular, the publication Golany and Thore (1997b) discusses the use of DEA to rank the economic and social performance of nations, including developing and poor nations from all continents.

The heart of the DEA calculations is a postulate of the possible existence of Pareto optimality: that there exists a generalized performance function (a "fair" globalization) balancing in each country the openness of the economy and social fairness. The measure of fairness to be employed here is an index of the equality of the vertical income distribution in each country, thus translating an increased income inequality into less social fairness. The inputs into the performance functions are standard economic variables and parameters of economic policy. The DEA calculations yield an efficiency rating for each country. A rating of 100 % indicates that the country is located on the Pareto frontier, tracing an optimal trade-off between inputs and outputs. An efficiency rating of less than 100 %

signals non-optimal behaviour. The country is then Pareto non-optimal in the sense that, given the economic inputs and policy parameters, it should be possible to improve the performance of the country in terms of one or several outputs without having to accept a poorer performance in terms of others.

In an earlier study Tarverdyan and Thore (2006), we estimated an idealized efficiency frontier of Decent Work, blending aspects of employment, absence of poverty and the ratio of women in the labor force. Employing data for a set of countries from all continents, we calculated the decent work deficit for each inefficient nation. Here, we start out from some of the same data to calculate an idealized efficiency frontier of A Fair Globalization. The frontier traces the maximal level of trade protection and social protection that the current level of globalization permits. Thus, remarkably, the same data gives rise to two connected efficiency concepts, each defining a trade-off between economic and financial variables on the one hand, and social inputs and policy variables on the other.

Section 2 discusses the various dimensions of globalization and the possible means of establishing a fair globalization. Section 3 reports on the DEA calculations for 72 countries, listing the Pareto optimal countries and discussing the efficiency frontier spanning them. Section 4 turns to the non-efficient countries, calculating the lack of fairness for each. Section 5 summarizes.

2. A FAIR GLOBALIZATION

The World Commission on the Social Dimension of Globalization (2002) aimed at shifting the perspective on globalization from a preoccupation with markets to a preccupation with people. It stressed the social dimensions of globalization – jobs, health, education, and the totality of the aspirations of people for democratic participation and material prosperity. The report states that if wisely managed, globalization can play a positive role in the fight against poverty and for sustainable development. It acknowledges the importance of domestic institutions and national policies and macroeconomic factors, and it recognizes the central role of a continuous social policy dialogue.

The main body of the report deals with the asymmetric effects of globalization on rich and poor countries (*ibid.* pp. 80 ff.). The Commission stresses the need to develop rules of the global economy that benefit the rights, livelihoods, security and opportunities of people around the world. The functioning of the free markets need to be complemented by environmental, social and cultural considerations. The rules of the global economy should be "fair". The goal is *a fair globalization*.

In its concluding sections, the report of the Commission enters on the subject of research, arguing for a stronger, up-to-date knowledge base on globalization

"What is measured is acted upon" (p. 137). It is argued that reliable and regular information, disaggregated by gender, is required on the social impact of globalization and the distribution of its benefits.

On 2 December, 2004 the UN General Assembly adopted a resolution recognizing the contribution of the World Commission's report in aiming for a fully inclusive and equitable globalization (see United Nations, 2002).

2.1. Toward a multi-criteria analysis of the socio-economic performance of nations

A series of international accords have recently brought attention to the wide variety of social and economic problems facing nations in a world of globalization, economic development (or lack thereof) and scarce resources. A notable event was the 2000 UN Millennium Declaration (see the reference United Nations, 2000), setting out a series of development goals (MDGs) including full employment, decent work, literacy and education, health, and the environment.

At the 2005 World Summit, the head of states, reviewing the progress on the Millennium Declaration, stated their strong support to a fair globalization and the need to make the goals of full and productive employment and decent work for all, including women and young people, a central objective of national and international policies (United Nations, 2005).

The logical relationship between the millennium development goals MDGs and the various social and economic policies at hand may be illustrated by a cognitive map as in Figure 1 below. Obviously, each country will have its own set of unique inputs (resources and policy parameters), striving for its own set of goals.

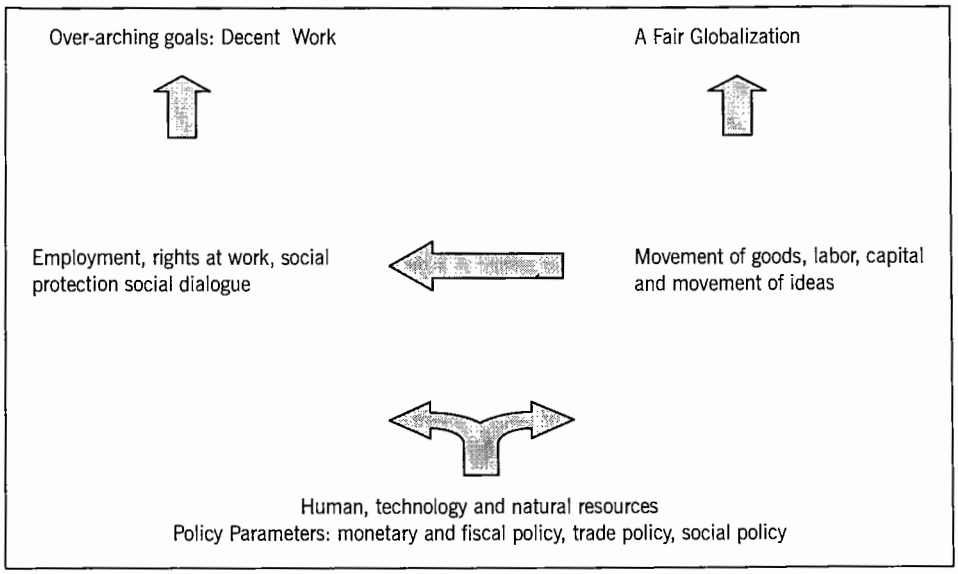
The important role of employment policy in national development strategies is now well recognized: improving the levels and conditions of employment is identified as one of the most effective means of achieving the MDGs. The concept of "decent work" provides a strategic framework for organizing all of the ILO's activities.

The causal trains determining decent work are illustrated in the left hand panel of Figure 1. The ILO Decent Work Agenda have four elements:

- employment – the principal route out of poverty is through work and income;
- rights – without them, people will not be empowered to escape from poverty;
- social protection – it safeguards income and underpins health;
- dialogue – the participation of employers' and workers' organizations.

FIGURE 1

Multi-hierarchical causal map explaining decent work and a fair globalization



These four aspects of decent work may be viewed as the outputs of a generalized input-output relationship, using human, technology and natural resources as inputs together with parameters of monetary and fiscal policy, trade policy and social policy.

The causal structure determining a fair globalization are illustrated in the right hand side panel of Figure 1. According to The World Commission on the Social Dimension of Globalization, already cited, the main characteristics of globalization are the following indicators of the openness of the borders of the country (see *ibid.* p. 24):

- the liberalization of international trade,
- the expansion of foreign direct investments (FDI)
- the emergence of massive cross-border financial flows.

The Commission also points at the impact of new technology, especially in information and communications. Again, this list of dimensions may be viewed as the outputs of a generalized input-output relationship, using human and natural resources, and variables of economic and social policy as inputs.

The Commission devoted an entire chapter to the subject matter of how countries can introduce fairer rules of competition, redressing inequities in terms of market access in international trade. In the present paper we shall put the *equality or skewness of the vertical income distribution* in focus. The increased

exports and in-flows of foreign capital that go together with an open economy builds profits – profits in the export industry, and in new ventures initiated from abroad. Swelling corporate profits tend, *ceteris paribus*, to make the vertical income distribution more unequal. We define a fair globalization for a given country as the maximal level of trade openness that is compatible with some given and ruling skewness of the income distribution (a more precise definition follows immediately below).

2.2. Efficiency, Pareto-optimality and sub-efficiency

Note that there exists no obvious mathematical relationship between the inputs and the goals. Rather, it is up to each nation to put in place a management system designed to maximize the returns on the efforts. The standard economic term for a combination of inputs and maximal returns is «efficiency». There exists an «efficiency frontier». In conventional economic analysis, at a (Pareto) efficient point it is impossible to obtain more of any desirable goal without accepting less of one or several other desirables. Economics works with such idealized relationships all the time. At the frontier, an optimal balance between market-based indicators of globalization and social indicators is struck. Ideally, a fair globalization is a point on an efficiency frontier.

The 2004 Marrakesh Roundtable on Results endorsed a coherent framework for development effectiveness. The Marrakesh principles include a dialogue on results at all phases of the development process, managing by results, in which performance information is used for improved decision making including progress monitoring and outcome evaluation. It called for a need to move to a results management agenda entailing a shift in institutional practices – with a new effort to develop a common performance management system (COMPAS) and integrating Management for Development Results into the practices of the multilateral development banks. This requires deepening efforts to systematically and transparently monitor performance indicators and defining the set of instruments that link behavior to performance outcomes (see World Bank and IMF, 2006).

Implicitly, the emphasis on enhanced performance means that not all countries will achieve the idealized optimal performance. Some countries will fall short of the efficiency frontier. Plotting a given country in a multi-dimensional space of inputs and goals, only those countries with an optimal input-goals mix will reach the efficiency frontier. The frontier is a multi-dimensional locus that is reached only by the best managed countries. Other countries will fall behind. Finally, economists have a chance to discover non-optimal behavior! As we shall see, in the real world most observations fall short of Pareto optimality.

The terms "inputs" and "outputs" (including goals) need to be used with some circunspection. As often occurs in multi-criteria applications in the economic and social field, the concept of causality can be difficult and cross-currents of causal mechanisms can sometimes be recognized (such as during an export-led expansion where exports are the cause rather than the effect). In conventional multi-variate analysis the task is to estimate some theoretical relationship, such as a postulated linear regression. DEA starts out from the opposite end. No *a priori* theoretical structure is postulated and no estimation in the statistical sense takes place. The DEA is entirely an empirical construct. The lists of inputs and outputs (including goals) is never tested; it is chosen to reflect the aims of a policy-maker who wants to assess how well nations are achieving these outputs. In particular, in the present instance, the list of inputs is chosen to include factors that a policy-maker may believe would influence the openness of the economy and the fairness of globalization.

3. A FAIR GLOBALIZATION: THE EFFICIENCY FRONTIER

Turning now to the formal representation of a fair globalization, we will be looking for a generalized input-output relationship that includes both conventional indicators of globalization and some measure of fairness. As demonstrated in our earlier study on decent work (see Tarverdyan and Thore, 2006), the general idea is to choose a set of output factors that blend both economic variables and social indicators, thus laying the groundwork for the construction of a social preference index that includes policy goals.

The statistical indicators of globalization here to be chosen will measure the openness of a country to international trade and to international capital markets. The indicator of social fairness will be the equality of the vertical income distribution. How do these indicators interact with each other? In the short run, increased exports builds profits and expands employment in the export industries. An increased influx of foreign capital brings in new risk capital and new management expertise. There will be increased profits, increased dividends, and increased wages being paid in the expanding sectors. Later, a process of "trickle down" may ensue, along the lines of the familiar Keynesian multiplier. But other sectors of the economy are shielded from competition from abroad and will experience little change. Even in the intermediate run, the net effect will typically be an increased inequality of the vertical income distribution.

But this is not the end of the story. At the same time, powerful economic and social processes that redistribute income may have been put in motion by the introduction of new technical knowledge. Consider the arrival of new computer technology that enters the classroom and revolutionizes education. Or, consider

new drugs and new health technology that benefits the less advantaged in the economy.

In the present paper, we shall use the familiar Gini index as a measure of the inequality of the vertical income distribution. Clearly, no fast and robust conclusions can be drawn regarding the net effects of globalization on the Gini index. Instead, we will simply use the recorded index as a piece of statistical evidence, shedding light on the economic and social fairness (or absence of fairness) in each country.

To sum up: As standard indicators of the openness and level of globalization in a given country, we shall choose

- Exports of goods and services, as a percentage proportion of GDP (EXP),
- Net foreign direct investment, as a percentage proportion of gross capital formation (FDI).

As a fairness index, we select a measure of the equality of the vertical income distribution, viz.

- 100 % minus the Gini index (1 – GINI)

Denoting output quantities by the letter *Y*, the social preference index to be formed may then be written

$$(1) \quad U(Y_{EXP}, Y_{FDI}, Y_{1-GINI})$$

In the common manner, the preference function defines a (preference) indifference map $U = U_0$ The slope coefficients of the (three-dimensional) indifference surface at any point in the space of all outputs *Y* are given by the marginal rates of substitution Preparing the way for the data envelopment to follow, we shall employ a linear function

$$(2) \quad \mu_{EXP} Y_{EXP} + \mu_{FDI} Y_{FDI} + \mu_{1-GINI} Y_{1-GINI}$$

where the coefficients v_{EXP}, v_{FDI}, v_{1-GINI} are positive numbers. The marginal rates of substitution are then constant. There is a constant rate of trade-off between globalization and fairness in the sense that a marginal shortfall of exports or foreign direct investments may always be compensated by increased fairness.

Tracing the causes of globalization

It is generally agreed that the roots of globalization lie with the increased communication – in particular electronic communication – and transfer of knowl-

edge in the modern world. Here we shall take these advances as given, and instead ask ourselves why the degree of exposure to such influence varies from country to country. Some countries are more receptive to change than others. The following three factors obviously facilitate the introduction of new communication techniques

- The annual growth of GDP (GROWTH),
- The degree of monetization of the economy, measured as 1 – the informal economy as a percentage of GDP (FORMAL)
- The degree of trade liberalization, measured as 1 minus the the proportion of government revenues collected as trade duties (1 – TARIFF).

The factors illustrate the role played by conventional macroeconomic variables (GROWTH), social conditions (FORMAL), and national and international policy parameters (1 – TARIFF).

Globalization obviously is in the nature of a change over time. An economy experiencing rapid GROWTH is better placed to reap the fruits of globalization, and also to suffer the inequities and environmental disturbances that may accompany it. There are many examples of the global transfer of recent advances in high technology and communication, building regional growth centers, attracting foreign capital and boasting national exports (the IT industry in India is a case in point). Rapid GROWTH then goes together with an export boom (EXP); at the same time, the high rate of return on real capital stimulates the influx of foreign investments (FDI).

Globalization essentially is a phenomenon of markets – local shielded markets being opened up to international competition. But many developing countries have huge non-monetized, non-market sectors that change little in the face of the communications and information explosion. These sectors constitute the "informal economy" where products and services are produced and consumed locally, without the intermediating role of market transaction. Only the FORMAL economy transmits the forces of globalization.

TARIFF represent taxes on international trade and includes import duties, export duties, profits of export or import monopolies, exchange profits, and exchange taxes. Government revenues are calculated as cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent and income from property and sales.

Import tariffs are of course typically used to protect local agriculture and industry, thus shielding domestic workers from foreign competition. Conversely, trade liberalization as measured by 1 - TARIFF stimulates domestic industry, exports (EXP) and foreign direct investments (FDI).

To illustrate the kind of reasoning that would require recourse to anyone of the three input factors now listed, consider a policy-maker who desires to promote

the forces of globalization, while at the same time avoiding excessive concentration of incomes on a few hands only. The following political measures are being contemplated:

- Promoting high-tech startups by preferenctial allocation of credit to new entrepreneurs, thus stimulating GROWTH,
- Promoting computer training courses aimed at unemployed and socially alienated youth, thus extending the FORMAL sector of the economy,
- Promoting foreign direct investments by lowering taxes on profits earned by foreign owners, thus increasing 1 – TARIFF.

All input and output data are averages 1998 – 2003. We were able to find data of acceptable quality and with no data missing and all data positive for $i = 1,2,...,72$ countries (for the detailed definition of each variable and the data sources, see the appendix to our earlier study, Tarverdyan and Thore 2006). When no explicit indexation is made, as in expressions (1) and (2), all variables and all data refer to the country currently being evaluated. Alternatively, this country will also be denoted as $i = 0$ (this being one of the indices 1,2,...,72).

3.1. A linear fractional programming problem

In order to introduce the procedures of DEA in the present application, we find it instructive to revert to the so-called ratio model by Charnes, Cooper and Rhodes (1978) originally proposed as a generalization of the concept of efficiency as used in physical sciences (the efficiency of a piece of machinery, say). The ratio model reduces the multiple-output and multiple-input situation for each "decision-making unit" (here, each country) to that of a single "virtual" output and a single "virtual" input. The virtual output is the utility (2). The virtual input, similarly, is the input aggregate (denoting individual inputs by the letter X)

$$(3) \quad v_{GROWTH} X_{GROWTH} + v_{FORMAL} X_{FORMAL} + v_{1-TARIFF} X_{1-TARIFF}$$

where the coefficients μ_{GROWTH} , μ_{FORMAL} , $\mu_{1-TARIFF}$ are positive numbers. The "efficiency"- analogue is the ratio between the virtual output and the virtual input, i.e.

$$(4) \quad \{\mu_{EXP} Y_{EXP} + \mu_{FDI} Y_{FDI} + \mu_{1-GINI} Y_{1-GINI}\} / \{v_{GROWTH} X_{GROWTH} + v_{FORMAL} X_{FORMAL} + v_{1-TARIFF} X_{1-TARIFF}\}$$

The ratio (4) can be calculated for every country (each country will need its own unique weights μ and v). The DEA procedure aims at maximizing the ratio for

the country currently analyzed, while seeing to it that the ratios (4) for all other countries stay less than or equal to one.

Collect outputs and inputs into the two column vectors

$$Y = (Y_{EXP}, Y_{FDI}, Y_{1-GINI}),\ X = (X_{GROWTH}, X_{FORMAL}, X_{1-TARIFF})$$

and the output and input weights into the row vectors

$$\mu = (\mu_{EXP}, \mu_{FDI}, \mu_{1-GINI}),\ v = (v_{GROWTH}, v_{FORMAL}, v_{1-TARIFF}).$$

The output aggregate (2) is then μY and the input aggregate (3) is vX. The efficiency analogue (4) is $\mu Y/vX$.

For each country $i = 0$ being evaluated, the task at hand then is to solve the linear fractional programming problem

(5) $\max \mu Y_0 / vX_0$
subject to
$\mu Y_i / vX_i \leq 1,\ i = 1,2,...,72$
$\mu Y_0 = 1$

In words, one wants to determine the virtual weights μ and v so that the virtual efficiency ratio for the country currently evaluated becomes as large as possible, while seeing to it that, using the same weights to calculate the efficiency of every other country, none of these efficiencies can exceed 1.

Furthermore, using the so-called output-oriented version of DEA, as we shall do here, the output weights are normalized to meet the condition $\mu Y_0 = 1$.

The linear programming equivalent is immediately obtained as

(6) $\min vX_0$
subject to
$-\mu Y_i + vX_i \geq 0,\ i = 1,2,...,72$
$\mu Y_0 = 1$

If the efficiency ratio (5) turns out to be unity, the country currently evaluated is assigned the efficiency score *100* %. If in addition all virtual weights μ and v are positive, one says that the country is *efficient* and lies on the *efficiency frontier*. Those on the frontier satisfy Pareto-Koopmans efficiency (see e.g. Charnes, Cooper *et. al.* 1994): Given the inputs, it is not possible to obtain more of any one output without accepting less of some other output. Conversely, given the outputs, it is not possible to employ less of any one input without employing more of some other input.

Model (5) defines a Pareto frontier that exhibits constant returns to scale. To see this, remember that at the point of optimum $\mu Y_0 = vX_0$. Hence, a proportional change of all inputs by one percent (from X_0 to $1.01X_0$) will sustain a proportional change of all outputs by one percent (from Y_0 to $1.01Y_0$). In words: if the causative factors all increase by 1 per cent, then both the market effects and the fairness effects will all increase by 1 per cent as well.

For the practical work, we employed the Frontier Analyst Professional version of Banxia Frontier Analyst 3. The efficient countries are listed in Table 1: the entries in the table show the optimal solutions which for these countries happen to coincide with the observed values (in general, an optimal output cannot fall below the observed output, and an optimal input cannot exceed an observed input). Except for Belgium, these are all developing countries.

TABLE 1

Constant returns to scale. Model (6) in the main text.
List of countries at the efficiency frontier. Observed values coincide with target values.

Country:	EXP(% of GDP)	FDI (% of GDP)	1-GINI, %	GROWTH, %	FORMAL, %	1-TARIFF, %
Jamaica	39.7	6.55	59.38	0.41	63.6	92.37
Madagascar	25.39	1.09	55.66	0.39	60.4	65.66
Uruguay	21.82	1.73	55.24	0.11	48.9	95.94
Belgium	81.61	31.85	67.03	1.66	76.8	99.41
Malaysia	118.16	3.2	50.85	1.61	68.9	93.3
Panama	68.96	5.83	43.5	2.42	35.9	91.43
Georgia	28.16	5.87	61.43	6.71	32.7	93.29
Azerbaijan	37.75	21.29	63.5	11.13	39.4	91.36
Thailand	65.47	2.95	57.27	2.03	47.4	90.94
Ethiopia	13.75	3.62	70	1.93	59.7	73.36
Ghana	38.51	2.11	60.45	2.54	61.6	68.15
Bangladesh	14.61	0.43	68.21	3.31	64.4	70.33
Ukraine	55.36	2.06	71.64	6.23	47.8	95.41
Belarus	63.72	1.44	70.2	7.35	51.9	92.96

Note that the list includes a few countries with some very considerable inequalities in their income distribution. Panama is one such country; its score of $1\text{-}GINI = 43.5$ is actually one of the four lowest in the world (The bottom score is for Brazil with 41.2). So, how can Panama still be ranked as being Pareto efficient? The answer is that Panama was nevertheless doing well compared to a few other poor countries with low outputs and low inputs (the monetized portion of the Panamanian economy was only 35.9 %).

But for most of the countries the ratio (5) will come out to be greater than unity, so that the normalized (inverted) efficiency score is less than one. The country is then nonoptimal. It lies behind the frontier. Only the frontier observations satisfy the idealized relationship; the others fall short.

3.2. Flexible returns to scale

The assumption of constant returns to scale is a quite restrictive one, and we shall therefore immediately drop it, replacing it by the possibility of flexible returns to scale: increasing, constant or decreasing returns to scale as the case may be. Instead of making an a priori assumption, we leave it to the data themselves to determine the returns to scale.

The linear fractional programming model with flexible returns to scale reads

$$
\begin{aligned}
(7)\quad & \max \mu Y_0 / (vX_0 + v_0) \\
& \text{subject to} \\
& \mu Y_i / (vX_i + v_0) \leq 1, \; i = 1,2,...,72 \\
& \mu Y_0 = 1
\end{aligned}
$$

where v_0 is the intercept of the supporting hyperplane at zero inputs. As before, if the optimal value of the optimand (7) is one, the country currently evaluated is located on the Pareto frontier and is ascribed the efficiency score of 1. But if the maximand turns out to be less than 1, the country is inefficient.

The linear programming equivalent is

$$
\begin{aligned}
(8)\quad & \min vX_0 + v_0 \\
& \text{subject to} \\
& - \mu Y_i + vX_i + v_0 \geq 0, \; i = 1,2,...,72 \\
& \mu Y_0 = 1
\end{aligned}
$$

If at the point of optimum $v_0 < 0$, the country exhibits increasing returns to scale. To see this, note that at the optimum $\mu Y_0 = vX_0 + v_0$. Hence, a proportional change of all inputs by one percent (from X_0 to $1.01X_0$) will sustain a proportional change of all outputs by more than one percent (from Y_0 to αY_0 with $\alpha > 1.01$). But if $v_0 < 0$, there are increasing returns to scale.

This time, the list of efficient countries (see Table 2) is longer, and includes a few Western European countries as well (Belgium, Norway, Sweden, Switzerland, the Netherlands). The countries in Tables 1 and 2 taken together represent conditions of Pareto optimality with the winds of globalization being optimally offset by a satisfactory fairness of the income distribution. All in all, these encouraging results are scored for 24 countries out of our total population of 72 countries.

TABLE 2

Allowing for flexible returns to scale. Model (8) in the main text. Additional countries at the efficiency frontier (in addition to those listed in Table 1). Observed values coincide with target values.

Country:	EXP (% of GDP)	FDI (% of GDP)	1-GINI, %	GROWTH, %	FORMAL, %	1 – TARIFF, %
Dominican Republic	43.88	4.77	48.31	3	67.9	66.38
Senegal	29.8	1.45	58.56	2.28	56.8	67.42
Netherlands	63.38	8.67	69.1	1.36	87	99.32
Hungary	66.65	5.6	73.75	4.68	74.9	97.81
Bulgaria	53.55	7.01	74.56	5.49	63.1	97.3
Bosnia and Herzegovina	26.95	4.06	73.85	5.49	65.9	86.06
Norway	42.24	2.02	74.21	1.52	80.9	99.76
Kyrgyz Republic	39.55	2.35	69.51	2.62	60.2	96.21
Czech Republic	62.5	7.55	74.18	2.88	80.9	98.75
Sweden	44.48	7.49	75	2.67	80.9	99.94

4. GLOBALIZATION AND TURBULENCE

The efficiency frontier is a piece-wise linear envelope spanning the observed points. It consists of linear facets and corner points. Each corner point is an efficient country. But most observations fall behind or below the envelope – they are sub-efficient. The generalized output ratio (4) is less than one. Given the inputs, the outputs are falling short of their efficiency potential.

The inefficient countries are listed in Table 3, in the order of increasing inefficiency. There are considerable gaps between the actual effects of globalization and its frontier values. Obviously, globalization is a dynamic process with strong features of disequilibrium. In this process, Pareto efficiency is often a distant ideal.

The figure 1 in the column headed RTS indicates the presence of increasing returns to scale. The figure -1 indicates decreasing returns to scale. Note that these conditions do not relate to the observed country itself, but to the projection of the country onto the piece-wise linear envelope.

Out of the 48 countries listed in Table 3, 44 countries exhibit increasing returns to scale. For them there are self-reinforcing mechanisms of globalization at work: increasing the causative factors (GROWTH, FORMAL and 1- TARIFF) by one percent, an increase of more than one per cent in both the effects of globalization and the degree of fairness will ensue. Only four countries stand outside this turbulence of globalization: Zambia, Guatemala, the Philippines and the Russian Federation. They face decreasing returns to scale.

To repeat: more than half of the countries studied are located behind the efficiency frontier, and are engaged in dynamic growth with increasing returns to scale. There are considerable gaps between their current performance (exports and foreign direct investments and also the equality of their income distributions) and the corresponding target values: globalization is a self-accelerating process.

TABLE 3

Flexible returns to scale. Inefficient countries. Score = efficiency score, RTS = see text.

Country	Score	RTS	Actual EXP (% of GDP)	Actual FDI (% of GDP)	Actual 1-GINI	Target EXP (% of GDP)	Target FDI (% of GDP)	Target 1-GINI
Switzerland	99.63	1	43.49	3.96	66.32	43.65	4.98	66.57
Mongolia	98.36	1	63.05	5.47	69.73	64.1	6.08	70.89
Finland	97.49	1	38.87	4.81	73.12	44.48	7.49	75
Albania	97.34	1	18.48	3.38	71.85	26.81	4.05	73.81
Pakistan	97.16	1	15.47	0.8	68.63	18.56	3.35	70.63
Slovenia	96.98	1	56.55	2.26	71.59	58.31	6.18	73.82
Croatia	96.64	1	46.02	5.81	70.41	47.62	6.01	72.86
Austria	96.19	1	46.48	2.19	70.85	48.33	5.13	73.66
Moldova	95.83	1	51.11	5.14	64.94	53.34	5.36	67.76
Kenya	95.49	1	23.11	0.31	55.07	32.64	4.34	57.67
Romania	94.77	1	32.7	3.75	69.29	39.27	5	73.11
Israel	94.29	1	38.58	2.7	60.8	40.91	5.07	64.49
Kazakhstan	94.22	1	47.18	8.75	67.39	50.08	9.28	71.53
Zambia	92.13	-1	22.16	4.2	54.99	28.39	4.56	59.69
Korea, Rep.	92.1	1	40.16	1.2	68.41	43.61	6.81	74.27
Sri Lanka	91.29	1	36.31	1.16	63.31	39.78	4.12	69.35
Italy	91.19	1	26.86	0.97	63.97	36.09	2.08	70.15
Armenia	90.98	1	25.55	6.02	65.49	52.42	6.61	71.98
Guatemala	90.72	-1	17.92	1.32	48.02	33.09	2.57	52.93
Philippines	90.63	-1	50.61	1.74	53.91	55.84	2.91	59.48
Canada	90.45	1	42.66	3.58	67.44	47.17	6.71	74.56
Algeria	90.41	1	36.18	1.29	64.67	40.02	5.98	71.53
France	90.39	1	26.84	2.73	67.26	42.81	3.42	74.41
Jordan	89.73	1	45.04	3.84	61.16	50.2	7.03	68.16
Nicaragua	89.36	1	23.59	5.87	56.4	26.58	6.57	63.11
Lithuania	88.92	1	48.61	4.18	66.26	54.67	7.2	74.52
Poland	88.81	1	30.12	3.64	66.25	48.26	5.91	74.6
Portugal	88.46	1	30.48	3.09	61.55	41.52	3.49	69.58
Greece	88.4	1	21.89	0.65	65.73	47.96	4.65	74.36
Spain	87.93	1	27.1	3.85	65.34	43.35	4.38	74.31
Morocco	87.31	1	32.01	1.17	60.54	36.66	10.64	69.34
New Zealand	86.05	1	32.23	2.74	63.83	40.34	5.13	74.18
Latvia	85.62	1	41.61	3.93	63.35	53.9	6.04	73.99
Tunisia	84.78	1	44.77	2.74	59.19	52.8	11.58	69.81
Uganda	82.93	1	12.23	2.93	57	15.32	3.76	68.73
Argentina	82.21	1	17.22	3.06	47.78	34.78	4.76	58.12
Nepal	82.04	1	19.9	0.07	52.83	24.25	4.14	64.39
Turkey	81.88	1	27.28	0.84	58.17	33.32	2.66	71.04
Russian Federation	80.72	-1	36.94	1.37	56.57	45.76	2.26	70.08
United States	79.47	1	10.4	1.78	59.19	42.41	4.99	74.48
Iran, Islamic Rep.	75.72	1	25.4	0.18	55.9	34.65	5.95	73.82
China	73.97	1	25.04	3.42	55.27	40.18	6.64	74.72
Costa Rica	73.55	1	47.05	3.45	51.42	63.98	18.25	69.91
Colombia	69.8	1	19.9	2.65	41.26	35.49	5.16	59.11
Brazil	67.88	1	14.25	3.98	41.17	35.01	5.86	60.65
Mexico	67.75	1	29.25	2.85	47.67	43.18	4.21	70.36
South Africa	59.44	1	27.82	1.4	42.23	46.81	7.32	71.05
Chile	58.98	1	34.26	6.87	42.63	58.08	11.65	72.28

To understand these results, one may discard the conventional economic model of equilibrium, and instead turn to the paradigms of disequilibrium and chaos. W.B. Arthur of the Santa Fe Institute has studied economic systems with "positive "feedback (see Arthur, 1990 and 1994). Once such systems get rolling, they keep snowballing and feed on themselves, up to a point. Positive feedback arises when there are increasing returns to scale.

When self-reinforcing mechanisms are at play, there is little reason to expect the resulting growth path to be orderly and linear. As is well known (see e.g. Nicolis and Prigogine 1977) even very simple systems of nonlinear difference equations are able to generate complex dynamic behavior, including chaos. Whereas the neoclassical economic paradigm is based on the premise of equilibrium, modern dynamic theory suggests that the real-world economy is in a perennial flux.

The crux of the matter, however, must be empirical investigation. Traditionally, such investigations are fraught with difficulties, since econometric estimation methods often incorporate economic assumptions of optimality or equilibrium. Fortunately, DEA makes no such assumptions. In fact, DEA seems to be an ideal tool to establish the presence of disequilibrium caused by increasing returns to scale. The results available from earlier studies indicate strong returns to scale in the digital industry (the production and delivery of communication, education and entertainment in digital form). See Thore (1996), (1999), and (2002). Since globalization is very much a a process of communication and information by digital means, it should not surprise us to find strong returns to scale from globalization.

4.1. The peers

For the argument to follow, we need to write down the dual to program (8). Denote the dual variable of $\mu Y_0 = 1$ by the letter Φ and the dual variable of each linear constraint $-\mu Y_i + vX_i + v_0 \geq 0$ by the letter λ_i. The dual then reads

(9) max Φ
subject to
$\Phi Y_0 - \Sigma\lambda_i Y_i \leq 0$, $i = 1,2,...,72$
$\Sigma\lambda_i X_i \leq X_0$
$\Sigma\lambda_i = 1$

The variables λ_i have an immediate and helpful interpretation. They can be interpreted as weights employed in forming a hypothetical model "composite country" with the output $\Sigma\lambda_i Y_i$ and the input $\Sigma\lambda_i X_i$. The composite country is formed as a weighted average of a few efficient countries with positive weights. As spelled out by program (9), it has the same inputs X_0 as the country currently evaluated (or less) and it delivers a vector of outputs ΦY_0 which represents an equiproportional expansion of the observed outputs (or more). In this sense, the composite country $(\Sigma\lambda_i Y_i, \Sigma\lambda_i X_i)$ is a projection of the observed point onto the frontier.

The projection is a linear combination of the corner points of a facet of the envelope. Each corner point represents a "peer" of the country currently evaluated

– an efficient country which participates with a positive weight in the model composite being formed. The peers are listed in Table 4 together with their weights λ_j. The peers are drawn from the list of efficiency countries in Tables 1 and 2.

TABLE 4

Flexible returns to scale. Inefficient countries: peers and their weights.

Switzerland:	Jamaica (0.47), Norway (0.4), the Netherlands (0.12)
Mongolia:	Czech Republic (0.55), Hungary (0.26), Ghana (0.12), Malaysia (0.06)
Finland:	Sweden (1.0)
Albania:	Bosnia (0.99), Ethiopia (0.01)
Pakistan:	Ethiopia (0.83), Norway (0.17), Uruguay (0.01)
Slovenia:	Czech Republic (0.61), Bulgaria (0.15), Norway (0.07), Ukraine (0.16)
Croatia:	Bulgaria (0.33), Norway (0.31), Ukraine (0.17), Ethiopia (0.12), Belgium (0.07)
Austria:	Norway (0.77), Czech Republic (0.15), Belgium (0.08)
Moldova:	Ukraine (0.37), Kyrgyz Republic (0.31), Thailand (0.19),Belgium (0.1), Ethiopia (0.04)
Kenya:	Jamaica (0.57), Uruguay (0.24), Madagascar (0.2)
Romania:	Bulgaria (0.5), Ethiopia (0.3), Norway (0.2)
Israel:	Jamaica (0.65), Norway (0.33), the Netherlands (0.2)
Kazakhstan:	Bulgaria (0.52), Ukraine (0.2), Azerbaijan (0.15), Ethiopia (0.07), Belgium (0.05)
Zambia:	Uruguay (0.42), Ethiopia (0.34), Panama (0.13), Georgia (0.06), Belgium (0.05),
Korea, Rep.:	Sweden (0.54), Bulgaria (0.32), Ethiopia (0.11), Bosnia (0.03), Czech Republic (0.01)
Sri Lanka:	Ethiopia (0.36), Ukraine (0.35), Kyrgyz Rep (0.16), Thailand (0.08), Belgium (0.05)
Italy:	Norway (0.73), Uruguay (0.2), Ethiopia (0.07)
Armenia:	Bulgaria (0.45), Ukraine (0.43), Azerbaijan (0.12)
Guatemala:	Urugauy (0.55), Panama (0.23), Madagascar (0.20), Ethiopia (0.02)
Philippines:	Thailand (0.4), Ethiopia (0.24), Malaysia (0.17), Ghana (0.12), Madagascar (0.07)
Canada:	Sweden (0.62), Czech Rep. (0.22), Norway (0.12), Ethiopia (0.03)
Algeria:	Ethiopia (0.43), Czech Rep. (0.27), Ukraine (0.17), Norway (0.07), Belgium (0.06)
France:	Norway (0.74), Sweden (0.26)
Jordan:	Czech Rep. (0.45), Ghana (0.37), Ethiopia (0.1), Belgium (0.08)
Nicaragua:	Ethiopia (0.39), Uruguay (0.38), Belgium (0.12), Georgia (0.11)
Lithuania:	Bulgaria (0.63), Czech Rep. (0.25), Sweden (0.12)
Poland:	Bulgaria (0.48), Sweden (0.28), Norway (0.25)
Portugal:	Norway (0.69), Jamaica (0.31)
Greece:	Bulgaria (0.52), Norway (0.47), Ethiopia (0.01)
Spain:	Norway (0.52), Sweden (0.29), Bulgaria (0.15), Ethiopia (0.04)
Morocco:	Ethiopia (0.57), Belgium (0.26), Norway (0.1), Ukraine (0.01)
New Zealand:	Sweden (0.54), Norway (0.35), Ethiopia (0.11)
Latvia:	Bulgaria (0.8), Ukraine (0.2)
Tunisia:	Belgium (0.3), Ukraine (0.29), Ethiopia (0.28), Belarus (0.07), Hungary (0.05)
Uganda:	Ethiopia (0.88), Georgia (0.09), Uruguay (0.03)
Argentina:	Jamaica (0.67), Madagascar (0.29), Uruguay (0.04)
Nepal:	Ethiopia (0.5), Jamaica (0.24), Madagascar (0.22), Norway (0.03)
Turkey:	Norway (0.41), Ethiopia (0.33), Kyrgyz Rep. (0.22), Thailand (0.04)
Russian Fed.:	Belarus (0.47), Ethiopia (0.31), Ukraine (0.18), Ghana (0.03)
United States:	Sweden (0.53), Norway (0.43), Ethiopia (0.04)
Iran:	Sweden (0.57), Bosnia (0.25), Ethiopia (0.18)
China:	Sweden (0.75), Bosnia (0.25)
Costa Rica:	Belgium (0.48), Czech Rep. (0.19), Ethiopia (0.17), Hungary (0.13), Ukraine (0.02)
Colombia:	Jamaica (0.71), Uruguay (0.24), Norway (0.05)
Brazil:	Uruguay (0.54), Norway (0.18), Jamaica (0.17), Belgium (0.11)
Mexico:	Norway (0.49), Kyrgyz Rep. (0.21), Ethiopia (0.12), Thailand (0.11), Belgium (0.06)
South Africa:	Norway (0.41), Kyrgyz Rep. (0.37), Belgium (0.17), Ethiopia (0.04)
Chile:	Czech Rep. (0.52), Belgium (0.21), Ethiopia (0.11), Norway (0.1), Sweden (0.06)

Most countries have four peers, a few have five peers (rather remarkably, Finland has only one peer – Sweden). Often, several of the peers have some affinity to the country currently rated – they may be geographically close, or their economies are remarkably alike.

In other instances, the peers constitute a mixture of opposites. Ethiopia is the most common peer (it occurs 31 times), Norway comes next (25 times). Norway imposes only small import duties on its imports and has a highly developed formal economy; Ethiopia on the other hand protects its economy with considerable import tariffs, and a large sector of its economy is informal (non-monetized). By blending these opposites in the right proportions (together with some fractional portions of a few other peers), one finds the ingredients of the target performance for many countries.

Three countries listed as efficient do not serve as peers to anybody: Bangladesh, the Dominican Republic, and Senegal. Such observations are usually considered as outliers or "self-evaluators", see the discussion in Cooper, Seiford and Tone (2006), p. 37.

To sum up, for each inefficient country an artificial composite country is created as a weighted average of up to five peers. The composite country is the "projection" of the observed country onto the efficiency frontier. The peers are all located on the efficiency frontier, and so is the composite country.

5. CONCLUSIONS

The concept of a "fair globalization" was launched in 2002 by the World Commission on the Social Dimension of Globalization, established by the International Labor Office (ILO). At the 2005 World Summit, the head of states, reviewing the progress on the Millennium Declaration, endorsed it. The original idea was to temper the presumed harsh effects of globalization by suitable use of economic and social social policy variables. The commission called for urgent research in this area.

Responding to this challenge, we have suggested a format for estimating a generalized input-output relationship for the economic and social performance of a country, striking a balance between globalization and protective measures. The relationship was estimated empirically as a piecewise linear input-output frontier, employing the technique of data envelopment analysis (DEA).

The premise of DEA is economic equilibrium and Pareto optimality. Pursuing the original fractional linear programming formulation of DEA, we formed a linear social preference or utility function featuring both globalization performance indicators and an indicator of social fairness (1 minus the Gini index, measuring the equality of the vertical income distribution). DEA proceeds by maximizing in each

country the ratio between this preference function and an imputed cost function of causative factors. At the Pareto frontier, the ratio equals unity so that total preference is exactly exhausted by total imputed costs. At the root of these procedures one recognizes standard ideas of economic equilibrium.

However, one of the great advantages of DEA is that it is equally well suited to analyze processes of disequilibrium. This is important in the present context, because globalization is essentially a dynamic and turbulent process. Fairness, on the other hand, in the first instance relates to the idea of redistributing economic and social desireables, of economic and social equilibrium. It should of course also be possible to arrive at a theory of economic and social fairness in a dynamic setting, but this aspect of the matter seems to be much less developed.

In our study of 72 countries from all continents (the data are averages for 1998 – 2003), we found only 14 countries that are indeed located on the (static) Pareto frontier, assuming constant returns to scale (see Table 1). Several of them are poor, and some of them display virtually no GDP growth (Jamaica, Madagascar, Uruguay). Only one Western country made the list: Belgium.

Relaxing the assumptions a bit and permitting flexible returns to scale, we this time ended up with a list of ten more efficient countries (Table 2). The list now includes three more countries of Western Europe (the Netherlands, Norway and Sweden) .

All other countries (48 countries in all, see Table 3) are inefficient, located behind the Pareto frontier. Four of them operate under decreasing returns to scale: Zambia, Guatemala, the Phillippines and the Russian Federation. Even though these countries currently fall short of equilibrium, globalization to them is an equilibrating process. Rather strikingly the list includes the Russian Federation. Geographical and cultural isolation numbs the impacts of globalization.

This leaves 44 countries exhibiting inefficiency and increasing returns to scale – more than half of the total number of countries rated (Table 3). They defy the premises of economic equilibrium theory. For each of them, we have calculated the projection on the piece-wise linear frontier, that projection being a composite of a few peers – the corner points of the linear facet onto which the country currently rated is being projected (Table 4). Several of these countries have quite low efficiency scores, that is, they are located far from equilibrium. They swirl in a world better described by modern chaos theory (for a non-technical account of such phenomena in economics, see Thore, 1995).

Rather significantly, we recognize at least two of the countries at the bottom of the list as the torch-bearers of globalization: the United States (efficiency score 79.47) and China (efficiency score 73.97). The peers of the US are Ethiopia, Norway and Sweden. (The 1- GINI index of Ethiopia is 70, that of the US was only 59.19). The peers of China are Bosnia and Sweden.

The current export ratio of the US is 10.4 % but the potential target is more than four times greater: 42.41 %. The current export ratio of China is 25.04 % but the potential target is 40.18 %. What do these figures mean? The potential target of economic equilibrium is a distant hypothetical point. It will of course never be realized. Instead it says something about the current direction of and the current turmoil in these economies.

Contemplating the results for China, and keeping in mind the very rapid annual growth of its per capita income (GROWTH was recorded as 8.2 %), some parallels spring to mind. Similar figures of rapid growth and deep disequilibrium have been recorded in studies of corporations in the digital industry (see Thore, 1996, 1999, and 2002). So-called *hypergrowth* occurred during the formative years in companies such as Microsoft and Cisco systems. Such companies are in a perennial state of disequilibrium: a gap between on the one hand the perceived technological potential of the future and on the other existing practices that are fast becoming obsolete. It is a neverending quest toward technological targets and market potentials that are forever evolving. In the same manner, entire countries apparently can experience hypergrowth – an all-pervading state of disequilibrium, a gap between the technological and marketing potential of the future and on the other existing practices and social boundaries that are fast becoming obsolete.

Is it possible to realize a modicum of social fairness during such turbulence? Our results should not discourage political efforts to move in this direction. Our argument is of a purely formal nature: it deals with the kind of economic theory that is needed to describe such processes. It points at the need to develop a theory of economic and social redistributive policy in a setting of disequilibrium rather than equilibrium.

A word of caution

While the results presented should indicate the potential of analyzing a fair globalization as a frontier of a generalized input-output (production) relationship, the computer runs here should be taken as those of an exploratory study only and our numerical results must await further confirmation. In particular, considerable work remains to be done determining the most suitable set of input and output variables. The two outputs EXP and FDI are certainly not the only way of characterizing the presence of globalization, nor is 1 - GINI the only way of characterizing fairness. Similarly, alternative sets (or more inclusive sets) of inputs are available. Unfortunately, the DEA efficiency scores are not robust in the sense that such renewed DEA calculations can be expected to yield similar numerical results. For instance, it is not true that a calculated efficiency score is an unbiased estimate of the theoretical score. To validate our results in cross-section data, extensive calculations are required using alternative and expanded sets of inputs and outputs,

and alternative populations of countries. To validate our results in time series data, calculations over alternative time periods are required, checking for time consistency and determining trends over time.

References:

Arthur, W.B. (1990). Positive Feedbacks in the Economy. *Scientific American*, vol. 262, pp.92-99.

Arthur, W.B. (1994). *Increasing Returns and Path Dependency in the Economy*. Ann Arbor: University of Michigan Press.

Charnes, A., Cooper, W.W. and Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, vol. 2(6), pp. 429-444.

Charnes, A., Cooper, W.W., Lewin, A.Y. and Seiford, L.M. (1994). *Data Envelopment Analysis: Theory, Methodology and Application.* Boston: Kluwer.

Cooper, W.W, Seiford, L.M. and Zhu, J. (2004). *Handbook on Data Envelopment Analysis.* Boston: Kluwer.

Cooper, W.W., Seiford, L.M. and Tone, K. (2006). *Introduction to Data Envelopment Analysis and its Uses: With DEA-Solver Software and References.* New York: Springer.

Golany, B. and Thore, S. (1997a). The Competitiveness of Nations. In W.W. Cooper, S. Thore, D. Gibson and F. Phillips (Eds), *IMPACT: How IC2 Research Affects Public Policy and Business Markets* (pp. 189 – 208). Westport , Connecticut: Greenwood Publishing.

Golany, B. and Thore, S. (1997b). The Economic and Social Performance of Nations: Efficiency and Returns to Scale. *Socio-Economic Planning Sciences*, vol. 31, pp. 191 – 204.

Golany, B. and Thore, S. (1997c). Restricted Best Practice Selection in DEA: An Overview with a Case Study Evaluating the Socio-Economic Performance of Nations. *The Annals of Operations Research*, vol. 73, pp. 117-140.

ILO, International Labor Office (1919). *Constitution of ILO: Declaration concerning the aims and purposes of the ILO.* For last update, see *http://www.ilo.org/public/english/about/iloconst.htm*

ILO, International Labor Office (1999). *Decent Work,* Report of the Director-General. Geneva: ILO.

ILO, International Labor Office (2001a). *Reducing the Decent Work Deficit: A Global Challenge,* Report of the Director-General. Geneva: ILO.

ILO, International Labor Office (2001b). *Poverty reduction and Decent Work in a globalizing world,* GB.280/WP/SDG/1. Geneva: ILO.

ILO, International Labor Office (2003). *Working out of Poverty*, Report of the Director-General. Geneva: ILO.

Land, K.C., Lovell, C.A.K. and Thore, S. (1994). Productive Efficiency under Capitalism and State Socialism: An Empirical Inquiry Using Chance-Constrained Data Envelopment Analysis. *Technological Forecasting and Social Change*, vol. 46, pp. 139-152.

Lovell, C.A.K. (1995). Measuring the Macroeconomic Performance of the Taiwanese Economy. *International Journal of Production Economics,* vol. 39:1, pp. 165 – 178.

Nicolis, A. and Prigogine, I. (1977). *Self-Organization in Nonequilibrium Systems: From Dissipative Structures to Order through Fluctuations.* New York: Wiley.

OECD, Organization of Economic Cooperation and Development (2005). *Measuring Globalization: OECD Handbook on Economic Globalization Indicators*, OECD, Paris: OECD.

Tarverdyan, R. and Thore, S. (2006). Using Data Envelopment Analysis to quantify ILO objectives and identify policies conducive to Decent Work. Presented at the OR48 annual conference, The University of Bath, England, September 2006. Submitted to *Socio-Economic Planning Sciences.*

Thore, S. (1995). *The Diversity, Complexity, and Evolution of High Tech Capitalism.* Boston: Kluwer. Also published on the Internet, see www.stenthore.info.

Thore, S. (1996). Economies of Scale, Emerging Patterns and Self-Organization in the US Computer Industry: An Empirical Investigation Using Data Envelopment Analysis. *Journal of Evolutionary Economics*, vol. 6, pp. 199-216.

S. Thore, S. (1999). Enterprise in the Information Age. In W.E. Halal and K.B. Taylor (Eds.), *Twenty-First Century Economics, Perspectives of Socioeconomics for a Changing World* (pp.131-153). New York: St. Martin´s Press.

Thore, S. (2002). Economies of Scale in the Digital Industry. In P. Conceição, D.V. Gibson, M.V. Heitor, G. Sirilli and F. Veloso (Eds), *Knowledge for Inclusive Development* (pp.157–172). Westport, Connecticut: Quorum Books.

United Nations (2000). *United Nations Millennium Declaration.* Adopted by the General Assembly. New York: United Nations A/55/L.2.

United Nations (2004*). A Fair Globalization: Creating Opportunities for All.* Resolution adopted by the General Assembly. New York: United Nations A/RES/59/57.

United Nations (2005). *2005 World Summit Outcome.* Adopted by the General Assembly. New York: United Nations A/60/L.1.

United Nations (2006). *Coherence, coordination and cooperation in the context of the implementation of the Monterrey Consensus and the 2005 World Summit Outcome.* Notes by the Secretary General. Geneva: United Nations E/2006/48.

World Bank and IMF (2004**).** *Policies and actions for achieving the MDGs and related outcomes.* Global monitoring report. Washington: World Bank.

World Bank and IMF (2006). *Millennium Development Goals: Strengthening Mutual Accountability, Aid, Trade, and Governance.* Global monitoring report. Washington: World Bank.

World Commission on the Social Dimension of Globalization (2002). *A Fair Globalization: Creating Opportunities for All.* Geneva: International Labor Office.

WTO, World Trade Organization. Trade liberalization statistics, *http://www.gatt.org/trastat_e.html*

Resumo

A Organização Internacional do Trabalho (OIT), um braço das Nações Unidas sedeado em Genebra, tem como objectivo promover oportunidades para que mulheres e homens obtenham trabalho decente e produtivo, em condições de liberdade, de equidade, de segurança e de dignidade humana. Desde 1999, a OIT conduziu uma série de estudos sobre trabalho digno e sobre os efeitos da globalização. Em 2004, a organização colocou o desafio de moderar os efeitos da globalização, visando uma globalização justa. É necessário implementar regras justas no comércio e nas finanças, beneficiando homens e mulheres em países ricos e pobres igualmente. Usando termos económicos correntes, a globalização pode ser vista como o output de uma função geral de input-output, que depende de variáveis de desempenho económico e de política económica e social. Usando data envelopment analysis (DEA), foi ajustada uma fronteira linear segmentada às observações de 72 países de todos os continentes. Os países ineficientes revelaram condições de falta de equidade na globalização.

Palavras Chave: Globalização, Organização Internacional do Trabalho, data envelopment analysis, índice Gini, eficiência de Pareto, rendimentos constantes à escala, países de referência, ineficiência, teoria do caos.