Advances in Performance Management – A Mainland Labs Series

MEASURING WELFARE BEYOND GDP

On our way to a new welfare index

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I. INTRODUCTION

Today, there is still a strong reliance on GDP data when it comes to comparing welfare levels between countries. This is despite of the criticism of the GDP measure, well established under economists. One aspect of it is the current conception of national accounts only recording activities rated via market price systems. This, of course, rules out any domestic work or the like, and any kind of (positive or negative) external effects in production and consumption not exerting influence on the economy in the period in question[1]. Also, the established system of accounting is notorious in its neglection of distributional aspects of national income. So, rather than building a utility-based measure of social welfare, current national accounts simply measure the value of market transactions[2] disregarding, in principle, their nature and the agents involved.

So, it is no wonder that there have been various attempts to provide welfare measures which go beyond GDP. Still, one has to admit that national income in a general sense can be at least a good starting point in the approximation of the utility reaped by the members of a society. In their 2016 essay on welfare measurement Jones and Klenow follow exactly that path. They propose an indicator for the welfare of a country which is (to a big extend) based on one major component of income namely consumption. In using the United States as the ruling stick in their study they try to assess by how much US consumption (given its current level of leisure, mortality and equality) has to be given up in order to match another country´s welfare based on the same variables. However, if the USA dominate as far as consumption is concerned, other countries might as well offset that advantage at least partly when other factors contributing to welfare are taken into account. In the case of France, for example, they show that based on consumption alone the country can only achieve a welfare level of about 60% of that of the USA, whereas if one adds the effects of all other variables this gap almost closes. Obviously, the opposite will also hold true for quite a substantial number of countries.

Jones and Klenow (2016, 2428) use "(…) a utility function to arrive at a consumption-equivalent welfare measure that can be compared across time for a given country as well as across countries". More precisely, they construct a relational measure (λ) which equalizes welfare levels between countries (i.e. between countries and the US) by adjusting consumption-based utility.

(1) $$\mathbf{U_i} = \mathrm{E_i} \sum_{a=1}^{100} \beta^a u(\mathrm{C_{ai}}, \mathrm{l_{ai}})\, \mathrm{S_i}(a)$$

$$\wedge \quad = \quad \vee$$

$$\mathbf{U_{us}} = \mathrm{E_{us}} \sum_{a=1}^{100} \beta^a u(\mathrm{C_{a\,us}}, \mathrm{l_{a\,us}})\, \mathrm{S_{us}}(a)$$

(2) $$\mathrm{E_{us}} \sum_{a=1}^{100} \beta^a u(\boldsymbol{\lambda_i} \mathrm{C_{a\,us}}, \mathrm{l_{a\,us}})\, \mathrm{S_{us}}(a) = \mathrm{E_i} \sum_{a=1}^{100} \beta^a u(\mathrm{C_{ai}}, \mathrm{l_{ai}})\, \mathrm{S_i}(a) = \mathbf{U_i}$$

Ad (1): Expected utility of a representative individual of country i is given by the risk adjusted sum of flows of utility (U) contributed by consumption (C) and leisure (l) over the expected lifetime (probability S) of that individual. Building on expected aggregated utility relative performance of societies (i.e. countries) can be analyzed (see Table 1). Ad (2): λ, an adjusting factor specific to every single country (i) in the comparison, is key in the Jones/Klenow

[1] If, of course, these external effects are immediate they would be implicitly taken into account through (now altered) current values of production and consumption.

[2] This said, we have to state that a significant part of the utility "produced" in a society in a period is directly connected to the value of goods and services produced and/or traded in the same period.

welfare ranking. It defines by how much US consumption has to be reduced before the US welfare advantage over country i (expressed in utility units) is completely leveled out. Table 1 gives an overview over the ranking of countries based on factor λ_i.

Table 1: Welfare across countries

	Welfare λ	Income	log ratio	Life exp.	C/Y	Leisure	ineq.	ineq.
US	100.0	100.0	0.000	0.000 *77.4*	0.000 *0.897*	0.000 *877*	0.000 *0.538*	0.000 *1,091*
UK	96.6	75.2	0.250	0.086 *78.7*	−0.143 *0.823*	0.073 *579*	0.136 *0.445*	0.097 *826*
France	91.8	67.2	0.312	0.155 *80.1*	−0.152 *0.790*	0.083 *535*	0.102 *0.422*	0.124 *747*
Italy	80.2	66.1	0.193	0.182 *80.7*	−0.228 *0.720*	0.078 *578*	0.086 *0.421*	0.075 *905*
Spain	73.3	61.1	0.182	0.133 *79.1*	−0.111 *0.786*	0.070 *619*	0.017 *0.541*	0.073 *904*
Mexico	21.9	28.6	−0.268	−0.156 *74.2*	−0.021 *0.879*	−0.010 *906*	−0.076 *0.634*	−0.005 *1,100*
Russia	20.7	37.0	−0.583	−0.501 *67.1*	−0.248 *0.733*	0.035 *753*	0.098 *0.489*	0.032 *1,027*
Brazil	11.1	17.2	−0.436	−0.242 *71.2*	0.004 *0.872*	0.005 *831*	−0.209 *0.724*	0.006 *1,046*
S. Africa	7.4	16.0	−0.771	−0.555 *60.9*	0.018 *0.887*	0.054 *650*	−0.283 *0.864*	−0.006 *1,093*
China	6.3	10.1	−0.468	−0.174 *71.7*	−0.311 *0.658*	−0.016 *888*	0.048 *0.508*	−0.014 *1,093*
Indonesia	5.0	7.8	−0.445	−0.340 *67.2*	−0.178 *0.779*	−0.001 *883*	0.114 *0.445*	−0.041 *1,178*
...	...	...	...	...	...	...	...	...

Source: Jones and Klenow 2016, p2445

In the following section, we will try to contrast the approach of Jones and Klenow to welfare measurement by drawing on the concept of a performance frontier in $\mathbb{R}^n$, which can act as a reference for individual countries in their quest of maximizing the welfare of their people. In this context, we employ mathematical programming techniques to establish relative welfare levels, adopting basically the same variables which were used in the original Jones/Klenow study.

II. PERFORMANCE FRONTIERS AND THE MEASUREMENT OF RELATIVE WELFARE

1. MODELLING WELFARE PRODUCTION

In our context, the concept of a performance frontier draws on the idea of a country´s welfare potential being based on a whole set of parameters such as income together with labor conditions and a range of societal factors responsible for outcomes as diverse as the distribution of wealth and life expectancy. Together these parameters or the specific formation of these parameters, respectively, determine what can be seen as an upper bound to the welfare possibly generated by that country. Having said that it is clear that the specific performance of a country can be measured vis-a-vis such a bound. This idea can be further

developed by employing mathematical optimization to identify slack in the organization of wealth and reach some sort of performance measure accordingly.

Since we can never know the exact inner functioning of the welfare formation process, following this path of analysis we have a number of methodological options to (up to a certain degree) estimate performance, among those specifically one which does without the exact layout of a welfare production function videlicet the instrument of data envelopment analysis (DEA). So, when trying to establish a performance measure relative to a group of peer countries, in line with the basic idea behind the Jones and Klenow study as is the case here, we will use DEA to establish the relative position of a country in the welfare production possibility set defined by the countries´ individual upper welfare bounds and linear combinations of those bounds in $\mathbb{R}_{+}^{m}$ (m indicating the number of performance dimensions entering into the comparison).

Obviously, the choice of performance dimensions – as is the case in any act of performance measurement – to a large extent preempts the outcome of the exercise. But this does not bother us too much, since here (for comparison reasons) we will more or less follow the logic of Jones and Klenow as far as the selection of decision variables is concerned. This means that consumption and time spend on leisure will both play an important role, as well as distributional effects and life expectancy. Where we differ is in the way we roll out the benchmarking process (the benchmark being the reference needed to establish the relative welfare position of each of the countries in the sample). Whereas Jones and Klenow a priori introduce the US as their measuring stick we will leave that to a self-referencing procedure involving individual welfare potentials established by projecting each of the countries on to their respective bit of the m-dimensional performance surface. This process is run employing non-parametric data envelopment analysis. The specific model used for that matter is laid out below.

2. EVALUATING WELFARE PRODUCTION

2.1. THE MODEL

Given a big variety of modelling options we settle for a non-radial DEA approach specifically assuming constant returns to scale (CRS). This is despite of the fact that increased levels of welfare will see (following marginalist reasoning) eventually decreasing marginal values in overall welfare production which would - no doubt - call for a VRS approach. On the other hand, in our analysis we want to produce an unambiguous ranking, like the one in the Jones and Klenow study[3], with one country acting as the ultimate reference and all others positioned relatively to it. This we can only provide by employing some kind of a CRS model.

[3] Canceling out any ambiguity using a CRS scheme makes sense but we have to bear in mind that Jones and Klenow must assume (in order to make their factor λ comparable and applicable across countries) that (1) welfare is an absolute concept detached from the fact that there are in practice different qualities and characteristics of the social systems analyzed, and (2) that a however derived absolute standard of welfare (the benchmark, e.g. the US) is fully divisible and scalable.

(1)
$$\delta^* = \min_{\lambda, s^-, s^+} \frac{1 + \frac{1}{m}\sum_{i=1}^{m} \frac{s_i^-}{x_{ih}}}{1 - \frac{1}{s}\sum_{r=1}^{s} \frac{s_r^+}{y_{rh}}}$$

$$subject\ to:$$

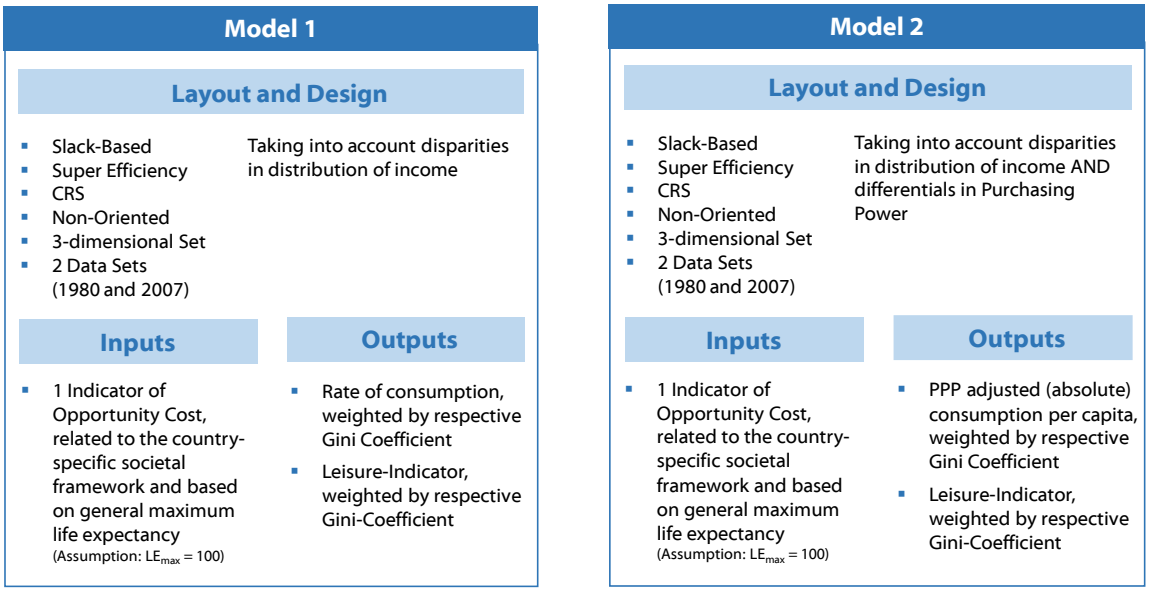
$$\boldsymbol{x}_h + \boldsymbol{s}^- = \sum_{j=1, j\neq h}^{n} \boldsymbol{x_j}\,\lambda_j$$

$$\boldsymbol{y}_h - \boldsymbol{s}^+ = \sum_{j=1, j\neq h}^{n} \boldsymbol{y}_j \lambda_j$$

$$\lambda \geq 0,\ s^- \geq 0,\ s^+ \geq 0$$

(1) shows a quite straightforward slack-based super-efficiency measure (Super-SBM) of performance which is non-oriented or simultaneously input and output oriented, respectively. We use this basic model in a three-dimensional setting with one input and two outputs, tracking respective realizations for two (non-consecutive) years, 1980 and 2007[4], and a couple of slightly different configurations of performance dimensions. Figure 1 gives an overview over two of three fully developed SBM variants, one of which (model 1) we will further lay out below.

Fig. 1: SBM-variants



All these models are – as stated above – in line with the Jones and Klenow perception of welfare contributing variables. Here, in the framework of DEA, with model 1, we decide on one input representing some sort of opportunity cost of living in any of the 128 countries in

[4] Actually, for our calculation to make the best of sense this time span is probably too long. Indeed, our approach (see below) is designed to offer a consistent welfare measure over a much shorter period, e.g. two to five years.

the sample. Since life expectancy (while depending on a whole range of factors) can - as a variable (LE_{act}) - perfectly represent the effects of the overall strain on a population, we construct a measure which uses relative deviations from a presumed maximum life expectancy (LE_{max}) of 100 years as a proxi for these opportunity costs. Equation (2) describes the relevant cost ratio o (opportunity costs expressed in normalized life years lost) employed in the models.

(2) $o_i = (LE_{max} - LE_{act,i})/LE_{max} \qquad LE_{max} = 100 \qquad i = 1, \dots, 128$

On the output-side of the model we do use consumption (as the main component of income) and leisure as descriptors of welfare gains (contributions to aggregate utility levels) but at the same time provide that inequalities in the distribution of income are taken into account by relating the respective values to the Gini coefficient. In our models we treat leisure, its amount and all the different manifestations and levels of quality connected to it, as another form of income, and prone to the same kind of potentially skewed distribution within population as consumption. (3) gives an overview of performance dimensions 2 and 3 of model 1 (outputs 1 and 2), the inequality-adjusted consumption rate c_G, and the inequality-adjusted leisure values, l_G.

(3)

$$c_{G,i} = \frac{c_{act,i}}{G_i} \qquad i = 1, \dots, 128$$

$$l_{G,i} = \frac{l_{act,i}}{G_i}$$

2.2. DEVELOPING A NEW WELFARE MEASURE USING DEA

While in the appendix we provide the data sets for model 1 and the respective Super-SBM results (see page 9), we are now concerned with constructing a potent general welfare measure based on specific characteristics of cross-period performance vectors of the individual countries, challenging the Jones and Klenow assessment. We define cross-period performance vectors as vectors running from the origin to positions in (intertemporal) efficiency space (geometrical space containing all possible combinations of efficiency scores of 1980 and 2007) taken by the individual countries. For a depiction of performance vectors in efficiency space see figure 2.

We are specifically interested in two of the features of these vectors, (a) the length of the respective line segments, or the distance from the origin to points in $\mathbb{R}^2_+$ efficiency space, i.e. our indicator of achieved relative welfare levels (w^l), and (b) in the angle between the adjacent and the performance vector (hypotenuse of a right triangle), i.e. our indicator of welfare dynamics between periods (w^d). See (4) and (5) for notations.

(4) Relative Welfare Level $\qquad w_i^l = \sqrt{\left(\delta_i^{1980}\right)^2 + \left(\delta_i^{2007}\right)^2} \qquad i = (1, \dots, 218)$

(5) Welfare Dynamics $\qquad w_i^d = tan^{-1}\left(\frac{\delta_i^{2007}}{\delta_i^{1980}}\right)$

Fig.2: Countries in intertemporal efficiency space

In order to build a strong overall welfare measure we integrate both aspects of welfare production. Using welfare improvements (w^d) as a lever, see (6), we are able to give more meaning to achieved welfare levels and at the same time solving issues of ambiguity inherent in criterion (4). Both aspects of welfare production (exploitation of welfare potentials, and improvements in it over time), when employed together in a CRS setting, provide a clear-cut welfare ranking of countries. Since the underlying welfare measure represents a cross-period average our approach also contributes to the quality of results considering the complexity of welfare-related data and the likelihood of measurement errors on the way.

(6) Overall welfare measure $W_i = w_i^l(\frac{w_i^d}{45})$

One note on the formation of the lever mentioned above. Obviously, it brings welfare growth into the equation. In order to take into account both welfare improvement and decline, we normalize the value of the slope of the individual performance vectors or, better, the value of the angle produced by these vectors using a constant reflecting zero growth between periods (i.e. 45 degree angle).

Table 2 gives an overview of the results produced employing our new overall welfare measure in rating the 128 countries of the Jones and Klenow study.

Tab. 2: A new overall welfare measure - results for the sample of 128 countries

Sample		Efficiency Scores		Indicators			
#	Country	1980	2007	Rel. Welfare Level	Welfare Dynamics	Welfare Performance	Rang
1	Maldives	0,15	0,38	40,67	67,64	61,13	51
2	South Korea	0,42	0,61	74,30	55,34	91,37	23
3	Bhutan	0,24	0,34	41,00	54,87	49,98	73
4	Iran	0,26	0,35	43,73	53,33	51,83	68
5	Egypt	0,32	0,46	56,22	54,91	68,59	43
6	Cape Verde	0,34	0,49	59,97	55,39	73,80	36
7	Turkey	0,26	0,41	48,49	57,91	62,41	49
8	Singapore	0,34	0,41	53,56	50,09	59,63	54
9	Cyprus	0,58	0,83	100,91	54,97	123,27	4
10	Cambodia	0,20	0,27	33,83	53,65	40,33	95
11	Argentina	0,44	0,48	64,82	47,39	68,27	45
12	Iraq	0,10	0,35	35,98	74,56	59,62	55
13	Poland	0,61	0,64	88,35	45,98	90,28	24
14	China	0,30	0,27	40,69	42,23	38,18	99
15	St. Vincent	0,48	0,54	71,88	48,28	77,12	32
16	Malta	0,71	0,86	111,35	50,32	124,51	3
17	Vietnam	0,30	0,41	50,96	53,32	60,38	53
18	Bolivia	0,18	0,25	31,34	54,07	37,66	103
19	Portugal	0,48	0,58	75,29	50,45	84,41	28
20	Oman	0,27	0,31	41,02	49,22	44,86	89
21	Greece	0,57	0,71	90,89	51,23	103,47	15
22	Mongolia	0,37	0,38	52,64	45,45	53,16	65
23	Ireland	0,50	0,49	70,25	44,18	68,98	42
24	Lao	0,27	0,33	43,00	50,40	48,16	78
25	Japan	0,56	0,76	94,08	53,57	112,01	9
26	Spain	0,56	0,67	87,03	50,20	97,08	19
27	Macao	0,41	0,36	54,36	41,07	49,61	75
28	Hungary	0,68	0,68	95,82	44,83	95,45	21
29	Thailand	0,33	0,36	49,18	47,11	51,49	69
30	Indonesia	0,29	0,38	47,43	52,65	55,49	62
31	Finland	0,64	0,77	99,63	50,37	111,51	10
32	Austria	0,69	0,82	107,33	49,94	119,12	5
33	Lebanon	0,46	0,45	64,30	44,77	63,97	47
34	Hong Kong	0,48	0,54	71,87	48,36	77,24	31
35	Albania	0,46	0,69	82,82	56,53	104,04	14
36	United Kingdom	0,69	0,73	100,84	46,74	104,74	13
37	Brazil	0,23	0,30	37,71	52,20	43,74	90
38	Bahamas	0,22	0,31	37,98	53,85	45,45	87
39	Sri Lanka	0,41	0,49	63,75	49,63	70,30	39
40	New Zealand	0,63	0,75	97,28	50,02	108,14	11
41	Australia	0,54	0,70	88,78	52,17	102,93	17
42	Barbados	0,40	0,42	58,50	46,46	60,40	52
43	Iceland	0,68	0,92	114,60	53,58	136,46	2
44	India	0,35	0,34	48,43	43,83	47,18	81
45	Italy	0,50	0,66	83,07	53,14	98,09	18
46	France	0,56	0,77	95,61	53,92	114,56	6
47	Saudi Arabia	0,15	0,30	33,14	63,55	46,80	83
48	Peru	0,26	0,33	41,91	50,91	47,42	80
49	Luxembourg	0,70	0,64	95,20	42,40	89,69	26
50	Sudan	0,31	0,34	46,67	47,56	49,32	76
51	Tunisia	0,31	0,40	50,23	52,12	58,17	59
52	Dominican Rep.	0,42	0,48	63,93	48,83	69,37	41
53	Germany	0,69	0,75	101,60	47,27	106,72	12
54	United States	0,51	0,56	75,60	47,87	80,42	29
55	Bulgaria	0,50	0,51	71,86	45,55	72,74	37
56	Botswana	0,22	0,12	25,30	29,12	16,37	128
57	Jamaica	0,38	0,45	58,46	49,90	64,82	46
58	Israel	0,54	0,64	83,99	49,68	92,72	22
59	Sweden	1,19	1,08	161,06	42,13	150,79	1
60	Malaysia	0,33	0,34	47,05	45,61	47,68	79
61	Guatemala	0,24	0,34	41,18	54,53	49,90	74
62	Netherlands	0,70	0,72	100,46	46,15	103,02	16
63	Chile	0,34	0,37	50,41	47,72	53,45	64
64	Fiji	0,34	0,47	58,26	54,02	69,94	40

Sample		Efficiency Scores		Indicators			
#	Country	1980	2007	Rel. Welfare Level	Welfare Dynamics	Welfare Performance	Rang
65	Uganda	0,23	0,23	32,82	44,30	32,31	110
66	Mali	0,22	0,23	31,78	46,20	32,62	109
67	Switzerland	0,50	0,62	79,58	50,81	89,86	25
68	Belgium	0,72	0,78	106,21	47,49	112,07	8
69	Kuwait	0,24	0,26	35,52	47,14	37,21	105
70	Mauritius	0,44	0,44	61,77	45,08	61,87	50
71	Canada	0,61	0,67	91,21	47,66	96,61	20
72	Norway	0,70	0,62	93,60	41,42	86,16	27
73	Mexico	0,29	0,38	48,01	53,02	56,57	61
74	Honduras	0,35	0,50	61,31	54,74	74,59	35
75	Denmark	0,84	0,81	116,35	43,99	113,73	7
76	Nepal	0,21	0,29	36,04	54,57	43,70	91
77	Ecuador	0,26	0,33	42,19	51,94	48,70	77
78	Chad	0,29	0,21	35,82	36,59	29,13	117
79	Panama	0,34	0,33	47,72	44,32	47,00	82
80	Belize	0,54	0,55	77,07	45,59	78,08	30
81	Costa Rica	0,41	0,49	63,59	50,07	70,75	38
82	Pakistan	0,38	0,41	55,98	47,20	58,71	57
83	Ghana	0,29	0,35	44,88	50,39	50,25	70
84	Nigeria	0,18	0,21	27,81	49,25	30,44	116
85	Burkina Faso	0,23	0,25	33,75	47,36	35,52	106
86	Morocco	0,31	0,36	47,76	49,40	52,43	67
87	Uruguay	0,37	0,43	56,99	49,54	62,73	48
88	Paraguay	0,29	0,32	43,53	47,96	46,38	85
89	Syria	0,52	0,53	74,66	45,74	75,88	33
90	Colombia	0,25	0,28	38,03	48,41	40,91	94
91	Angola	0,16	0,13	20,93	38,15	17,74	127
92	Benin	0,24	0,27	35,90	47,82	38,15	100
93	Namibia	0,16	0,18	24,26	48,26	26,02	123
94	Comoros	0,27	0,37	45,32	53,96	54,35	63
95	Venezuela	0,36	0,40	53,70	47,97	57,24	60
96	Mauritania	0,28	0,27	38,91	43,57	37,68	102
97	Togo	0,24	0,31	38,81	52,09	44,93	88
98	Philippines	0,32	0,32	45,46	45,50	45,96	86
99	Bangladesh	0,37	0,41	55,31	47,98	58,97	56
100	Senegal	0,25	0,28	37,52	47,70	39,77	96
101	Jordan	0,46	0,48	66,77	46,10	68,40	44
102	Ethiopia	0,30	0,35	46,19	48,90	50,19	71
103	Madagascar	0,22	0,31	37,99	55,14	46,55	84
104	Qatar	0,29	0,21	35,78	36,49	29,01	119
105	Sao Tome/Princi	0,40	0,41	56,96	46,00	58,23	58
106	Saint Lucia	0,59	0,54	79,80	42,24	74,91	34
107	South Africa	0,17	0,16	23,12	42,30	21,73	126
108	Rwanda	0,21	0,22	30,32	45,54	30,69	114
109	Gabon	0,22	0,21	30,13	43,46	29,10	118
110	Suriname	0,40	0,38	55,10	42,92	52,55	66
111	Lesotho	0,38	0,28	47,36	36,54	38,46	98
112	Malawi	0,22	0,22	30,55	45,12	30,63	115
113	Djibouti	0,25	0,26	36,10	46,72	37,48	104
114	Niger	0,19	0,28	34,24	55,36	42,13	93
115	Bahrain	0,41	0,28	49,83	34,24	37,92	101
116	Cameroon	0,22	0,20	29,57	41,99	27,58	121
117	Zimbabwe	0,29	0,21	35,36	35,56	27,95	120
118	C. Afr. Republi	0,28	0,25	37,60	41,15	34,38	107
119	Cote dIvoire	0,24	0,23	32,86	43,54	31,79	112
120	Zambia	0,25	0,18	30,55	35,93	24,39	125
121	Kenya	0,26	0,23	34,76	40,94	31,63	113
122	Tanzania	0,30	0,28	40,81	43,26	39,23	97
123	Swaziland	0,26	0,19	31,99	35,48	25,23	124
124	Guinea	0,20	0,24	31,18	49,23	34,11	108
125	Sierra Leone	0,26	0,23	34,46	42,19	32,30	111
126	Trinidad/Tobago	0,42	0,32	52,50	37,09	43,27	92
127	Liberia	0,24	0,34	41,13	54,77	50,06	72
128	Congo	0,30	0,20	35,56	33,95	26,83	122

2.3. CONCLUDING REMARKS

At the first glance these results seem plausible taking into account e.g. the specific social conditions still prevailing in some of the formally richer countries in the sample. After all, with their working population "imported" on a massive scale (roughly 90% of the overall population), low standard of living for the many and exploitative labor schemes, why should prominent countries of the golf region rank any higher? To a lesser extend this also holds true for the United States (the ruling stick or role model in the Jones and Klenow study) which in our ranking holds position 29 out of 128. That all the top positions in our ranking are occupied by European countries known for solid economies and high social standards does not come as a surprise (Sweden being on top of the list, followed by Iceland[5]).

[5] We are talking pre-financial crises Iceland here, in 2007.

But even when the results seem more in line with reality, compared to the results of the Jones and Klenow study anyway, we still have to point out where the relative methodological advantages of our modelling approach really lie. First, the DEA framework we employ can easily deal with a world (or countries, for that matter) characterized by a myriad of different preference sets. This is not the case with Jones and Klenow. They develop a (intertemporal) welfare production function which is meant to be universally valid. That function sets out to explain the sources and composition of utility across all countries. The contributions to welfare of a unit of any of the decision variables are uniformly predefined for all of the sample not allowing for divergence in the importance of those variables between countries or cultures. Basically, this produces one single ruling set of preferences which – in the Jones and Klenow study – is also constant over time. In that, a lot of valuable information is lost. So, even when the authors share with us a common perception of a welfare production technology (we both use the same factors of production), we are less deterministic at the start, at least as far as production techniques (preferences) are concerned. The utility of the individual and with it the welfare of a whole nation is to be judged with local traditions and cultural heritage in mind. In short, a potent welfare measure has to take into account that welfare as a concept is not easily objectifiable. DEA can get part of the work done and will provide a fairer individualistic approach in cross-country comparison.

A short remark at the outset regarding monetary values for non-traded "goods" like life years or leisure time. In welfare economics we will of course find ways to argue prices in those cases (be it via some sort of stated preferences approach, reference to surrogate markets, or else), but results of welfare calculation will heavily depend on how we deal with the problem. Not to mention the extraordinary influence the choice of discount rates will have on results, especially over long periods, like the one in the Jones and Klenow study (almost 30 years). So, here too, DEA proves advantageous, since it can handle non-monetary data perfectly, which we have shown in the analysis presented above.

2.4. APPENDIX

A. Data Sets Model 1 for 1980 and 2007

Super-SBM | CRS | NO | 1980				
Sample		Input	Outputs	
#	Country	o	c_G	l_G
1	Maldives	0,47	0,90	2,37
2	South Korea	0,34	2,38	2,85
3	Bhutan	0,54	2,09	2,47
4	Iran	0,48	2,08	2,42
5	Egypt	0,44	2,70	2,41
6	Cape Verde	0,40	2,41	2,51
7	Turkey	0,43	1,87	2,17
8	Singapore	0,28	1,40	2,28
9	Cyprus	0,25	2,22	3,20
10	Cambodia	0,61	2,32	2,12
11	Argentina	0,31	2,36	2,45
12	Iraq	0,43	0,42	2,61
13	Poland	0,30	3,33	3,27
14	China	0,33	1,71	1,87
15	St. Vincent	0,34	3,61	2,52
16	Malta	0,27	3,50	3,43
17	Vietnam	0,44	2,44	2,40
18	Bolivia	0,48	1,47	1,71
19	Portugal	0,29	2,47	2,49
20	Oman	0,39	1,48	2,55
21	Greece	0,26	2,52	2,72
22	Mongolia	0,43	2,91	2,77
23	Ireland	0,28	2,55	2,44
24	Lao	0,51	2,58	2,47
25	Japan	0,24	2,12	2,74
26	Spain	0,25	2,31	2,65
27	Macao	0,27	1,65	2,42
28	Hungary	0,31	3,69	3,86
29	Thailand	0,35	2,01	2,14
30	Indonesia	0,42	1,94	2,49
31	Finland	0,27	2,68	3,47
32	Austria	0,28	3,36	3,50
33	Lebanon	0,33	2,92	2,59
34	Hong Kong	0,25	2,06	2,29
35	Albania	0,30	2,09	3,04
36	United Kingdom	0,26	3,22	3,32
37	Brazil	0,38	1,54	1,57
38	Bahamas	0,32	1,10	1,57
39	Sri Lanka	0,32	2,25	2,47
40	New Zealand	0,27	3,01	3,10
41	Australia	0,26	2,29	2,78
42	Barbados	0,28	2,22	1,87
43	Iceland	0,23	2,54	3,25
44	India	0,45	2,80	2,82
45	Italy	0,26	2,16	2,53
46	France	0,26	2,45	2,81
47	Saudi Arabia	0,38	0,61	2,58
48	Peru	0,40	1,89	1,91
49	Luxembourg	0,28	3,59	3,49
50	Sudan	0,51	3,27	2,57
51	Tunisia	0,38	2,05	2,16
52	Dominican Rep.	0,37	3,11	2,55
53	Germany	0,27	3,24	3,50
54	United States	0,26	2,26	2,55
55	Bulgaria	0,29	2,56	2,65
56	Botswana	0,40	1,51	1,63
57	Jamaica	0,30	1,98	2,01
58	Israel	0,26	2,53	2,57
59	Sweden	0,24	4,24	4,49
60	Malaysia	0,33	1,69	2,23
61	Guatemala	0,43	1,88	1,79

Super-SBM | CRS | NO | 1980				
Sample		Input	Outputs	
#	Country	o	c_G	l_G
65	Uganda	0,50	2,15	2,06
66	Mali	0,60	2,53	2,27
67	Switzerland	0,25	1,97	2,50
68	Belgium	0,27	3,35	3,57
69	Kuwait	0,30	0,84	2,53
70	Mauritius	0,33	2,70	2,49
71	Canada	0,25	2,57	2,95
72	Norway	0,24	2,73	3,47
73	Mexico	0,33	1,65	1,82
74	Honduras	0,41	2,60	2,56
75	Denmark	0,26	3,83	3,96
76	Nepal	0,52	2,01	1,88
77	Ecuador	0,37	1,67	1,80
78	Chad	0,52	3,02	2,45
79	Panama	0,30	1,79	1,89
80	Belize	0,30	3,37	2,56
81	Costa Rica	0,27	2,11	1,93
82	Pakistan	0,42	2,94	2,83
83	Ghana	0,47	2,35	2,47
84	Nigeria	0,55	1,56	2,05
85	Burkina Faso	0,54	2,27	2,15
86	Morocco	0,42	2,43	2,31
87	Uruguay	0,30	1,82	2,16
88	Paraguay	0,33	1,62	1,88
89	Syria	0,34	3,78	2,74
90	Colombia	0,35	1,57	1,56
91	Angola	0,60	1,56	2,03
92	Benin	0,55	2,32	2,42
93	Namibia	0,42	1,01	1,53
94	Comoros	0,48	2,08	2,55
95	Venezuela	0,32	1,78	2,40
96	Mauritania	0,47	2,39	2,37
97	Togo	0,50	1,91	2,46
98	Philippines	0,37	2,01	2,21
99	Bangladesh	0,45	3,07	2,90
100	Senegal	0,53	2,70	2,16
101	Jordan	0,33	3,18	2,43
102	Ethiopia	0,56	3,24	2,91
103	Madagascar	0,52	2,25	1,85
104	Qatar	0,29	1,06	2,43
105	Sao Tome/Princi	0,41	3,37	2,53
106	Saint Lucia	0,31	5,04	2,48
107	South Africa	0,43	1,12	1,60
108	Rwanda	0,52	2,16	1,83
109	Gabon	0,45	1,37	2,46
110	Suriname	0,34	2,37	2,58
111	Lesotho	0,46	4,61	2,44
112	Malawi	0,56	2,22	2,10
113	Djibouti	0,52	2,37	2,27
114	Niger	0,61	1,79	2,55
115	Bahrain	0,30	2,03	2,46
116	Cameroon	0,49	2,08	1,81
117	Zimbabwe	0,41	2,12	2,10
118	C. Afr. Republi	0,51	2,84	2,42
119	Cote dIvoire	0,49	2,09	2,07
120	Zambia	0,48	2,47	1,89
121	Kenya	0,42	2,06	1,94
122	Tanzania	0,50	2,88	2,46
123	Swaziland	0,46	2,66	1,81
124	Guinea	0,61	2,19	2,28
125	Sierra Leone	0,57	3,12	2,27

Super-SBM | CRS | NO | 2007				
Sample		Input	Outputs	
#	Country	o	c_G	l_G
1	Maldives	0,25	1,44	2,30
2	South Korea	0,21	2,16	2,76
3	Bhutan	0,34	1,99	2,45
4	Iran	0,28	1,58	2,35
5	Egypt	0,28	2,16	2,81
6	Cape Verde	0,27	2,68	2,44
7	Turkey	0,27	2,03	2,27
8	Singapore	0,20	1,19	2,19
9	Cyprus	0,21	3,54	3,16
10	Cambodia	0,39	2,01	2,05
11	Argentina	0,25	2,11	2,46
12	Iraq	0,32	1,81	2,58
13	Poland	0,25	3,31	2,77
14	China	0,27	1,19	1,81
15	St. Vincent	0,29	3,79	2,39
16	Malta	0,21	3,36	3,41
17	Vietnam	0,26	1,78	2,33
18	Bolivia	0,35	1,70	1,67
19	Portugal	0,22	2,42	2,41
20	Oman	0,27	1,18	2,48
21	Greece	0,21	2,90	2,70
22	Mongolia	0,33	2,10	2,70
23	Ireland	0,21	1,50	2,84
24	Lao	0,34	1,93	2,49
25	Japan	0,18	2,42	2,66
26	Spain	0,19	2,21	2,74
27	Macao	0,20	0,97	2,30
28	Hungary	0,27	4,02	3,05
29	Thailand	0,27	1,71	1,96
30	Indonesia	0,32	2,17	2,52
31	Finland	0,21	2,78	3,35
32	Austria	0,20	2,86	3,49
33	Lebanon	0,28	2,36	2,52
34	Hong Kong	0,18	1,53	2,22
35	Albania	0,24	3,14	3,08
36	United Kingdom	0,21	3,32	2,58
37	Brazil	0,28	1,44	1,77
38	Bahamas	0,26	1,54	1,47
39	Sri Lanka	0,26	2,15	2,68
40	New Zealand	0,20	3,05	2,64
41	Australia	0,19	2,31	2,75
42	Barbados	0,24	2,08	1,82
43	Iceland	0,19	3,53	3,17
44	India	0,36	2,21	2,40
45	Italy	0,19	2,09	2,76
46	France	0,19	2,50	3,29
47	Saudi Arabia	0,27	1,09	2,49
48	Peru	0,27	1,52	1,87
49	Luxembourg	0,20	2,05	3,03
50	Sudan	0,40	2,68	2,57
51	Tunisia	0,26	1,73	2,25
52	Dominican Rep.	0,28	2,59	2,48
53	Germany	0,21	2,83	3,04
54	United States	0,22	2,48	2,30
55	Bulgaria	0,27	2,70	2,67
56	Botswana	0,48	0,88	1,57
57	Jamaica	0,28	2,88	2,06
58	Israel	0,19	2,39	2,37
59	Sweden	0,19	3,63	3,68
60	Malaysia	0,27	1,40	2,19
61	Guatemala	0,30	2,11	1,76
62	Netherlands	0,20	2,45	3,16

Super-SBM | CRS | NO | 2007				
Sample		Input	Outputs	
#	Country	o	c_G	l_G
65	Uganda	0,48	2,15	2,09
66	Mali	0,50	2,15	2,27
67	Switzerland	0,18	1,77	2,76
68	Belgium	0,21	2,85	3,33
69	Kuwait	0,26	0,87	2,37
70	Mauritius	0,27	2,18	2,43
71	Canada	0,19	2,44	2,52
72	Norway	0,20	1,85	3,12
73	Mexico	0,24	1,67	1,87
74	Honduras	0,28	2,96	2,46
75	Denmark	0,22	3,21	3,55
76	Nepal	0,33	1,83	1,88
77	Ecuador	0,25	1,46	1,74
78	Chad	0,52	1,84	2,47
79	Panama	0,25	1,36	1,84
80	Belize	0,25	2,80	2,47
81	Costa Rica	0,21	2,09	1,89
82	Pakistan	0,36	2,65	2,95
83	Ghana	0,38	2,57	2,43
84	Nigeria	0,50	1,98	2,06
85	Burkina Faso	0,47	2,24	2,19
86	Morocco	0,29	1,87	2,19
87	Uruguay	0,24	1,95	2,06
88	Paraguay	0,28	1,71	1,79
89	Syria	0,25	2,36	2,73
90	Colombia	0,27	1,42	1,55
91	Angola	0,51	0,91	2,01
92	Benin	0,46	2,24	2,42
93	Namibia	0,40	1,29	1,48
94	Comoros	0,41	3,27	2,52
95	Venezuela	0,26	1,74	2,39
96	Mauritania	0,43	2,05	2,33
97	Togo	0,44	2,85	2,40
98	Philippines	0,32	2,02	1,98
99	Bangladesh	0,32	2,37	2,74
100	Senegal	0,42	2,33	2,15
101	Jordan	0,27	2,61	2,39
102	Ethiopia	0,43	2,88	2,89
103	Madagascar	0,35	2,08	2,05
104	Qatar	0,22	0,57	2,27
105	Sao Tome/Princi	0,36	3,33	2,50
106	Saint Lucia	0,26	3,10	2,40
107	South Africa	0,49	1,39	1,54
108	Rwanda	0,46	2,03	1,82
109	Gabon	0,39	1,13	2,48
110	Suriname	0,31	1,91	2,56
111	Lesotho	0,55	3,74	2,45
112	Malawi	0,49	1,95	2,13
113	Djibouti	0,44	2,17	2,22
114	Niger	0,47	2,58	2,51
115	Bahrain	0,25	0,95	2,41
116	Cameroon	0,50	1,73	2,10
117	Zimbabwe	0,54	2,33	1,97
118	C. Afr. Republi	0,55	2,79	2,41
119	Cote dIvoire	0,47	2,15	1,96
120	Zambia	0,54	1,80	1,90
121	Kenya	0,46	2,04	1,94
122	Tanzania	0,45	2,39	2,45
123	Swaziland	0,53	1,98	1,81
124	Guinea	0,48	2,05	2,28
125	Sierra Leone	0,54	2,54	2,28
126	Trinidad/Tobago	0,31	1,53	2,42

B. Results Model 1 - Super SBM CRS Non-Oriented for 1980 and 2007

Super-SBM | CRS | NO | 1980 - EFFICIENCY			
#	Country	Score	Rank
1	Maldives	0,15	126
2	South Korea	0,42	40
3	Bhutan	0,24	105
4	Iran	0,26	90
5	Egypt	0,32	66
6	Cape Verde	0,34	62
7	Turkey	0,26	93
8	Singapore	0,34	59
9	Cyprus	0,58	18
10	Cambodia	0,20	119
11	Argentina	0,44	38
12	Iraq	0,10	128
13	Poland	0,61	16
14	China	0,30	73
15	St. Vincent	0,48	33
16	Malta	0,71	4
17	Vietnam	0,30	71
18	Bolivia	0,18	121
19	Portugal	0,48	32
20	Oman	0,27	86
21	Greece	0,57	19
22	Mongolia	0,37	55
23	Ireland	0,50	28
24	Lao	0,27	85
25	Japan	0,56	21
26	Spain	0,56	22
27	Macao	0,41	45
28	Hungary	0,68	12
29	Thailand	0,33	64
30	Indonesia	0,29	78
31	Finland	0,64	13
32	Austria	0,69	9
33	Lebanon	0,46	37
34	Hong Kong	0,48	34
35	Albania	0,46	36
36	United Kingdom	0,69	8
37	Brazil	0,23	107
38	Bahamas	0,22	109
39	Sri Lanka	0,41	43
40	New Zealand	0,63	14
41	Australia	0,54	23
42	Barbados	0,40	48
43	Iceland	0,68	11
44	India	0,35	58
45	Italy	0,50	31
46	France	0,56	20
47	Saudi Arabia	0,15	127
48	Peru	0,26	88
49	Luxembourg	0,70	5
50	Sudan	0,31	68
51	Tunisia	0,31	70
52	Dominican Rep.	0,42	41
53	Germany	0,69	10
54	United States	0,51	27
55	Bulgaria	0,50	29
56	Botswana	0,22	110
57	Jamaica	0,38	52
58	Israel	0,54	24
59	Sweden	1,19	1
60	Malaysia	0,33	65
61	Guatemala	0,24	101
62	Netherlands	0,70	7
63	Chile	0,34	63

Super-SBM | CRS | NO | 1980 - EFFICIENCY			
#	Country	Score	Rank
65	Uganda	0,23	106
66	Mali	0,22	111
67	Switzerland	0,50	30
68	Belgium	0,72	3
69	Kuwait	0,24	99
70	Mauritius	0,44	39
71	Canada	0,61	15
72	Norway	0,70	6
73	Mexico	0,29	77
74	Honduras	0,35	57
75	Denmark	0,84	2
76	Nepal	0,21	117
77	Ecuador	0,26	92
78	Chad	0,29	81
79	Panama	0,34	61
80	Belize	0,54	25
81	Costa Rica	0,41	46
82	Pakistan	0,38	51
83	Ghana	0,29	82
84	Nigeria	0,18	122
85	Burkina Faso	0,23	108
86	Morocco	0,31	69
87	Uruguay	0,37	54
88	Paraguay	0,29	76
89	Syria	0,52	26
90	Colombia	0,25	96
91	Angola	0,16	124
92	Benin	0,24	100
93	Namibia	0,16	125
94	Comoros	0,27	87
95	Venezuela	0,36	56
96	Mauritania	0,28	84
97	Togo	0,24	102
98	Philippines	0,32	67
99	Bangladesh	0,37	53
100	Senegal	0,25	95
101	Jordan	0,46	35
102	Ethiopia	0,30	72
103	Madagascar	0,22	114
104	Qatar	0,29	80
105	Sao Tome/Princi	0,40	49
106	Saint Lucia	0,59	17
107	South Africa	0,17	123
108	Rwanda	0,21	116
109	Gabon	0,22	113
110	Suriname	0,40	47
111	Lesotho	0,38	50
112	Malawi	0,22	115
113	Djibouti	0,25	97
114	Niger	0,19	120
115	Bahrain	0,41	44
116	Cameroon	0,22	112
117	Zimbabwe	0,29	79
118	C. Afr. Republi	0,28	83
119	Cote dIvoire	0,24	103
120	Zambia	0,25	98
121	Kenya	0,26	89
122	Tanzania	0,30	74
123	Swaziland	0,26	91
124	Guinea	0,20	118
125	Sierra Leone	0,26	94
126	Trinidad/Tobago	0,42	42
127	Liberia	0,24	104

Super-SBM | CRS | NO | 2007 - EFFICIENCY			
#	Country	Score	Rank
1	Maldives	0,38	61
2	South Korea	0,61	27
3	Bhutan	0,34	78
4	Iran	0,35	69
5	Egypt	0,46	45
6	Cape Verde	0,49	37
7	Turkey	0,41	53
8	Singapore	0,41	51
9	Cyprus	0,83	4
10	Cambodia	0,27	100
11	Argentina	0,48	43
12	Iraq	0,35	71
13	Poland	0,64	24
14	China	0,27	99
15	St. Vincent	0,54	32
16	Malta	0,86	3
17	Vietnam	0,41	56
18	Bolivia	0,25	105
19	Portugal	0,58	28
20	Oman	0,31	87
21	Greece	0,71	15
22	Mongolia	0,38	63
23	Ireland	0,49	38
24	Lao	0,33	81
25	Japan	0,76	10
26	Spain	0,67	20
27	Macao	0,36	68
28	Hungary	0,68	18
29	Thailand	0,36	67
30	Indonesia	0,38	60
31	Finland	0,77	9
32	Austria	0,82	5
33	Lebanon	0,45	46
34	Hong Kong	0,54	31
35	Albania	0,69	17
36	United Kingdom	0,73	13
37	Brazil	0,30	90
38	Bahamas	0,31	88
39	Sri Lanka	0,49	40
40	New Zealand	0,75	12
41	Australia	0,70	16
42	Barbados	0,42	50
43	Iceland	0,92	2
44	India	0,34	76
45	Italy	0,66	21
46	France	0,77	8
47	Saudi Arabia	0,30	91
48	Peru	0,33	82
49	Luxembourg	0,64	22
50	Sudan	0,34	73
51	Tunisia	0,40	58
52	Dominican Rep.	0,48	41
53	Germany	0,75	11
54	United States	0,56	29
55	Bulgaria	0,51	35
56	Botswana	0,12	128
57	Jamaica	0,45	47
58	Israel	0,64	23
59	Sweden	1,08	1
60	Malaysia	0,34	74
61	Guatemala	0,34	77
62	Netherlands	0,72	14
63	Chile	0,37	64

Super-SBM | CRS | NO | 2007 - EFFICIENCY			
#	Country	Score	Rank
65	Uganda	0,23	111
66	Mali	0,23	110
67	Switzerland	0,62	26
68	Belgium	0,78	7
69	Kuwait	0,26	104
70	Mauritius	0,44	48
71	Canada	0,67	19
72	Norway	0,62	25
73	Mexico	0,38	59
74	Honduras	0,50	36
75	Denmark	0,81	6
76	Nepal	0,29	92
77	Ecuador	0,33	80
78	Chad	0,21	116
79	Panama	0,33	79
80	Belize	0,55	30
81	Costa Rica	0,49	39
82	Pakistan	0,41	54
83	Ghana	0,35	72
84	Nigeria	0,21	118
85	Burkina Faso	0,25	106
86	Morocco	0,36	66
87	Uruguay	0,43	49
88	Paraguay	0,32	84
89	Syria	0,53	34
90	Colombia	0,28	93
91	Angola	0,13	127
92	Benin	0,27	102
93	Namibia	0,18	124
94	Comoros	0,37	65
95	Venezuela	0,40	57
96	Mauritania	0,27	101
97	Togo	0,31	89
98	Philippines	0,32	83
99	Bangladesh	0,41	52
100	Senegal	0,28	98
101	Jordan	0,48	42
102	Ethiopia	0,35	70
103	Madagascar	0,31	86
104	Qatar	0,21	117
105	Sao Tome/Princi	0,41	55
106	Saint Lucia	0,54	33
107	South Africa	0,16	126
108	Rwanda	0,22	115
109	Gabon	0,21	119
110	Suriname	0,38	62
111	Lesotho	0,28	94
112	Malawi	0,22	114
113	Djibouti	0,26	103
114	Niger	0,28	95
115	Bahrain	0,28	96
116	Cameroon	0,20	122
117	Zimbabwe	0,21	120
118	C. Afr. Republi	0,25	107
119	Cote dIvoire	0,23	113
120	Zambia	0,18	125
121	Kenya	0,23	112
122	Tanzania	0,28	97
123	Swaziland	0,19	123
124	Guinea	0,24	108
125	Sierra Leone	0,23	109
126	Trinidad/Tobago	0,32	85
127	Liberia	0,34	75

2.5. LITERATURE

Jones, Charles I. and Klenow, Peter J. (2016). "Beyond GDP? Welfare across Countries and Time". American Economic Review 106 (9): 2426-2457