2011

Efficiency of the Welfare State: A Comparative Approach Using Data Envelopment Analysis

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EFFICIENCY OF THE WELFARE STATE:

A COMPARATIVE APPROACH USING DATA ENVELOPMENT ANALYSIS

by

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by

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DISSERTATION

Presented to the Faculty of

The University of Texas at Dallas

In Partial Fulfillment

of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY IN

PUBLIC POLICY AND POLITICAL ECONOMY

THE UNIVERSITY OF TEXAS AT DALLAS

December 2011

ACKNOWLEDGEMENTS

I would like to acknowledge my loving wife April and my sons Isaac and Christian Thomas for giving me the inspiration during the arduous years of preparation for this dissertation. I am indebted and grateful to Dr. Brian Berry for his encouragement, wisdom, guidance, and persistence throughout this process, and to my committee members Drs. Peinhardt, Harpham, and Elliott for their willingness to give me feedback at important times. I am also thankful to Professor Tim Coelli at the University of Queensland's Centre for Efficiency and Productivity Analysis for making available his Data Envelopment Analysis software without which the present analysis would not have been possible. Lastly, I thank Drs. Dale Sims and Stephen Conover for inspiration, and Dr. Charlene Conner for her crucial support.

November 2011

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Publication No. ______________

Jekabs Bikis, Ph.D.
The University of Texas at Dallas, 2011

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As governments continue to evolve over the past century or so in their perceived role of providing economic security for their populations, a ubiquitous yet ill-defined concept of *the welfare state* is increasingly taking center stage in political and economic debates. With fiscal crises looming over the horizon in many parts of the world, the fingers of blame point with greater frequency to *the welfare state* as the entity which is contributing more to fiscal problems than to economic solutions. Reformation of the welfare state is rapidly becoming more likely and more urgent and this study proposes one mechanism for evaluating welfare state performance and setting benchmarks for optimizing such performance. The study uses Data Envelopment Analysis to evaluate comparative efficiencies of various welfare state models in 137 countries, and to propose potential pathways to efficiency savings in the laggard efficiency states. The study contextualizes the welfare state efficiency differences by referring to the well-established welfare state typologies of 18 Organisation for Economic Co-operation and Development

(OECD) countries. The results are consistent with previous findings in identifying the lower spending states as generally more efficient and finding the social-democratic welfare state model less efficient. The results are qualified by the recognition that definitional and data availability issues remain to be solved by future studies, as many of the ideal variables for welfare state performance measurement do not exist at this time.

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CHAPTER 1

INTRODUCTION: IMPORTANCE OF EFFICIENCY MEASUREMENT IN WELFARE STATE STUDIES

This study examines the efficiency with which welfare states manage to reach their stated goals. By scrutinizing the relationship between inputs and outputs of the welfare state on a comparative basis the study identifies the more successful welfare state variants as it crafts policy recommendations for leaner, more efficient welfare states of the future.

The welfare state of the twenty first century is a framework of policies, programs, and institutions partially designed and partially evolved to address the perceived needs of individuals and societies. As an embodiment of the belief that the state ought to provide a safety net to its citizenry in actual or potential need, the welfare state has been looked upon to provide services such as health care or education, or even to redistribute incomes in some 'equitable' manner. Financed by tax revenue or borrowed funds, the state plays this role by attempting to reach pre-set but evolving goals in education, health provision, income redistribution and income replacement in sickness, unemployment, or retirement. As in any arrangement where inputs and outputs of a process are considered, variability of the process efficiency implies a related variability of outcome achievement.

1.1 Welfare state efficiency: unanswered questions in an important field

The efficiency of the welfare state is of particular interest because of the magnitude of the tax burden it requires and the perceived importance of the services it provides to the voting citizenry. The burden of supporting the welfare state has tended to rise during much of the twentieth century and where taxes have been insufficient to finance spending, borrowing has supplemented revenue. Consequentially, tax burdens in many nations have risen and debt levels have grown to worrisome levels. (see Figure 1.1) With high debt levels particularly hard to accept in the post "Great Recession" era and with an unprecedented share of government spending going to welfare-state-associated expenditures, the question of welfare state efficiency is continuing to gain urgency (see, for example, efficiency discussion in Sapir 2006). Are states efficient in providing program outputs to their constituents, or can efficiency improvements be attained? (Gonand, Joumard and Price 2007)

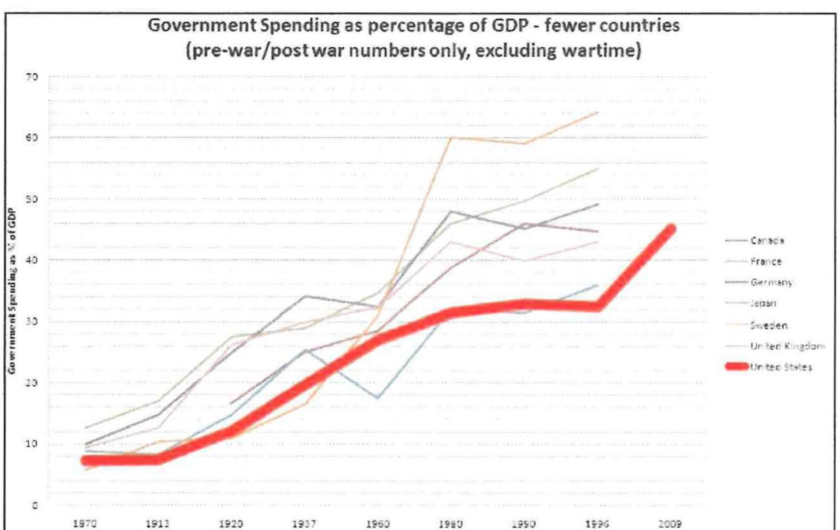

Figure 1.1. Government Spending as percentage of GDP, 1870 – 2009

1.2 How well we are doing? The value of understanding efficiency

Where welfare state inefficiencies are found to exist, two types of adjustments can potentially be made: welfare state outputs can be provided by consuming less inputs than before (*input focused* efficiency improvement), or—alternatively—more welfare state output can be provided for the same level of spending (*output focused* efficiency improvement). The first adjustment eliminates avoidable input waste while the second leads to realization of previously unrealized output potential. (Ray 2004) Either of these approaches increases welfare of citizens while also enhancing the standing of policymakers in the eyes of the voting public. Additionally and most importantly the moral case for improved efficiency is hard to ignore where taxpayers are asked to shoulder the burden of program funding.

With a goal of identifying the most efficient welfare state regimes (in individual nations) or types of welfare states (groupings along geographical lines or feature-driven lines), this study proceeds by discussing efficiency measurement concepts, identifying approaches for measuring efficiency of a welfare state, utilizing four specifications of a welfare state efficiency model using Data Envelopment Analysis and finally discussing the results and proposing directions for further research.

CHAPTER 2

THE CONCEPT OF EFFICIENCY

Researchers and practitioners in multiple fields have sought to understand and measure efficiency in order to improve operations. Efficiency has been studied in such fields as operations research, productivity studies in business, applied economics, management and computer science.[1] With the evolution of Data Envelopment Analysis as a methodology for studying efficiencies over the past half century or so it has become possible to study efficiencies of less traditional 'production' processes, such as presidential campaigns in the US (Berry and Chen 1999), smallholder maize producers in Kenya (Mulwa, Emrouznejad and Muhammad 2009), or neonatal care units in Scotland (Field and Emrouznejad 2003).

2.1 Efficiency – converting inputs into outputs

In a general sense, efficiency describes the relationship between inputs and outputs. When several units use the same amount of inputs to produce differing amounts of output, then the one producing more is said to be more efficient in terms of *output-focused* efficiency. When several units produce the same amount of output using differing amount of inputs, then the one

[1] The particular fields of research are mentioned here due to availability of DEA articles in the field journals, such as European Journal of Operational Research (373 DEA articles), Journal of Productivity Analysis (242 DEA articles), Applied Economics (86 DEA articles), Management Science (83 DEA articles), and Computer and Operations Research (48 DEA articles). Data from Emrouznejad (Emrouznejad, Parker and Tavares 2008)

consuming less input is said to be more efficient in terms of *input-focused* efficiency. (Sengupta 2000)

2.1.1 Farrell's breakthrough in process efficiency measurement

Operational efficiency in the modern sense was discussed effectively by Farrell, who identified these two general categories of (in)efficiency. (Farrell 1957) Both types of (in)efficiency can be demonstrated by examining production possibilities of a hypothetical productive agent in a two-input/one-output model, following Farrell's original paper. As Figure 2.1 illustrates, one unit of output (indicated by the unit isoquant YY') can be produced by combining inputs X_1 and X_2. An agent producing one unit of output using input bundle P is inefficient, since the same output could be produced by using the lesser input bundle R. Technical efficiency (TE) is calculated as OR/OP, which is less than one in the present example, indicating the presence of inefficiency. The given producer is additionally inefficient because of the subobtimality of the input ratio used in production. The lowest cost way to reach one unit of output is to use input bundle T, which costs the same as bundle S. Such a bundle would cost less than R and clearly less than P. Input-focused allocative efficiency (AE)[2] is thus seen as OS/OR, which again is less than one, indicating an imperfect efficiency. In this approach, each producer's performance is compared to a frontier of efficient performances (theoretical or factual) to determine the amount of inefficiency present.

[2] This (in)efficiency was called 'price inefficiency' by Farrell (Farrell 1957)

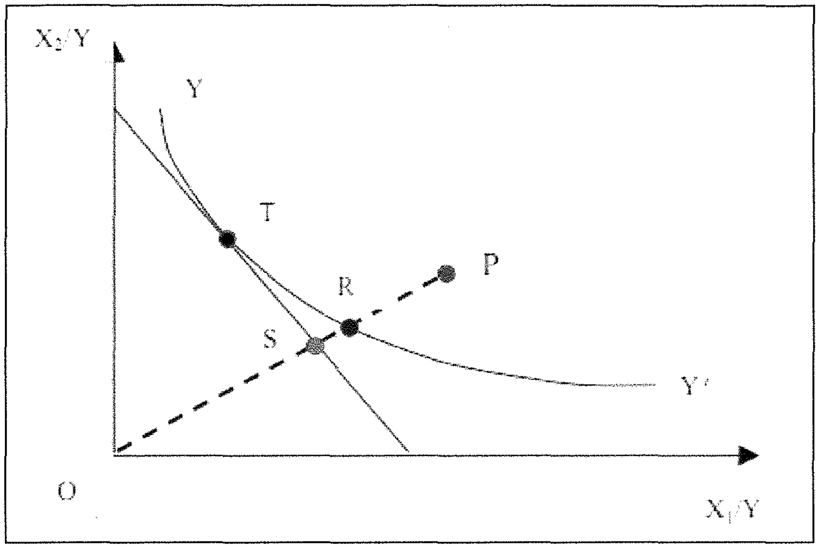

Figure 2.1. Technical and Allocative Inefficiencies[3]

2.2 Efficiency in social sciences

It is quite a bit more difficult to define and measure efficiency in social sciences than it is in many manufacturing processes. Researchers in the social sciences must be able to define the goals of a particular process and identify the inputs and outputs of that process. After goals, inputs and outputs are identified, they must be measured, which again is often difficult. Still, despite the difficulties, the need to understand efficiency is as great in social sciences as in other fields.

> "The problem of measuring the productive efficiency of an industry is important to both the economic theorist and the economic policy maker. If the theoretical arguments as to the relative efficiency of different economic systems are to be subjected to empirical testing, it

[3] Source: Example from Farrell (Farrell 1957); graphic from Herrera (Herrera and Pang 2005)

is essential to be able to make some actual measurements of efficiency. Equally, if economic planning is to concern itself with particular industries, it is important to know how far a given industry can be expected to increase its output by simply increasing its efficiency, without absorbing further resources." (Farrell 1957)

2.3 Efficiency in political economy

While the benefits of defining and utilizing a concept of efficiency in the social sciences are quite well understood, a theoretical and practical move from definition to measurement has proved elusive in many important topics, including the topic of welfare state studies. There are some uses of *one-dimensional* efficiency measures in political economy, where indicators or ratios are used as proxies for process efficiency. For example, efficiency of the welfare state might be measured by simply looking at the rate of poverty, or rate of employment in a nation.

Research in *multi-dimensional* welfare state efficiency, on the other hand, is relatively sparse. Inhibiting this theoretically appealing path are difficulties associated with gathering the necessary data in a comparative fashion, finding theoretical agreement about the major goals of the welfare state and perhaps dealing with the relative novelty of non-parametric efficiency measurement tools as applied to welfare state issues.

Another complicating factor preventing researchers from fully engaging with the topic of welfare state efficiency has been the fact that the performance of a welfare state is driven not only by the efficiency of input conversion into outputs, but also by other factors, such as "institutional settings, structural framework conditions, or … country-specific features." (Mandl,

Dierx and Ilzkovitz 2008) Despite such difficulties, pressure continues to build on policy-makers and researchers to *understand* and *improve* process efficiency for the welfare state policies and institutions.

2.4 Efficiency vis-à-vis frontier - parametric and nonparametric approaches

In order to estimate welfare state efficiency, performance needs to be compared against a theoretical understanding of what is possible. Such an understanding can be quantified in a simple number or in a frontier of possible efficient outcomes. If a frontier is used, then it needs to be established based on theory (parametric approaches) or on observations (nonparametric approaches). Parametric approaches require a specification of a functional form to define "what is possible and what is efficient". Nonparametric measures use observed best-practice performance of the most efficient states to do the same.

2.4.1 Parametric Approaches: Corrected Ordinary Least Squares, Stochastic frontier function

Theoretical efficient frontiers can be estimated using corrected ordinary least squares (COLS) as discussed by Winsten (Winsten 1957) or several forms of stochastic frontier functions described by Aigner (Aigner, Lovell and Schmidt 1977) and Meeusen and van den Broeck (Meeusen and van den Broeck 1977).

In COLS, the theoretical efficient frontier is estimated by calculating an average (OLS) relationship between the inputs and outputs, then shifting the regression line so that it passes through the "most efficient" data point(s). The rest of the points, lying below the upshifted

regression line, are considered inefficient, the extent of their inefficiency calculable in relation to the hypothetically feasible maximum output reflected by the efficient frontier. (Winsten 1957)

Stochastic frontier function approach is similar to COLS but in this approach it is assumed that the error term is composed of two parts: a random error component and a technical inefficiency component (either time-specific or time-invariant). This approach requires additional strong distributional assumptions regarding country-specific inefficiency components. Fixed-effects methodologies can be incorporated with the stochastic frontier estimations to make the production frontiers country-specific. (Aigner, Lovell and Schmidt 1977)

An advantage of estimating efficiencies using parametric approaches is that standard statistical tests can be used to establish the significance level of the results. However, there are important disadvantages which make the selection of parametric methods inappropriate for the current research. Use of COLS leads to the observed data not being bound closely by the efficient frontier, especially further away from the 'definitionally efficient' region. In the presence of heteroskedasticity some inefficiency scores will be excessively high when COLS is used for inefficiency estimation. An even more important disadvantage of both COLS and stochastic frontier approaches is the difficulty in estimating efficiencies in presence of multiple outputs.[4] This difficulty can be overcome if multiple outputs can be aggregated into a single output used for efficiency measurement (see Gupta and Verhoeven 2001, for example). Evans and Tandon offer a more detailed concise description of the parametric methods (Evans, et al. 2001).

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[4] Some methods have been developed to allow multiple-output efficiency comparisons (see Bauer 1990, for example), but they have not found wide use in practice.

2.4.2 Nonparametric approaches: Free Disposal Hull and Data Envelopment Analysis

When using nonparametric approaches no attempt is made to estimate a theoretically feasible functional form of the efficient frontier. Instead, the efficient frontier is derived directly from an array of observed data points. Once the frontier is established, relative efficiencies can be estimated for all other data points. Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA) are two of the commonly used nonparametric methods used for efficiency analyses.

Free Disposal Hull (FDH) imposes the least a priori assumptions on the production technology based on the observed data. Using FDH a producer is considered relatively inefficient in comparison with another if it uses more input to produce the same (or less) output, or if it uses the same (or more) input to produce less output. Simply, FDH establishes a frontier using only the best practices observations (without assuming that the unobserved input-output *combinations* are possible as combinations of the actual observations) subsequently calculating the inefficiency of all producers inside the frontier (Tulkens 1993). Since the convexity of the production possibilities set is not assumed in FDH, the only necessary assumption is the free disposability of resources (i.e if a worker made 10 bowls from 10 pieces of clay, then surely another worker could make at least 10 bowls from 12 pieces of clay as long as assuming that it is costless to dispose of the extra 2 pieces of clay should they go unused).

Data Envelopment Analysis (DEA) is an observations-based nonparametric method used to calculate comparative efficiencies of decision making units using multiple inputs to produce multiple outputs. The use of DEA has grown in acceptance (see Figure 2.2) because "measuring efficiency and productivity of large organizations is a non-trivial exercise, involving a complex

multi-input/output structure" and "DEA technology, by design, naturally accounts for such issues efficiently and effectively." (Emrouznejad, Parker and Tavares 2008)

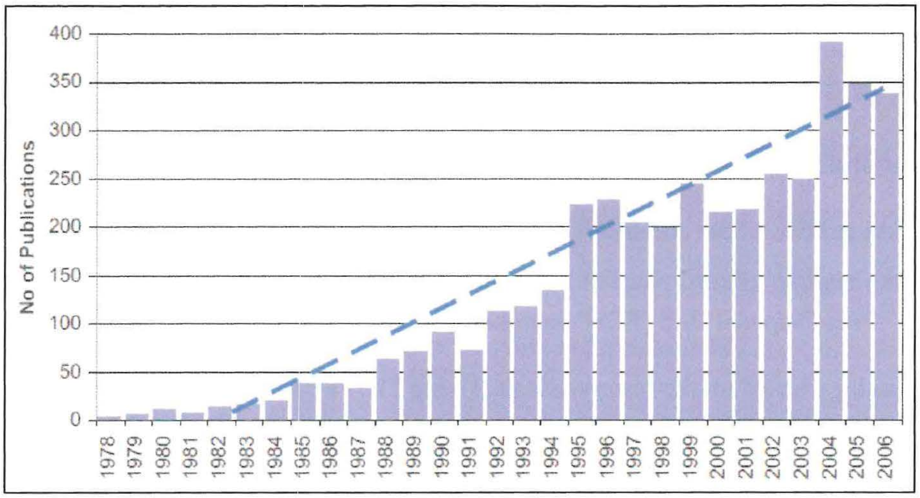

Figure 2.2. Publications utilizing DEA methodology[5]

2.5 Data Envelopment Analysis – introduction to methodology

As an example of how DEA is used, consider efficiencies of similar factories which can be compared by accounting for each factory's inputs (say, workers, capital, raw materials) and outputs (such as the number of cars, number of trucks and perhaps some measure of quality, such as warranty claims or defect rates). A production frontier would be fit over the existing data, defined according to the efficiency leaders in the various input-output combinations. Subsequently efficiency slacks would be calculated for laggards as the relative distances of the datapoints from the frontier. DEA is conceptualized in a straightforward way in either the one-

[5] Source: Evaluation of research in efficiency (Emrouznejad, Parker and Tavares 2008)

input/one-output case where quantities of input and output vary, or in a two-input/one-output case, where quantities of inputs vary.

Where one input is used to produce one output, DEA requires first that the existing input-output combinations are observed and noted. The observed datapoints are then enveloped by an estimated set of "most efficient" feasible linear input-output combinations. The envelope of the "most efficient" combinations is comprised of actually observed datapoints with the highest output/input ratios, which are then connected with linear segments, implying theoretically achievable multiples of inputs and outputs.

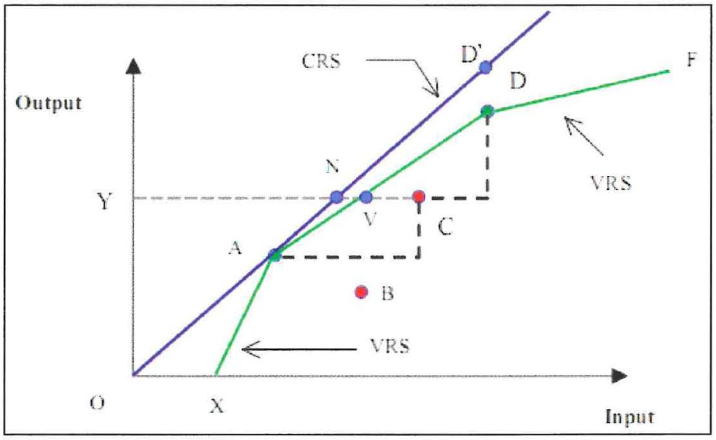

Figure 2.3. Example of efficiency estimates using DEA[6]

[6] Source: Efficiency of Public Spending in Developing Countries (Herrera and Pang 2005)

2.5.1 Returns to scale assumptions in DEA

Following Coelli, the actual envelopment may vary with the returns to scale assumptions as illustrated in the Figure 2.3 above (Coelli, Lefèbvre and Pestieau 2008). In the illustrative example, if constant returns to scale are assumed, then only one productive agent (A) may be considered efficient. D is inefficient if we assume that D should be able to scale inputs proportionally to A in order to reach D.'

Assuming that returns to scale can vary in the example, the entire frontier XADF would become the efficient frontier against which the performance of productive agents could be compared. D would now be efficient, since there is no other observation (or linear combination of observations) producing more with the same inputs or producing the same output with less inputs. C is inefficient, since V (a linear combination of bundles A and D) could produce the same output as C using less input. C's technical (in)efficiency is calculated as TE=YV/YC. For some applications, as shown by Charnes, Cooper and Rhodes (Charnes, Cooper and Rhodes 1978) and by Banker, Charnes and Cooper (Banker, Charnes and Cooper 1984) it may be useful to disentangle C's scale inefficiency from C's technical inefficiency, with the former calculated as YN/YV and the latter as YV/YC. Scale inefficiency shows what C should be able to produce if it could be expected to abide by globally constant returns to scale based on A's productivity, while technical efficiency shows what C should be able to produce assuming globally varying returns to scale, constant only between observed bundles A and D.

2.5.2 Aggregate inputs and aggregate outputs in DEA

Mathematically, DEA is based on applications of linear programming. In the most basic conception, efficiency in DEA is calculated as (the weighted) input divided by (the weighted) output. Following Ramanathan (Ramanathan 2003):

$$\text{Efficiency} = \frac{Output}{Input}$$

Where multiple inputs are used, the 'input' measure is just linear aggregation of all inputs:

$$\text{Aggregate (virtual)input} = \sum_{i=1}^{I} u_i x_i$$

Similarly, where multiple outputs are used, the 'output' measure is an aggregate:

$$\text{Aggregate (virtual)output} = \sum_{j=1}^{J} v_i y_i$$

u_i and v_i are nonzero positive weights assigned to each input and each output respectively.

Efficiency in multiple input, multiple output scenarios then becomes:

$$\text{Efficiency} = \frac{Output}{Input} = \frac{\sum_{j=1}^{J} v_i y_i}{\sum_{i=1}^{I} u_i x_i}$$

The issue of assigning weights to each DMU's inputs and outputs is essentially the crux of the issue addressed by DEA. A welfare state which does very well with poverty reduction will be shown to have high efficiency if high weight is assigned to some poverty measure, but it may

score low in efficiency if poverty measures are given a low weight. The weight selection problem is addressed in DEA by using mathematical programming rather than arbitrary weight selection. The method determines the optimal weights for each DMU; weights which generate the highest possible efficiency subject to the constraint of keeping other DMU efficiencies between 0 and 1.

CHAPTER 3

EFFICIENCY MEASUREMENT IN PRACTICE

Existing research in the area of multi-dimensional welfare state efficiency is still in its infancy. Researchers are beginning to use non-parametric methods to at least consider the question of efficiency in regards to a welfare state (see Table 3.1). Most of the existing efforts evaluate sub-sections of a welfare state (health services, education systems, etc.), however, and not the "welfare state" as a whole.

Table 3.1. Selected public sector efficiency studies

Subject Study	**Authorship**	**n=____, DMUs**	**Time period**	**Inputs or Independent Variable**	**Outputs or Dependent Variable**	**Method Employed**
Social Protection efficiency and Convergence in EU	Coelli, Lefebvre, Pestieau, 2009	15 EU nations	12 years (1995-2006)	"one unit" of government for each DMU	Poverty (after-transfer at-risk-of-poverty rate) Inequality (top quintile/bottom quintile ratio for income earners) Unemployment (long term unemployed share of population) Education (early school leavers' share of 18-24 year olds) Health (life expectancy at birth)	DEA with index variable as output
Welfare state efficiency	Gouyette, Pestieau, 1999	13 countries	1 year	Social Spending share of GDP	Poverty Inequality	Efficient Frontier and regression

Table 3.1 Continued

Subject Study	**Authorship**	**n=____, DMUs**	**Time period**	**Inputs or Independent Variable**	**Outputs or Dependent Variable**	**Method Employed**
Government expenditure efficiency in Africa	Gupta, Verhoeven, 1999	37 countries in Africa (appendix for 85 total countries)	12 years (1984-1995), data averaged over three- or six-year periods	Education spending (per capita, PPP) Health spending (per capita, PPP)	life expectancy, infant mortality, immunizations , primary/secondary enrollments, adult literacy	FDH
Education and Health in OECD	Afonso, St. Aubyn, 2004	24 countries	1 year	Intended instruction time in public schools, teachers per student, doctors, nurses, hosp. beds per capita	PISA scores for reading, math, science Infant mortality, life expectancy	FDH and DEA
Public sector efficiency	Afonso, Tanzi, 2003	23 countries	End points or averages for an 11 year period 1990-2000	Public spending share of GDP	Composite of indices for corruption, red tape, quality of judiciary, size of shadow economy; enrollments, educational attainment, infant mortality, life expectancy, infrastructure quality, economic variables • doubly indexed into a composite	FDH

3.1 Welfare state defined

What is a welfare state and what are its goals? Friedrich von Hayek has written that "the conception of the welfare state has no precise meaning. The phrase is sometimes used to describe any state that 'concerns' itself in any manner with problems other than those of maintenance of law and order." (Hayek 1959) An author of a noted welfare state classification Gosta Esping-Andersen cites a similarly general definition of the welfare state as a state that "involves state responsibility for securing some basic modicum of welfare for its citizens." (Esping-Andersen 1990). Such general definitions are hardly helpful in allowing one to identify inputs and outputs of a process through which goals are reached.

In contrast to Hayek and Esping-Andersen, others have attempted extraordinarily detailed definitions. Asa Briggs for example defined the welfare state in great detail:

> "[a welfare state is] a state in which organized power is deliberately used (through politics and administration) in an effort to modify the play of market forces in at least three directions – first, by guaranteeing individuals and families minimum income irrespective of the market value of their work or their property; second, by narrowing the extent of insecurity by enabling individuals and families to meet certain 'social contingencies' (for example, sickness, old age and unemployment) which lead otherwise to individual and family crises; and third, by ensuring that all citizens without distinction of status or class are offered the best standards available in relation to a certain agreed range of social services." (Briggs 1961)

Driven by necessity for sufficient detail that would allow goal identification and performance measurement, the present study defines a welfare state as a framework of policies, programs and institutions created to provide a safety net or services in health care, education and various forms of income replacement. The welfare state is financed through taxation or borrowing in the short run; taxation only in the long run.

3.2 Inputs and outputs in existing welfare state efficiency literature

Once the welfare state has been successfully defined, measuring its efficiency requires identification of a certain set of measurable inputs and outputs. In very general terms, the welfare state transforms inputs (such as tax revenue or percentages of government budgets) into outputs (such as better health and education, reduced poverty and increased income replacement for the unemployed or the retired). Since the inputs and outputs are neither necessarily self-evident nor equal for all types of welfare states, then the selection of these variables can vary from study to study depending on the particular research hypothesis and the researcher's general framework of welfare state understanding.

3.2.1 Commonly used inputs

One approach to input identification in welfare state studies is to explicitly reject *particular* inputs that may be used to accomplish the goals of a welfare state. Pestieau, for instance, argues that when the welfare state is examined as a whole, then inputs should not be considered and the efficiencies should be estimated on outputs alone. (Pestieau 2009) He recommends using a standard "***one government***" as the sole input for every welfare state. Policies and institutions

differ so greatly from one nation to another that the standardized, equal input approach is the only tenable solution in his view. Pestieau's argument rests on the sober acknowledgement that input selection for welfare states is difficult and researchers risk introducing bias in selecting those input variables which help them reach favorable conclusions.

Others use some measures of social spending to explain the varied outcomes of the welfare state effort. Coelli uses ***social spending as a percentage of GDP*** from the Eurostat database, while Afonso uses the even broader ***total public expenditure*** share of GDP; both assume that higher social spending should bring about increased better achievement of welfare state outcomes, other things being equal. (Coelli, et al, 2010; Afonso, et al, 2005, 2006) Spending measures are frequently favored for inputs in welfare state processes because government spending data is available for a large number of countries and for most purposes, data is quite comparable from country to country.

Still, it is true that variables other than social spending affect health performance and longevity (overall improvements in medical technology, family support, cultural values, etc.) which is why some authors prefer supplementing spending measures with other types of input effort measures. Gupta and Veerhoeven, for example, estimate the ***per capita*** *education and health spending* undertaken by each government he reviews (Gupta and Veerhoven, 2001) The authors recognize that equal nominal spending per capita may buy vastly different amounts of health or educational services in various states, so the amounts are expressed in terms of their purchasing power parity.

Some researchers abandon exchange rate adjsuted expenditure amounts because of the difficulty of differing cross-country costs for welfare state services and settle instead on physical

input variables such as ***average class size*** or ***ratio of students to teaching staff***, ***number of instruction hours***, or ***availability of computers***, when efficiency in education is estimated (Afonso and St. Aubyn, 2005) or the ***count of doctors***, ***nurses*** and ***beds*** when efficiency in health care is estimated. (Ibid)

Even when social spending is used to measure the inputs of the welfare state, the use of these time-dependent variables is not uniform across existing research. Since taking any given year's social spending would result in a snapshot which may or may not be representative of the general characteristics of a nation's social spending, some authors average the social spending across a set of years. Gouyette and Pestieau use the ***mean social spending*** for years 1992 through 1994 as the input for each welfare state. (Gouyette and Pestieau, 1999) Yet other studies break social spending amounts down into ***three year averages*** and use these averages as inputs for the welfare state. (Gupta and Verhoeven, 2001) This allows researchers to get further away from the potential one-year anomaly to note trends over time.

When researchers consider "social spending"[7] as a key input, as do Gouyette and Pestieau (1999), Gupta and Verhoeven (2001) and others, there was still an open issue of whether "social spending" should have been included nominally or adjusted to the demographic characteristics of recipient population, as Scruggs recommends (Scruggs 2008). The rationale is that a country with twice the net population weight of youth under 15 would be expected to spend twice as much on education as the comparison nation.

[7] By "social spending" in this case I refer to the estimates of government spending on social programs as percentage of GDP

3.2.2 Commonly used outputs

Output variables are similarly difficult to establish. While it is clear that states seek to, for example, improve health outcomes or unemployment security of their populations, what exactly constitutes a measure of a health outcome? The approaches vary, with some taking ***life expectancy*** as their proxy for health outcomes (Coelli, Lefèbvre and Pestieau 2008) while others consider variables such as ***immunization percentages*** for particular diseases (Evans, Tandon, Murray and Lauer 2001).

Similar choices among potential output variables takes place in the other dimensions of the welfare state – education, poverty prevention, income replacement. General efforts have been made to measure the extent to which welfare states are able to reach their goals. For a review and a few (of many) examples see "Public Sector Efficiency: An International Comparison" by Afonso et al. (Afonso, Schuknecht and Tanzi 2003)

3.2.2.1 Standalone outputs vs. composite (index) outputs

After the appropriate output indicators have been chosen, researchers also face a choice in the way outputs are used. Some treat multiple outputs as equally important welfare state outputs, while others combine multiple outputs in some type of an output index. For example, Coelli and coauthors use a composite of five variables to estimate the efficiency of the welfare state: ***at-risk-of-poverty rate***, ***inequality measure***, ***long term unemployed***, ***early school leavers*** and ***life expectancy***, and instead of comparing the states in achieving success in each of these variables, the authors construct an 'aggregate social protection index.' (Coelli, et al, 2010) At-risk-of-poverty is estimated as the percentage of people who are below 60% of the nation's disposable

income, after transfers are considered.[8] The inequality measure here is defined as the ratio of the total income received by the top 20% of income earners versus the total income received by the bottom 80% of income earners. Unemployment is defined as the percentage of the total workforce that has been unemployed for 12 months or more. Education is defined as the percentage of 18-24 year olds with at most a lower secondary education and life expectancy is defined as the number of years that a person can be expected to live at birth. Afonso and his co-authors similarly use a composite indicator as a proxy for welfare state performance output indicator. (Afonso, et al, 2005) They combine seven major measures into an aggregate 'public sector performance indicator' – administrative state performance (including measures for corruption, red tape, judiciary quality, shadow economy), education (secondary enrollment, achievement), health (Infant mortality, life expectancy), infrastructure (communications and transport), inequality (income share of 40% poorest households), economic stability (GDP and inflation stability) and economic performance (GDP per capita, GDP growth, unemployment.) Such a composite approach allows the researchers to include multiple output variables, even if indirectly, without needing to increase the viable sample size for efficiency frontier use. The weakness of aggregating the output variables may be the fact that the strengths and weaknesses of various sub-indicators offset each other in such a way that the aggregates come out too similar for countries that are in reality quite different.

Other writers (Gouyette and Pestieau, 1999; Gupta and Verhoeven, 2001) limit the outputs of the welfare state to inequality (Gini coefficient at a particular point in time) and poverty

[8] Ideally any usage of a relative poverty measure would be supplemented by, or combined with, some type of absolute poverty measure, since – even if the relative poverty fell with absolute poverty rising, then this would hardly constitute success for the welfare state.

(percentage of population at 50% of median income), or isolate one of the functions of the welfare state, such as health care (Evans, et al, 2000) or education, or both. (Ravallion, 2003; Afonso and St. Aubyn, 2005) Afonso and St. Aubyn estimate separate efficiency models, first using PISA literacy scales in reading, mathematics and science as outputs for efficiency in educational services and then using infant survival and life expectancy as outputs for efficiency in health services. (Afonso and St. Aubyn, 2005)

3.3 Sample – nations studied in existing welfare state efficiency literature

Most of the comparative welfare state literature is devoted to investigations of a similar group of major OECD countries, dominated by western European democracies. Some studies limit themselves to as few as twelve or thirteen European nations (Gouyette and Pestieau, 1999) including the US for reference, others expand the set to the more recent EU entrants (Coelli, et al, 2010), while yet others take account of most of the worlds' nations, employing a looser definition of the welfare state. (Gupta and Verhoeven, 2001; Evans, et al, 2000)

3.4 Survey of methodology and some results from the existing welfare state efficiency literature

Although the existing welfare state efficiency literature is not very deep, a handful of different approaches have attempted to measure the relevant variables. Gupta, for example, uses FDH with a single input and single output to compare welfare state efficiencies for particular years over a multi-year period. He observes that over time African nations rank lower in welfare

state efficiency than do Asian or Western Hemisphere countries, but finds that this differential is diminishing over time. (Gupta and Verhoeven, 2001)

Afonso and St. Aubyn use both FDH and DEA to compare efficiencies in health services and educational attainment (Afonso and St. Aubyn, 2005). They differ from the other studies by their purposeful selection of some non-monetary input variables (number of hospital beds instead of dollars spent on health care.) The strength of such study is the ability to get away from exchange rate or cost of services implications, which may distort cross-country comparisons.

Since FDH and DEA studies comparing state performance risk identifying too many 'efficient states' when they use multiple output indicators, then it is worth noting the methodologies of Afonso and Coelli who use aggregated output indicators. (Afonso, et al, 2005; Coelli, 2010) This approach allows the researchers to operationalize a more complete concept of 'the welfare state' while still avoiding the potential problem of too many independently perfectly efficient Decision Making Units (governments in charge of their welfare states). By relying on composite (index) variables, Afonso and his coauthors identify only 3 of 23 countries as efficient – a rather good result for efficiency frontier analysis with a small sample size.

Several authors employ parametric methods to estimate the efficient frontiers. Evans, for example, estimates efficiencies of state healthcare systems, and to do this he creates a fixed effects panel for a large number of countries. (Evans, et al, 2010)

3.5 Advantages and disadvantages of existing approaches

The diverse foci of the existing studies give evidence to the theoretical difficulty of, first, defining 'the welfare state' and, second, measuring its performance. To increase the ease of

measurability and data collection some researchers have defined the welfare state (perhaps too) narrowly. They have focused on 'education' and 'health' outcomes as proxies of the overall welfare state effort. (Herrera and Pang 2005) What this approach gains in tractability it loses in comprehensiveness. Even if one were to show efficiency in health and education, a giant leap would be required to call the respective welfare state efficient as a whole. How does this state perform with regard to poverty reduction or income replacement? When welfare state is defined broadly (including and capturing its various goals), then the result is perhaps a more realistic understanding of the workings of this multifaceted framework of policies and institutions, even though a such a broadly defined entity is less tractable and more open to theoretical critiques (as a comprehensive conception of the welfare state).

The present study defines the welfare state more broadly, by starting with three inputs and six outputs, thus choosing to be *aggressive in its definition.* The proposed research utilizes Data Envelopment Analysis to add feasibility of efficiency measurement for such a broadly defined welfare state.

CHAPTER 4

METHODOLOGICAL PROBLEMS: VARIABLES AND DATA

Existing research on efficiencies of political economic arrangements is largely related to individual programs or features of the welfare state, not to efficiencies of the welfare state as a whole. The present study contributes to the understanding and measurement of welfare state efficiency by applying the methodology of Data Envelopment Analysis to the analysis of the whole system of state provisions of key welfare state components.

Evaluation of the welfare state as the whole will aid in identifying the areas of greatest inefficiencies within the (dollarwise) massive frameworks of institutions and policies, in addition to making efficiency comparisons between different conceptions of welfare states. Much thought has been given to classifying types of welfare states and the performance of the various categories has been studied. For example, in a widely cited classification Gosta Esping-Andersen classified welfare states as liberal, corporatist, or social-democratic (Esping-Andersen 1990) and many subsequent researchers have used this classification to see how the each type of state performs in reaching its stated goals. Understanding whether efficiency differences exist between the various types of welfare state models also enhances the understanding of the classification itself. Are the liberal welfare states more efficient than social-democratic ones in that they provide proportionally the same income levels of (factual) income replacement per dollar of welfare money spent? Are corporatist welfare states less efficient in providing income equality

than are liberal ones? Such questions have eluded satisfactory answers until now, but the present study will yield answers along precisely these lines.

4.1 Proposed DEA model

4.1.1 A focus on reducing inputs, keeping the output level fixed

As discussed above, DEA permits the investigation into input-focused (allocative) efficiency or output-focused (technical) efficiency of a decision making unit. (Sengupta 2000) Since one of the intended goals of the present study is to achieve an increase of efficiencies for the laggard welfare states, and since the incrementalist and realist approach to policy making advises against recommendations for rapid, drastic changes, the present study proposes to focus on welfare states' ***allocative (input-focused) efficiencies***. If the study can show that Waste-a-stan uses too many resources to produce proportionally *the same* output as does Lean-a-stan, then Waste-a-stan can be encouraged to change some of its welfare program designs so that it can *keep the existing levels of provisions* through spending less (inputs). This would amount to a (clandestine?) approach to a *de facto* welfare state retrenchment in Waste-a-stan. This approach is more likely to yield real policy fruit.

Focus on allocative efficiencies amounts to first identifying the leaders in welfare state efficiency (i.e. Lean-a-stan) among the comparison group. DEA then allows for identification of 'efficiency slacks' along the various dimensions of the welfare state performance. For example, if Lean-a-stan spends 5% of its GDP on health expenditures and achieves 1-per-1000 infant mortality before age 2, and if Waste-a-stan spends 10% of its GDP on health expenditures, then

(assuming constant returns to scale[9]) Waste-a-stan should be able to reduce its infant mortality to 0.5-per-1000. If Waste-a-stan does not show such a comparatively lower mortality rate, then DEA will reveal an input focused allocative efficiency slack in this area. When allocative efficiency slacks are announced and compared among nations, regions, or welfare state types, then impetus for retrenchment can be generated.

4.2 Model specification – theoretical output variables

The crux of the issue for this study, and an issue on which the success or failure of the study hinges, is the proper identification of the output and input variables for the hard to grasp, heterogeneous concept of the 'welfare state'. What are the proper 'outputs of the welfare state? Do all welfare states share a similar set of outputs? Is it possible to compare the goals and the performance of welfare states?

In broad strokes, welfare states aim to provide in the areas of education, health care (curative and preventative), poverty reduction and/or inequality reduction, and income replacement (a broad area subsuming pensions, maternity/paternity leave, and unemployment benefits). Figure 4.1 delineates these major dimensions of welfare state effort as understood for the purposes of this study, although for some writers a finer level of detail is necessary (Afonso, Schuknecht and Tanzi 2003) and other writers include some less traditional welfare state performance indicators, such as net migration, social integration, or 'dignity'. (Barr 1992)

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[9] This assumption is discussed in more detail in Section and again in model specification B in Section 5.3

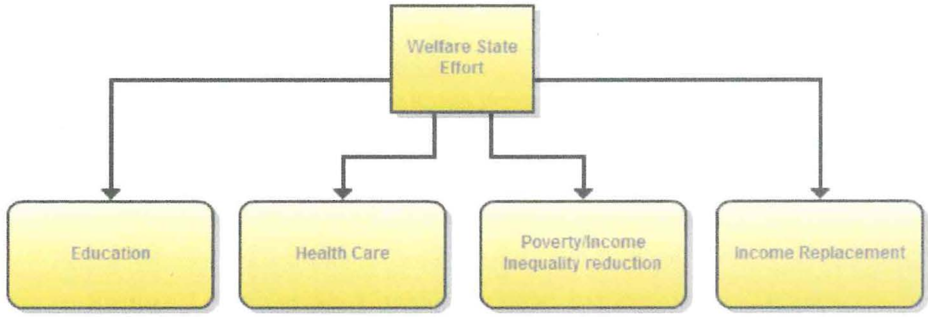

Figure 4.1. Major dimensions of welfare state effort

The ideal variables for assessing the performance of the welfare state would be variables that in total describe not only each of these performance dimensions but also the welfare state as a whole. Much of the existing research dealing with the welfare state evaluates small groups of countries (developed nations, European nations, Mediterranean nations, Asian nations, etc.) and utilizes some of the Figure 4.2 variables to capture the state's performance. However, not all desired variables exist for the broad sample included in this study, so the variables actually used are only a subset of the group of ideal variables, as discussed in more detail in subsequent sections.

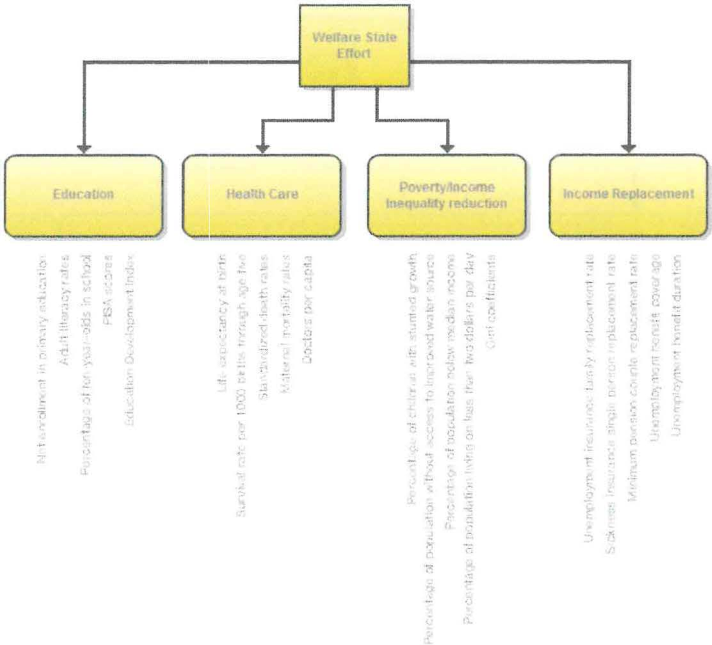

Figure 4.2. Ideal output variables for measuring welfare state effort

The variable selection in this study is constrained by two major factors – variable availability for the 137 countries in the sample (data availability) and the capabilities of the methodology (overspecification). A careful deliberation in light of the existing research has led to selection of two of the most important output variables in each major performance dimension as this number of variables allows an evaluation of the welfare state as a whole without overspecifying the model beyond the capabilities of the Data Envelopment Analysis methodology. Variables (such as *life expectancy*) are deemed 'important' both if a theoretical basis exists for using a variable as a proxy for the performance of the entire dimension (such as *health*), and if multiple existing studies include the variable in their evaluations of a dimension's performance.

4.2.1 Final output variable selection

The final output variables used in the study represent a crystallized version of the original universe of output variables considered ideal for welfare state performance measurement.

Table 4.1. Welfare state output variables and descriptive statistics

	Mean value	Median value	Standard Deviation	Minimum Value	Min Country	Maximum Value	Max Country
Total Net Enrollment Ratio in Primary Education	90.12	94.06	11.57	40.00	Liberia	99.99	Japan
Percentage of population under five without stunted growth	81.63	87.00	15.46	47.00	Burundi	100.00	Australia
Literate Adults as percentage of population	82.08	91.00	20.82	24.00	Burkina Faso	100.00	Norway (and others)
Life Expectancy at birth	67.69	72.00	11.36	40.00	Swaziland	82.00	Iceland, Japan
Survival rate through five years per 1000 live births	944.40	975.00	65.35	730.00	Sierra Leone	997.00	Iceland
Percentage of population with access to improved water source	86.46	94.00	16.17	38.00	Ethiopia	100.00	Belgium (and others)

4.2.1.1 Outputs – Poverty prevention

Despite the widely available statistics of the number of people in the world living on less than 2 USD per day, no useable measure exists for comparing absolute poverty across borders.

Some measures are reported for the developing countries (percentage of population which is malnourished, number of people living on less than 1 USD or 2 USD per day, etc.) while other absolute measures are reported for the developed countries (percentage of people living under a particular income level, defined differently in each country). The fact that poverty data are not widely available is a fact that is readily seen in the cross-border development and welfare state literatures. (Coelli, et al. 2011) A number of researchers are forthright in their dismay at the fact that no truly comparable absolute poverty measure exists. Miriam Sharkh writes in her welfare regimes cluster analysis:

> "However, it transpired that ***there are no accurate measures of poverty for a large number of countries*** for a range of years, even restricting ourselves to the common but arbitrary cut-off measure of one dollar per person per day. It is astonishing that there is no remotely accurate way of tracking this, the most commonly cited Millennium Development Goal!" (Abu Sharkh and Gough 2010)

It is not that poverty is impossible to measure or to proxy, but the currently available variables are simply not ideal. As a proxy for poverty, two measures were used in this study: (1) ***percentage of population with access to improved water source*** and (2) ***presence of stunting***[10] in children under age five. Neither of the variables is a direct measure of poverty, but both can be used as approximate proxies for poverty. Countries with higher Gross National Income have higher levels of access to improved water sources and lower levels of stunting among children under five.

[10] Percentage of children stunted is the percentage of children under five years who have a height-for-age below minus two standard deviations of the National Center for Health Statistics (NCHS)/WHO reference median. (World Health Organization 2009)

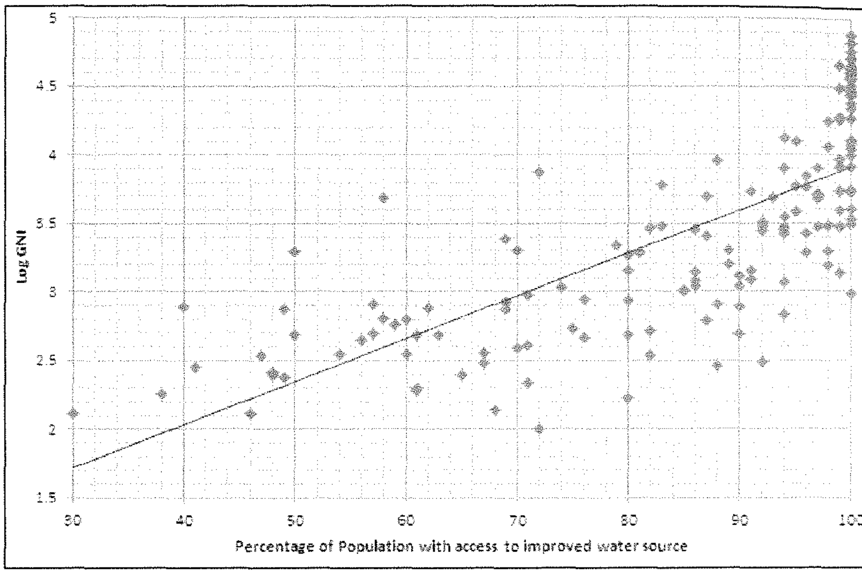

Figure 4.3. Access to improved Water Source and Log(GNI)

Since stunting is a 'negative' outcome of a welfare state (i.e. the poverty-prevention goal of the welfare state would be to reduce, not increase, stunting) then data for this study is converted to reflect the percentage of children who are five and under who are not stunting. Such conversion of 'negative' outcomes is common in the Data Envelopment Analysis research and practice and in this case is done simply by subtracting the raw data from 100 percent for each country in the sample.

$$\textit{not\_stunting}_i = 100 - \textit{stunting}_i$$

No such conversion is necessary for the other poverty variable, since increase in the percentage of population with access to an improved source of water is consistent with a poverty prevention goal of a welfare state.

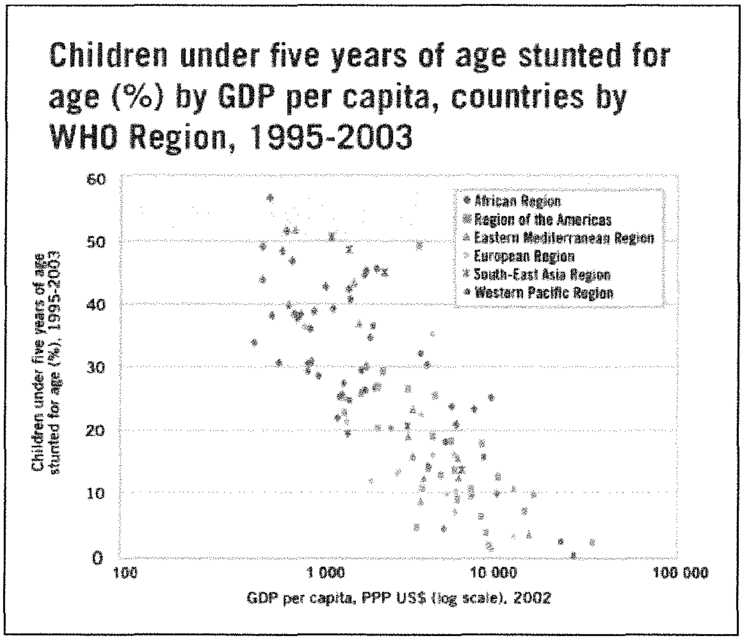

Figure 4.4. Stunting and Log GDP per capita[11]

4.2.1.2 Outputs – Education

Education variables present a similar although somewhat lesser challenge. The ideal output variable for measuring a welfare state's ability to educate its subjects would be a particular test which compares knowledge of individuals who start out with equal knowledge and are subsequently exposed to different education systems. Subsequent increase in knowledge would be compared to provide an indicator for the efficacy of the education system. Clearly, such an indicator-variable does not exist. However, various organizations measure student performance, school enrollment ratios, even cross-border knowledge tests so that researchers can gain some

[11] Source: World Health Organization (World Health Organization 2011)

idea about the level of education by country. Perhaps the most desirable output variable is the OECD Programme for International Student Assessment (PISA) – a once in three years exam currently administered in 61 countries. Since this study evaluates the welfare state efficiency in 137 countries (see discussion on country selection) the major drawback of this measure is the lack of data on student performance in the remaining 76 countries.

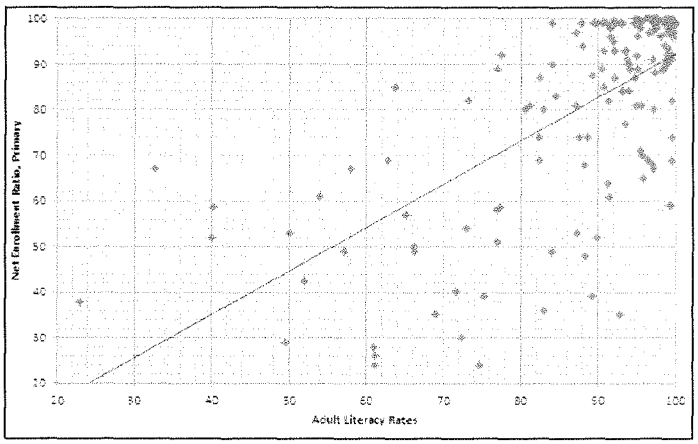

Figure 4.5. Adult Literacy Rates and Net Enrollment Rates

This leaves several other potential output variables for inclusion in the study, out of which the variables actually included are (3) ***total net enrollment*** in primary education, and (4) ***rate of literacy*** among adult populations. These variables are carefully tracked and well reported by World Bank and UNICEF respectively. In using these variables this study follows other welfare state researchers, such as Gupta and Verhoeven (Gupta and Verhoeven 2001) and Afonso and Tanzi (Afonso, Schuknecht and Tanzi 2003). These researchers also take these two variables as approximate proxies for welfare state's educational component's ability to reach its goals.

4.2.1.3 Outputs – Health

Health care is perhaps the area where the greatest abundance of internationally comparable indicators exists. From the array of available variables, this research uses (5) ***life expectancy*** at birth, and (6) ***5 and under mortality*** as indicators of the welfare state's ability to provide health outcomes for its constituents. Again, it is not the case that these two measures somehow capture the entirety of health outcomes for the affected populations, nor is it the case that nothing else, other than the welfare state's policy and practice, affects the two outcome variables (lifestyle, culture, diet, genetics also affect both the life expectancy and child mortality). However, the use of these two variables has the advantage of data availability and relatively similar definitions for measurement, so the variables are included as proxies for health outcomes of the respective welfare states.

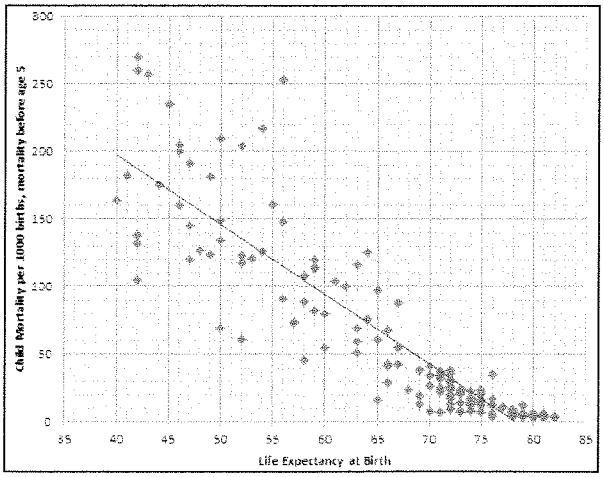

Figure 4.6. Life Expectancy and Child Mortality before age 5 (per 1000 live births)

4.2.1.4 Outputs – Pensions

Unfortunately it is not possible to incorporate pension-related data among the output variables for the welfare states of the large sample (137 countries) which is the focus of this research. Despite the fact that a key output of the welfare state is income replacement in old age, sickness, or unemployment, no internationally comparable statistics exist at this time for a large pool of countries. The International Monetary Fund keeps a record of International Monetary Statistics but this report only covers a select group of (mostly developed) nations. Some welfare state researchers include a welfare state output variable such as the IMF's 'social taxes as percent of GDP', 'social spending as percent of GDP, or 'social spending as percent of total central government spending'. However, for the present purposes it is impossible to use a variable where more than half of the 137 countries under investigation have no comparable basis for evaluating the welfare state effort (or achievement) in the area of pensions. Perhaps the current research can highlight the need for creation of a new dataset that could track pension coverage or effort for a broad group of developed *and* developing countries, leading to a future opportunity to include pensions data in a welfare state efficiency study.

4.2.2 Final input variable selection

In order to approximate the inputs of a welfare state, three variables are used; (1) ***tax burden as % of GDP***, (2) ***education spending as % of GDP***, and (3) ***health spending as % of GDP***. The three input variables, when taken together, provide a proxy for observing the resources committed to the welfare state outcomes in general (input variable one) and in particular (input variables two and three).

When attempting to estimate welfare state effort caution is necessary in variable selection, since some variables are potentially superior to others in revealing the extent of resources committed to accomplishing the welfare state's goals. To measure the commitment to education some researchers rely on the percentage of central government's budget that is used to pay for education services, but this approach does not capture large variability in the extent to which the central government is involved in the economy. In addition, such an approach does not reveal non-government payments toward education or non-central-government payments toward education. A country where much education spending is conducted privately or at state or local levels would appear as a 'low spending country' and that might not necessarily be an accurate portrayal of the true commitments. Similar concerns exist in regard to health spending, which can be done privately or publically and which can be done by a large central government or small central government. The present research uses the percent of GDP committed to health and education spending respectively as proxies for commitments (inputs) in these welfare state areas.

In addition to evaluating the commitment to education and health outcomes, the present study uses a tax burden as percentage of GDP as a catch-all variable that would include other commitments to welfare state policies and institutions (it is true that the tax burden represents something much broader than the welfare state input alone; certainly the military expenses, infrastructure spending, etc. come out of the tax revenue in many nations).

Table 4.2. Welfare state input variables and descriptive statistics

	Mean value	**Median value**	**Standard Deviation**	**Minimum Value**	**Min Country**	**Maximum Value**	**Max Country**
Public spending on health as percentage of GDP	6.63	6.07	2.65	1.95	Kuwait	15.18	United States
Public spending on Education as percentage of GDP	4.51	4.30	2.20	0.98	Sri Lanka	16.80	Timor-Leste
Tax burden as percentage of GDP	22.61	19.20	11.86	1.50	Kuwait	63.10	Lesotho

4.2.3 Country selection and sample size

The sample for this study began with a list of all countries and territories as of May 2011, and was first narrowed down by population. Following in the footsteps of other researchers, the very small countries were eliminated to reduce the probability of very small country outliers the results for which would be incomparable to the other countries. Countries with less than one million population were excluded from the sample resulting in a sample of 157 countries with population one million or greater, plus a few other key countries (such as Luxembourg) which did not reach the population cut-off, but were still included in the sample because many other studies had included them in their samples.

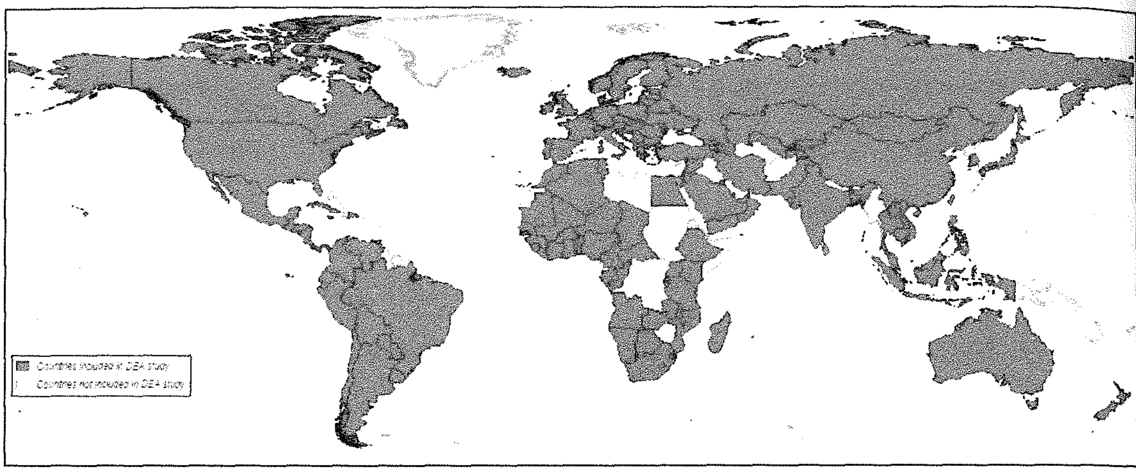

Figure 4.7. Countries included in the study

In the next step, several countries were excluded due to lack of data. Since DEA is a nonparametric methodology that is based on a best practice efficient frontier, then it is extremely difficult to treat missing observations. Assumptions which are required for filling in the missing values reduce the objectivity of the subsequent results. Twenty countries were excluded because data needed for this model was not available (see Table 4.3).

Table 4.3. Countries excluded from sample due to missing data

Country	**Missing Variable(s)**
Afghanistan	Tax burden as percentage of GDP
Congo, Dem. Rep.	Education spending as percentage GDP
Eritrea	Tax burden as percentage of GDP
Haiti	Tax burden as percentage of GDP
Sudan	Tax burden as percentage of GDP
Bosnia Herzegovina	Tax burden and education spending as percentage of GDP
Guinea-Bissau	Tax burden and education spending as percentage of GDP
Haiti	Tax burden and education spending as percentage of GDP
Iraq	Education spending as percentage of the total central government spending

Table 4.3 continued

Country	**Missing Variable(s)**
Libya	Tax burden and education spending as percentage of GDP
Myanmar	Tax burden and education spending as percentage of GDP
Papua New Guinea	Tax burden and education spending as percentage of GDP
Hong Kong SAR, China	Tax burden and health spending as percentage of GDP, life expectancy at birth
Korea, Dem. Rep.	Tax burden, education and health spending as percentage of GDP
Kosovo	Tax burden and health spending as percentage of GDP, life expectancy at birth
Somalia	Tax burden, education and health spending as percentage of GDP
Turkmenistan	Tax burden and education spending as percentage of GDP; percentage of population with access to improved water source
West Bank and Gaza	Tax burden, education and health spending as percentage of GDP
Puerto Rico	Tax burden, education and health spending as percentage of GDP; percentage of population with access to improved water source; life expectancy at birth
Zimbabwe	Tax burden, education and health spending as percentage of GDP

The remaining 137 countries were included in research making the present study the broadest existing inquiry into welfare state efficiency. A list of included countries (along with the welfare state input/output variables) in Table 4.4 reveals performance differences in the relevant indicator variables.

Table 4.4. Countries and variables included in the study

Coun-try Name	Total Net Enroll-ment Ratio in Primary Education	Percen-tage of popula-tion under 5 without stunted growth	Literate Adults as percent-tage of populati on	Life Expec-tancy at birth	Survival rate through 5 years per 1000 live births	Percen-tage of population with access to improved water source	Public spen-ding on health as percent-tage of GDP	Public spen-ding on educatio n as percent-tage of GDP	Tax burden as percen-tage of GDP
Alba-nia	87.77	78	76	99	983	97	6.80	1.31	24.3

Table 4.4 continued

Algeria	95.75	89	72	70	962	83	5.35	4.30	8.0
Angola	58.00	55	42	67	740	50	3.34	2.60	6.1
Argentina	99.14	96	75	97	984	97	8.44	4.90	26.1
Armenia	92.88	87	72	99	976	96	3.77	3.00	16.8
Australia	97.07	100	81	99	994	100	8.51	4.50	30.8
Austria	97.37	98	80	98	995	100	10.48	5.40	42.9
Azerbaijan	83.99	87	67	99	912	80	4.28	2.80	17.7
Bangladesh	88.38	57	63	48	931	80	3.32	2.40	8.8
Belarus	94.84	97	69	100	987	100	5.59	4.50	30.4
Belgium	98.61	97	79	99	996	100	11.12	6.01	46.5
Benin	92.82	62	56	35	852	75	4.11	3.50	17.2
Bolivia	92.08	73	65	87	939	86	4.36	6.30	28.5
Botswana	87.14	77	49	81	876	95	7.58	8.90	30.2
Brazil	95.12	89	72	89	980	97	8.44	5.08	34.4
Bulgaria	97.39	91	73	98	986	100	7.07	4.10	33.3
Burkina Faso	61.17	65	52	24	796	76	5.94	4.60	12.1
Burundi	99.42	47	49	59	819	72	13.00	8.30	18.0
Cambodia	88.59	63	59	74	918	61	5.67	2.10	10.5
Cameroon	88.30	70	50	68	851	74	5.30	3.70	18.5
Canada	99.48	99	80	99	994	100	9.84	4.90	32.2
Central African Republic	66.28	62	44	49	825	67	4.33	1.30	7.9
Chad	61.18	59	50	26	791	50	6.41	3.20	5.3
Chile	95.11	99	78	96	991	96	7.49	4.00	18.6

Table 4.4 continued

China	97.02	89	73	91	976	89	4.32	2.09	18.0
Colombia	93.54	88	73	93	979	92	5.88	4.80	19.3
Congo, Rep.	63.85	74	54	85	874	71	2.74	1.90	5.3
Costa Rica	92.00	94	79	95	988	97	9.42	6.30	15.6
Cote d'Ivoire	57.25	66	48	49	873	80	5.39	4.60	15.2
Croatia	91.44	99	76	98	994	99	7.83	4.60	23.3
Cuba	99.51	95	78	100	993	94	12.00	13.60	41.2
Czech Republic	89.59	98	76	99	996	100	7.11	4.20	36.2
Denmark	95.38	98	78	99	995	100	9.92	7.80	49.0
Dominican Republic	82.45	93	72	87	971	86	5.71	2.30	15.0
	98.35	83	78	89	992	100	2.52	1.20	1.8
Ecuador	98.86	77	75	91	976	94	5.32	1.31	16.0
Egypt	95.40	82	71	71	965	99	4.81	3.80	15.4
El Salvador	95.59	81	72	81	975	87	6.02	3.60	13.0
Estonia	96.53	99	71	100	993	98	6.11	4.90	32.3
Ethiopia	82.98	53	52	36	877	38	4.31	5.50	9.9
Finland	96.19	98	79	100	996	100	8.81	5.90	43.2
France	99.12	98	80	99	996	100	11.15	5.60	44.6
Gabon	94.00	79	56	84	909	87	2.63	1.61	9.9
Gambia	71.58	78	59	40	887	92	5.47	2.00	19.2
Georgia	99.01	88	71	100	968	98	8.68	3.20	24.9
Germany	99.69	99	79	99	996	100	10.55	4.50	40.6
Ghana	76.97	78	59	58	880	82	7.77	5.40	20.6

Table 4.4 continued

Greece	99.62	94	79	96	996	100	10.10	4.00	35.1
Guatemala	96.45	51	70	69	959	94	6.46	3.20	11.3
Guinea	72.33	65	55	30	839	71	5.52	2.40	14.7
Honduras	97.19	75	70	80	973	86	6.29	1.69	16.3
Hungary	95.43	97	73	99	993	100	7.22	5.20	40.5
Iceland	97.65	98	82	99	997	100	9.24	7.40	40.1
India	91.41	52	64	61	924	88	4.17	3.10	18.6
Indonesia	98.74	60	70	90	966	80	2.26	2.80	13.3
Iran	99.58	85	71	82	966	92	5.53	4.70	6.1
Ireland	97.14	98	79	99	995	100	8.74	4.90	30.8
Israel	97.12	92	80	97	995	100	7.57	5.90	33.5
Italy	99.25	96	80	98	996	100	8.71	4.30	43.1
Jamaica	80.51	97	72	80	969	94	4.75	5.80	26.0
Japan	99.99	94	82	99	996	100	8.29	3.50	28.3
Jordan	93.70	91	72	91	975	96	9.40	5.10	18.3
Kazakhstan	99.06	87	66	100	971	95	3.87	2.80	27.7
Kenya	82.33	70	53	74	879	59	4.23	7.00	20.9
Korea	99.02	92	78	98	995	98	6.51	4.20	26.6
Kuwait	93.42	76	77	93	989	99	1.95	3.80	1.5
Kyrgyz Republic	91.04	86	66	99	959	90	5.70	5.90	23.3
Lao PDR	82.42	58	64	69	925	57	3.99	2.30	12.5
Latvia	97.00	99	72	100	991	99	6.58	5.00	29.1
Lebanon	89.28	89	72	87	970	100	8.49	1.80	16.6

Table 4.4 continued

Lesotho	73.19	62	42	82	868	85	7.63	12.40	63.1
Liberia	40.00	61	45	52	765	68	11.93	2.70	28.6
Lithuania	96.14	99	73	100	992	97	6.59	4.70	30.6
Luxembourg	97.45	98	79	100	996	100	6.82	5.40	36.5
Macedonia	91.54	91	74	96	983	100	6.81	2.59	28.3
Madagascar	99.28	52	59	59	885	41	4.41	3.00	12.9
Malawi	91.18	54	47	64	880	80	6.53	4.20	16.5
Malaysia	94.06	93	74	89	988	100	4.30	4.10	15.3
Mali	74.66	62	54	24	783	56	5.63	4.40	15.0
Mauritania	76.90	65	64	51	875	49	2.59	4.40	13.4
Mauritius	93.14	90	73	84	986	99	5.51	3.20	19.0
Mexico	99.52	87	76	92	965	94	5.88	4.80	8.2
Moldova	90.46	92	69	99	981	90	10.65	9.60	33.4
Mongolia	99.23	79	66	98	957	76	3.75	5.60	30.8
Morocco	89.92	82	71	52	963	81	5.32	5.60	26.9
Mozambique	89.27	59	42	39	862	47	4.66	5.00	14.2
Namibia	90.71	76	52	85	939	92	6.86	6.40	24.8
Netherlands	98.94	99	79	99	995	100	9.86	5.30	39.8
New Zealand	99.47	97	80	99	994	100	9.73	6.10	34.5
Nicaragua	93.44	80	72	77	964	85	9.36	3.10	18.0
Niger	49.51	50	56	29	747	48	5.86	4.50	11.4
Nigeria	62.78	62	47	69	809	58	5.18	1.53	5.9
Norway	98.68	98	80	100	996	100	8.53	6.80	42.1

Table 4.4 continued

Oman	81.22	90	75	81	988	88	2.09	3.90	3.0
Pakistan	66.13	63	65	50	903	90	2.63	2.70	10.2
Panama	98.86	82	75	92	977	93	7.23	3.80	10.6
Paraguay	88.06	86	71	94	978	86	5.97	4.00	11.8
Peru	97.25	76	71	88	975	82	4.47	2.70	16.0
Philippines	92.11	70	71	93	968	91	3.68	2.80	14.1
Poland	95.24	98	75	100	993	100	7.01	4.90	34.9
Portugal	98.72	96	78	94	995	99	10.57	4.40	37.7
Qatar	98.37	92	75	89	979	100	2.05	3.30	4.9
Romania	96.52	90	72	97	982	58	5.44	4.30	28.5
Russian Federation	92.24	87	65	99	984	96	4.82	3.90	34.1
Rwanda	95.86	55	46	65	840	65	9.41	4.10	13.5
Saudi Arabia	84.58	80	72	83	975	95	3.59	5.60	6.6
Senegal	75.19	84	63	39	884	69	5.70	5.80	18.3
Serbia	98.00	94	74	96	992	99	10.04	4.70	36.3
Sierra Leone	69.00	60	42	35	730	49	13.33	4.30	10.8
Singapore	76.90	98	80	89	997	100	3.34	3.00	14.2
Slovak Republic	92.00	99	74	100	992	100	8.00	3.60	29.3
Slovenia	97.48	97	78	100	996	99	8.29	5.20	37.6
South Africa	91.37	75	50	82	931	91	8.24	5.40	25.7
Spain	99.84	96	81	97	996	100	8.97	4.30	33.9
Sri Lanka	99.48	86	72	91	987	90	4.07	0.98	13.3
Swaziland	82.91	70	40	80	836	69	5.82	7.80	36.0

Table 4.4 continued

Sweden	94.63	98	81	99	997	100	9.39	6.60	47.9
Switzerland	99.13	98	81	99	995	100	10.73	5.20	29.4
Syrian Arab Republic	95.00	78	74	81	986	89	3.06	4.90	10.2
Tajikistan	97.52	73	66	100	932	70	4.95	3.50	18.7
Tanzania	99.60	62	52	69	882	54	4.53	6.80	14.8
Thailand	90.77	88	70	93	992	98	4.05	4.10	16.0
Timor-Leste	77.28	51	60	59	945	69	13.77	16.80	24.6
Togo	87.30	76	58	53	892	60	5.85	4.60	16.3
Trinidad and Tobago	95.32	96	69	98	962	94	4.66	3.57	19.4
Tunisia	99.50	88	74	74	977	94	6.16	7.10	22.4
Turkey	94.69	88	72	87	974	99	6.07	2.90	23.5
Uganda	97.24	68	50	67	866	67	8.40	3.20	11.9
Ukraine	89.35	97	68	99	976	98	6.85	5.30	37.7
United Arab Emirates	99.84	98	79	99	994	100	8.66	5.50	38.9
United Kingdom	93.14	99	78	99	992	99	15.18	5.50	26.9
United States	98.97	89	76	97	988	100	7.78	2.90	17.9
Uruguay	90.60	85	67	99	957	87	4.89	3.91	19.6
Uzbekistan	92.09	87	73	93	979	83	5.40	3.70	13.6
Venezuela	94.00	70	74	90	983	94	7.25	5.30	23.6
Vietnam	73.03	47	62	54	900	62	5.31	5.20	7.3
Yemen	97.06	50	41	68	818	60	5.87	1.30	17.5
Zambia	87.77	78	76	99	983	97	6.80	1.31	24.3

4.3 Use of the results

With the nine key variables selected for the 137 countries in the sample, it is possible to investigate the comparative efficiencies of the individual nations, regions, and welfare state regime type groupings. The concept underlying the relationships modeled is that the three input variables drive the six output variables. That is, when nations spend more on education and health, and when they tax more for other welfare state (and non-welfare state) expenditures, then they should be able to achieve better outcomes in education, health, and poverty.

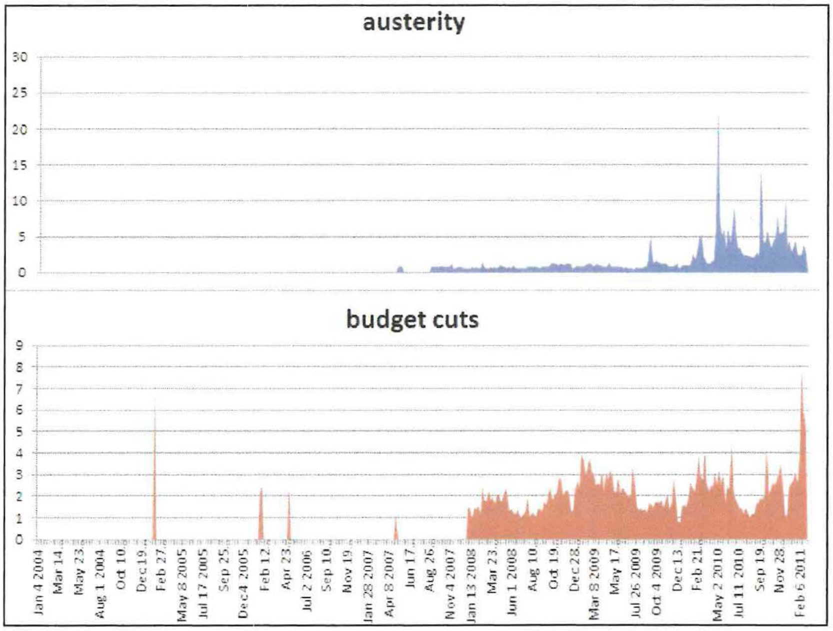

Figure 4.8. Google Trends indicator for "austerity" and "budget cuts"[12]

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[12] Charts portray the relative frequency of search terms "austerity" and "budget cuts". Source: Data from Google Trends (Trends) as of March 8, 2011; graphical presentation original

4.3.1 Possible case for retrenchment or austerity

If nations spend more and achieve less, then the programs are ripe for re-structuring, retrenchment, and austerity. Although not popular, "austerity plans" and "budget cuts" are terms that are used with increasing frequency at the beginning of the second decade of the twenty first century (see search term trends in Figure 4.8). Politicians and policy-makers are re-evaluating the relationship between the state and the individual. Many are argue for more efficient public spending (The Economist 2011), for increased private provision of services formerly provided by the state, and for a 'welfare state retrenchment in general', although few argue that all state provided services should be eliminated. Related discussions tend to polarize the discussants, and progress in this realm is often difficult.

4.4 Model specifications

What is lacking in today's discussion is the technical understanding of comparative welfare state efficiencies. If we are able to show existing levels of output can be provided by using less input, then policy-makers from both sides of the political spectrum can find new common ground to propose solutions in this politically sensitive area. Austerity plans can become less painful if expenditures can be saved through increased efficiency and the output cuts can be reduced or avoided. In a way, identifying efficiency slacks can subsequently allow the inefficient states to 'have their cake and eat it too' if proposals to cut spending and maintain output become possible.

In order to carry out these comparisons, Data Envelopment Analysis was applied to the data in the four model specifications highlighted in Figure 4.9.

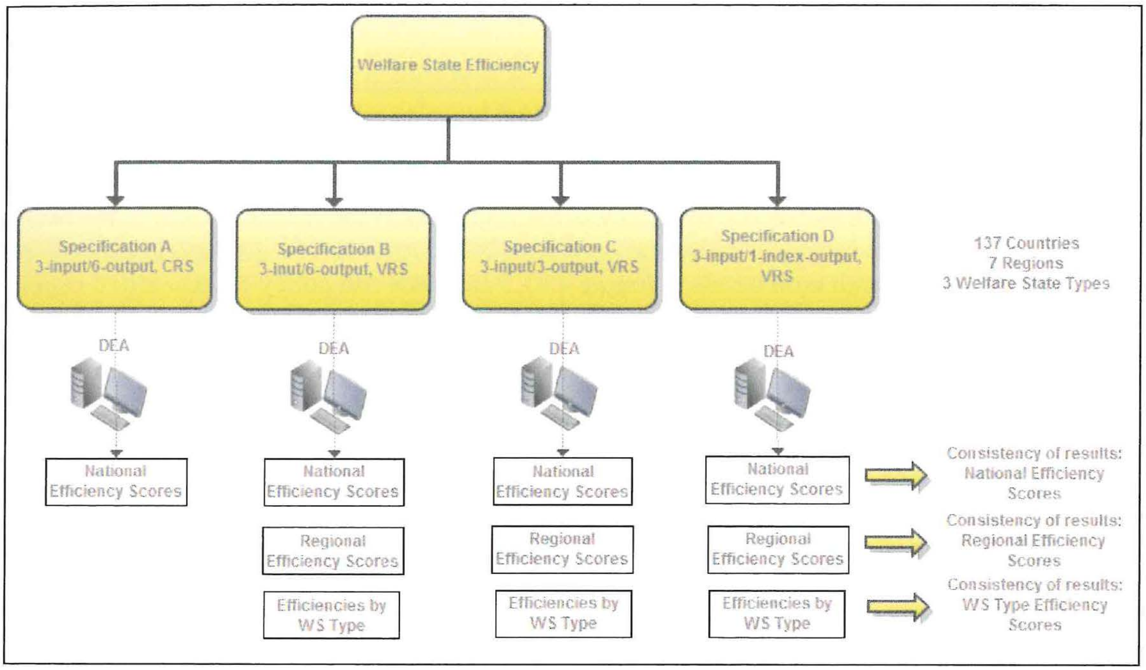


Figure 4.9. Diagram of model specifications

Specification A carried out a straight forward input-focused Data Envelopment Analysis with the three inputs and six outputs and an enforced assumption of constant returns to scale. For reasons discussed in section 2.5.1 and in the results of this specification, constant returns to scale was found to be unlikely to yield a good representation of the real relationship between inputs and outputs. The principle of diminishing marginal returns implies that the 'low hanging fruit' would be collected by the early, not the subsequent welfare state incentives.

With this in mind, the model was re-specified to allow for decreasing returns to scale in model specification B. This specification results in a high number of independently efficient welfare states, reducing the explanatory power of the model. The model was therefore re-specified for two additional iterations – specification C used a reduced number of output

variables, and specification D used a normalized and aggregated composite output variable in the place of six output variables used before. The consistency of results was then tested to check the sensitivity of results to model specifications.

CHAPTER 5

MODELLING EFFICIENCY: RESULTS UNDER ALTERNATIVE SPECIFICATIONS

5.1 Specification A: results in three-input/six output, CRS model

During the first scenario, three inputs were used along with all six outputs in an input-oriented constant returns to scale (CRS) single step Data Envelopment Model using the DEAP software[13] developed by Tim Coelli. (T. J. Coelli 1996) The resultant efficiency scores for all countries in the sample are included in Appendix 1 and presented graphically in Figure 5.1.

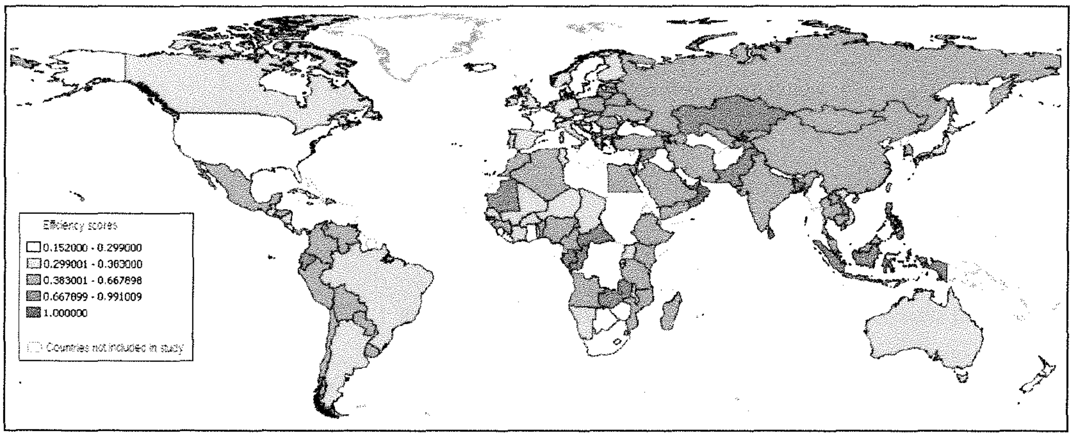


Figure 5.1. DEA results – model specification A (three input, six output, CRS)

[13] After evaluating Stata, DEA Frontier (Excel Add-in), DEA Solver and DEAP, a decision was made to proceed with DEAP because of the flexibility the package offered for utilizing multiple variations of DEA as well as for the ease speed of processing this DEA solver application provided compared with the others.

Country efficiencies vary from 1.0 in United Arab Emirates and Kuwait to 0.190 and 0.152 in Burundi and Timor-Leste respectively. In Specification A, 15 countries report independently perfect efficiency scores and the mean efficiency score for the entire sample is 0.457. What is the meaning of these 15 perfect efficiency scores? It is important to remember that within Data Envelopment Analysis, a non-parametric approach to a best-practice efficiency frontier, the DMUs with the lowest input (in any input category) or the highest output (in any output dimension) will be selected as maximally efficient. This is to say that Kuwait, with the lowest 'tax burden' input is automatically selected as 100% efficient and United Arab Emirates, with the highest possible education output in 'poverty' is also selected as 100% efficient.

An examination of the developed nations' welfare states included in this sample is revealing. Selected OECD countries are included in Table 5.1 below to illustrate inter-country differences in welfare state efficiency for the developed nations.

Table 5.1. Welfare State Efficiency for OECD Countries – model specification A

Country	SpecA Eff. Score	Ranking under SpecA
Japan	0.3760	1
Australia	0.3510	2
Ireland	0.3310	3
Italy	0.3310	4
United Kingdom	0.3270	5
Finland	0.3180	6
Norway	0.3160	7
Germany	0.3070	8
Canada	0.3030	9
Netherlands	0.2990	10
Sweden	0.2960	11
New Zealand	0.2890	12
Austria	0.2810	13
Switzerland	0.2750	14

Table 5.1 continued

Country	SpecA Eff. Score	Ranking under SpecA
Denmark	0.2740	15
France	0.2640	16
Belgium	0.2580	17
United States	0.2420	18

The results are quite surprising. Japan and Australia are shown as being the most efficient welfare states among the listed 18 OECD nations, an indication that these nations have been able to achieve more in education, poverty prevention, and health, per fraction of GDP dedicated to these areas than the United States and the Scandinavian Countries.

While the results of the Constant Returns to Scale (CRS) efficiency analysis are intriguing, the question inevitably arises as to why the Scandinavian nations and the higher spending nations in general tend to group at the bottom of this group of selected countries. When individual nations are compared, many of the efficiency leaders are the relatively low spending nations while Belgium, Denmark, France, United States, the high spenders, do not do particularly well in this efficiency measure. While we assume that providing more input to the welfare state will produce more output, is it reasonable to also assume that doubling the input would necessarily double the output? In a model where Constant Returns of Scale are assumed for the theoretical efficient frontier, it is presumed that a doubling of resources devoted to an outcome should lead to a doubling of the outcome indicator. The first percentage point of GDP that is devoted to education should have the same impact as the twentieth percentage point of GDP in government spending on education. This assumption is probably not realistic

5.2 Variable Returns to Scale – a reasonable assumption in welfare state modeling

One of basic properties in economic life is diminishing returns, "the property whereby the benefit from an extra unit of input declines as the quantity of the input increases." (Mankiw 2008) Is it possible that this property is absent in the case of the welfare state as assumed in model specification A? A simple examination of the correlation of GNI per capita and Life expectancy (see Figure 5.2) shows that at the very least, there seem to be diminishing returns to wealth when it comes to "earning" a higher life expectancy.

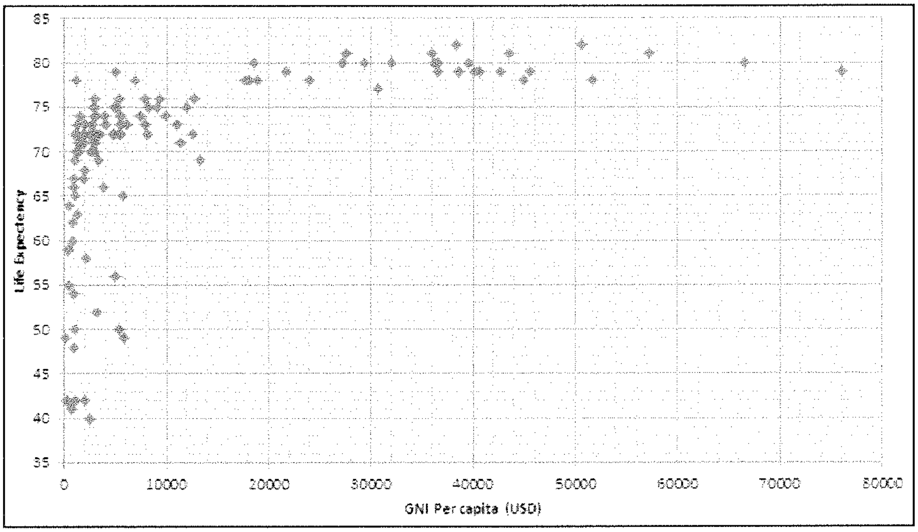


Figure 5.2. Life Expectancy and GNI per capita, 137 nations

Similarly, a casual observation of life expectancy and the central government spending (see Figure 5.3) also reveals a non-constant return to scale relationship between spending and life expectancy, albeit a much weaker relationship (life expectancy is affected, after all, by many other factors beyond government spending on health, so it is expected that an excessively close relationship between spending and life expectancy would not be uncovered.)

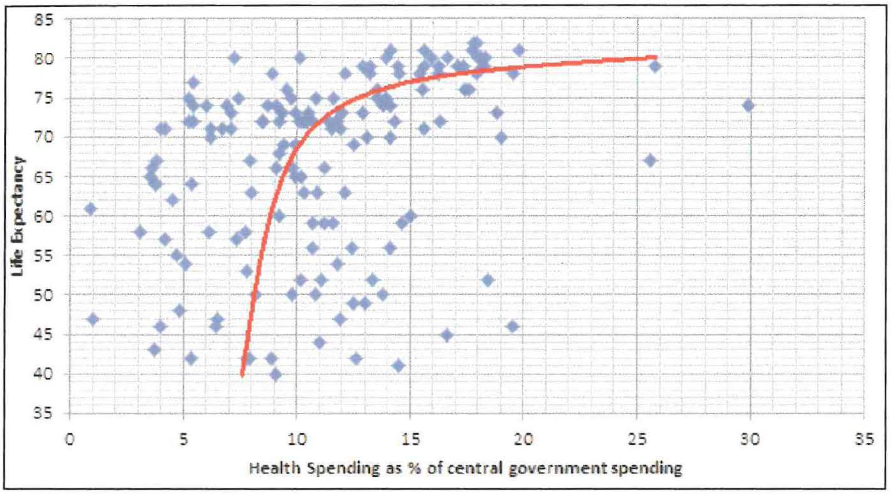


Figure 5.3. Health spending and life expectancy; 137 countries

Presentations of the simple correlation between the selected variables above suggest that non-constant (diminishing) returns of scale exist in regard to welfare state effort, and the utilization of VRS models by other researchers adds to the validity of this conclusion. (Herrera and Pang 2005), (Cincera, Czarnitzki and Thorwarth 2009)

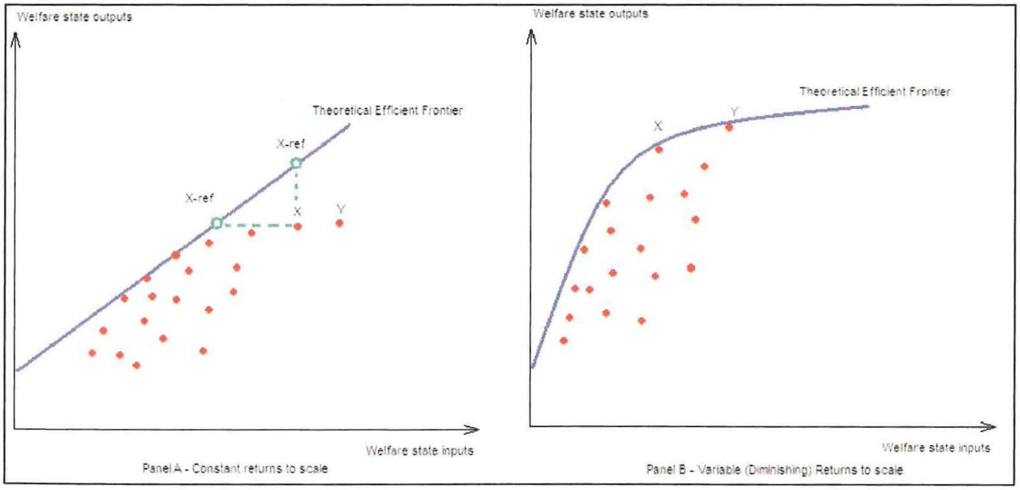


Figure 5.4. Returns to Scale for welfare state inputs/outputs

As illustrated in Figure 5.4, higher spending countries tend to be viewed as inefficient if we assume CRS where VRS is present. In panel A, countries X and Y are viewed as inefficient since they spend more than other countries on their welfare state effort, but do not reach the proportionally greater expected welfare state outcomes implied by CRS. In panel B, similar countries X and Y are now viewed as efficient since CRS is no longer assumed. The greater welfare state effort is rewarded with greater welfare state outcome, albeit by a diminishing margin. It is worth noting that a country which is efficient under variable returns to scale would also be efficient under constant returns to scale, but the converse does not necessarily hold.

5.2.1 Decomposition of inefficiencies under VRS

In addition to being more realistic, the assumption of variable returns to scale in welfare state inputs/outputs has the advantage of allowing researchers to decompose the efficiency slacks into their constituent programmatic inefficiencies (pure technical efficiencies) and scale inefficiencies. Banker proposed this approach where the Scale Efficiency (SE) measure for each DMU (presently – country) would indicate the ratio of CRS total efficiency to VRS total efficiency. (Banker, Charnes and Cooper 1984) Where SE is less than one, the combination of inputs and outputs is not scale efficient. Scale inefficiency in the welfare state context yields opportunities to raise the output by better leveraging the system resources in education, health, poverty prevention and the other welfare state dimensions.

5.3 Specification B: results in three-inputs/six-outputs, VRS model

With variable returns to scale the input and output data remain the same as in the previous model specification, but the efficiency scores are calculated with the new assumption. The results of the input-focused Data Envelopment Analysis are presented in Figure 5.5 and are listed in detail in Appendix 1, column "SpecB".

5.3.1 Individual nation welfare state efficiencies – specification B

Introduction of Variable Returns to Scale assumption into the welfare state efficiency model should make more welfare states individually perfectly efficient, and this is indeed the result. In all 45 countries now reflect individual perfect efficiency (32.8% of the sample), as do 10 of the 18 OECD countries included for comparison in Table 5.2 below.

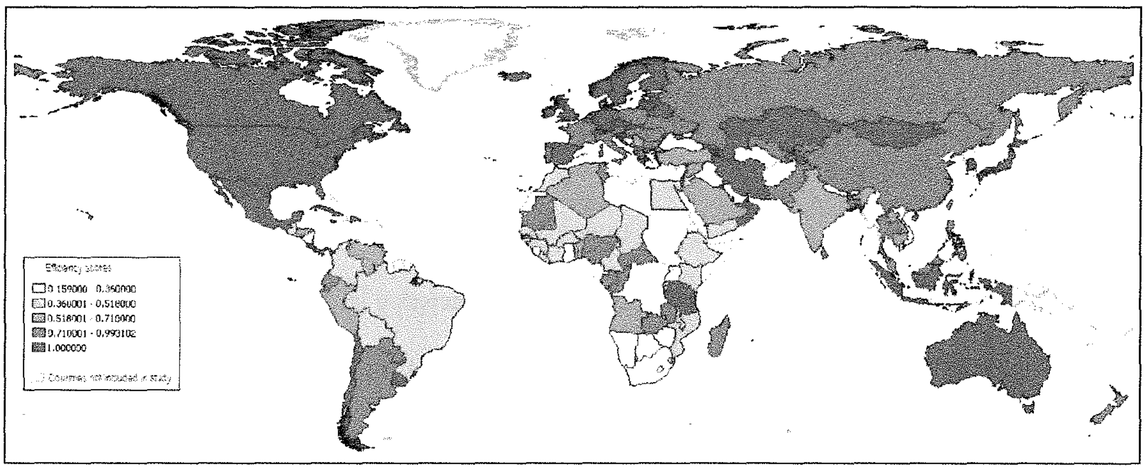


Figure 5.5. DEA results – model specification B (three input, six output, VRS)

This is a normal result since the previously enforced assumption of constant returns to scale is relaxed and the new VRS efficient frontier is not as rigid as the former CRS frontier. Japan and Australia still lead the efficiency rankings from the selected group (rankings first by VRS efficiency score, then by scale efficiency[14]), which is explained by the combination of the relatively proportionally high performance in welfare state output and the relatively low level of tax burden in the respective nations. The lagging nations have high commitments to the welfare state inputs without matching high performance in outputs, as compared to the other nations in the sample which consume similar inputs but produce greater outputs.

Table 5.2. OECD nation welfare state efficiencies – model specification B

Country	SpecB Efficiency Score	Ranking under SpecB
Japan	1.000	1
Australia	1.000	1
United Kingdom	1.000	1
Finland	1.000	1
Norway	1.000	1
Germany	1.000	1
Canada	1.000	1
Sweden	1.000	1
Switzerland	1.000	1
United States	1.000	1
Ireland	0.996	11
Netherlands	0.977	12
Italy	0.937	13
New Zealand	0.913	14

[14] An inefficient country in the CRS model which becomes efficient in the VRS model would have its entire efficiency slack attributed to scale (in)efficiency (SE), so the SE score for Estonia in the VRS model is equivalent to the Total Efficiency score for Estonia in the CRS model. Countries which are inefficient in both models have efficiencies decomposed, so that the total VRS inefficiency comes partially from scale inefficiency and partially from technical (programmatic) inefficiency. Scale efficiency estimates for the sample countries are shown in Appendix 4)

Table 5.2 continued

Country	SpecB Efficiency Score	Ranking under SpecB
France	0.871	15
Austria	0.797	16
Belgium	0.726	17
Denmark	0.693	18

The fact that so many countries emerge as independently efficient is quite problematic, since it prevents efficiency comparisons between the respective welfare states which could yield potential ideas for programmatic improvement. Indeed, little can be learned about welfare state efficiency differences from countries deemed independently efficient. Other researchers have hit similar roadblocks when exploring efficiency differences in welfare state designs or in public spending and several standard solutions have been proposed.

Some suggest simply cutting output indicators to reduce the number of independently efficient DMUs (Gupta and Verhoeven 2001) while others address the problem by constructing input or output indexes instead of using separate input/output variables (Coelli, Lefèbvre and Pestieau 2008) Reducing the number of input and output variables does indeed result in fewer independently efficient countries simply by the virtue of the properties of DEA methodology. With fewer variables, there are fewer potential dimensions along which a country can be deemed to be efficient (note that a country which is fully efficient in any one dimension is deemed independently fully efficient in the traditional DEA model). For example, eliminating the literacy rate as a welfare state output measure in education would reduce the number of independently efficient countries in the present model from 32.8% of all countries to 19.7% of countries (See data in Appendix 2).

5.3.2 Regional variations in welfare state efficiencies – specification B

Regional differences in welfare state efficiency are evident in this model. In order to evaluate regional efficiency differences the 137 nations in the sample were divided in seven subgroups: Africa, Asia, former Commonwealth of Independent States, Latin America, non-OECD Europe, OECD, and South-East Asia. The regions are selected based on the United Nations Statistics Division regional guidelines (United Nations 2011) and are intended to provide a general regional comparison between welfare state efficiencies. A finer break-down in regional assignments could be utilized, for example, separating East Asia (China, Mongolia) from the Western Asia (Saudi Arabia, Tajikistan, Iran) or separating the Caribbean from the Latin America, but, this is not pursued in this document but left for subsequent investigation.

Table 5.3. Regional divisions of the sample countries

Africa (n=40)		
Algeria	Gabon	Mozambique
Angola	Gambia	Namibia
Benin	Ghana	Niger
Botswana	Guinea	Nigeria
Burkina Faso	Kenya	Rwanda
Burundi	Lesotho	Senegal
Cameroon	Liberia	Sierra Leone
Central African Republic	Madagascar	South Africa
Chad	Malawi	Swaziland
Congo, Rep.	Mali	Tanzania
Cote d'Ivoire	Mauritania	Togo
Egypt, Arab Rep.	Mauritius	Tunisia
Ethiopia	Morocco	Uganda
		Zambia
Asia (n=19)		
Bangladesh	Korea, Rep.	Saudi Arabia
China	Kuwait	Sri Lanka
Dubai (UAE)	Lebanon	Syrian Arab Republic

Table 5.3 continued

Asia (n=19) continued		
India	Mongolia	Turkey
Iran, Islamic Rep.	Oman	Yemen, Rep.
Israel	Pakistan	
Jordan	Qatar	
Former Commonwealth of Independent States (n=10)		
Armenia	Kazakhstan	Tajikistan
Azerbaijan	Kyrgyz Republic	Uzbekistan
Belarus	Moldova	
Georgia	Russian Federation	
Non-OECD Europe (n=20)		
Albania	Iceland	Romania
Bulgaria	Latvia	Serbia
Croatia	Lithuania	Slovak Republic
Czech Republic	Luxembourg	Slovenia
Estonia	Macedonia, FYR	Spain
Greece	Poland	Ukraine
Hungary	Portugal	
Latin America (n=21)		
Argentina	Dominican Republic	Nicaragua
Bolivia	Ecuador	Panama
Brazil	El Salvador	Paraguay
Chile	Guatemala	Peru
Colombia	Honduras	Trinidad and Tobago
Costa Rica	Jamaica	Uruguay
Cuba	Mexico	Venezuela, RB
OECD nations (n=18)		
Australia	France	New Zealand
Austria	Germany	Norway
Belgium	Ireland	Sweden
Canada	Italy	Switzerland
Denmark	Japan	United Kingdom
Finland	Netherlands	United States

Table 5.3 continued

South-East Asia (n=9)		
Cambodia	Malaysia	Thailand
Indonesia	Philippines	Timor-Leste
Lao PDR	Singapore	Vietnam

The regional comparison within this model specification (see Figure 5.6 and Figure 5.7) reveals that the OECD countries are the most efficient, with an average efficiency of 93.94%, followed by the European non-OECD countries (average efficiency 93.19%).

Figure 5.6. Regional efficiency scores and average sample efficiency in model specification B

The direct meaning of the uncovered efficiency in this model is that per dollar of taxes collected, percent of GDP spent on education, and percent of GDP spent on health, the OECD nations are able to achieve greater output in health measures, education measures, and poverty prevention measures than are other regional groupings of nations. Africa reveals the lowest

average efficiency (52.14%) and South-East Asia and Latin America do only slightly better (67.17% and 73.03% respectively). All three of the poorly performing regions fall below the unweighted average for all nations in the sample – 74.89% welfare state efficiency.

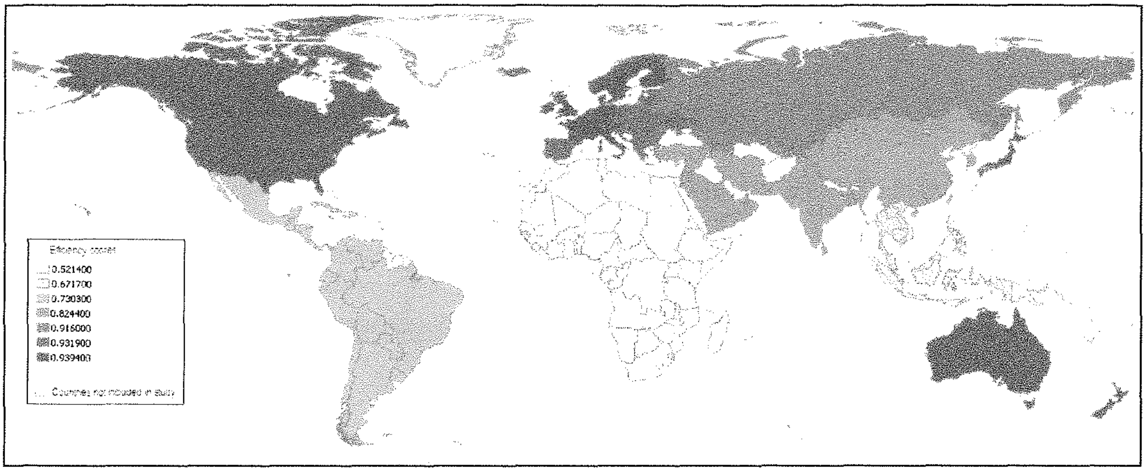


Figure 5.7. DEA results – regional efficiencies in model specification B

5.3.3 Welfare state efficiencies by type of welfare state regime – specification B

Ever since the publication of Gosta Esping-Andersen's seminal work on welfare state regime types, there has been a significant amount of discussion regarding the types of welfare state arrangements in the OECD countries. (Esping-Andersen 1990) One goal for the present study was to apply DEA methodology to welfare state input and output variable data in order to compare the efficiencies of the various welfare state types. Although multiple typologies of welfare states exist, this study splits the welfare state arrangements in the three classic varieties of Liberal, Conservative, and Social-Democratic Welfare states. See Table 5.4 for country-identification along the welfare state regime types.

Conservative welfare state regimes are 'corporatist' in nature. The state provides income maintenance benefits based on occupational status, an arrangement that leads to moderate decommodification from the labor market. Private insurance and private fringe benefits are quite limited in corporatist welfare states, so the state provides a significant amount of benefits. However, the redistributive element is largely missing, since the benefits are closely associated with work status. Liberal welfare state regimes offer means-tested assistance and very basic universal transfers or social insurance plans. Entitlement rules are relatively strict, and states utilize market solutions for some traditional welfare state roles, and subsequentally levels of decommodification from labor market are markedly low. Social-Democratic welfare state regimes purposefully crowd out the market from welfare state roles, and offer largely universal, non-means tested benefits and high degrees of decommodification from the labor market. (Arts and Gelissen 2002)

Table 5.4. Welfare state regime types

Conservative	**Liberal**	**Social-Democratic**
Japan	Australia	Norway
Finland	Canada	Sweden
Germany	Ireland	Netherlands
Switzerland	New Zealand	Austria
Italy	United Kingdom	Belgium
France	United States	Denmark

Are there efficiency differences between the three types of welfare state regimes? Three-input/six-output specification indicates that there are indeed efficiency variations between the regime types. Liberal and conservative welfare state types reach the highest efficiency, while social-democratic types are unable to convert inputs into outputs with matching efficiency.

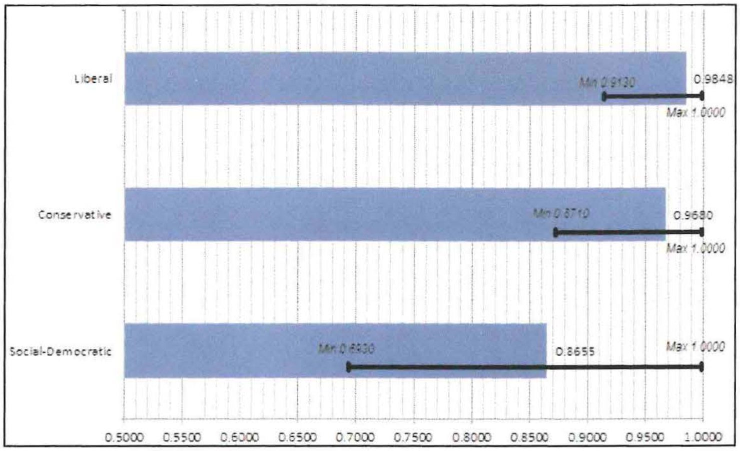


Figure 5.8. DEA results – welfare state type efficiencies in model specification B

While each type has representative countries with independently perfect efficiency, on average the social-democratic welfare states exhibit lower efficiency and greater variability of efficiency.

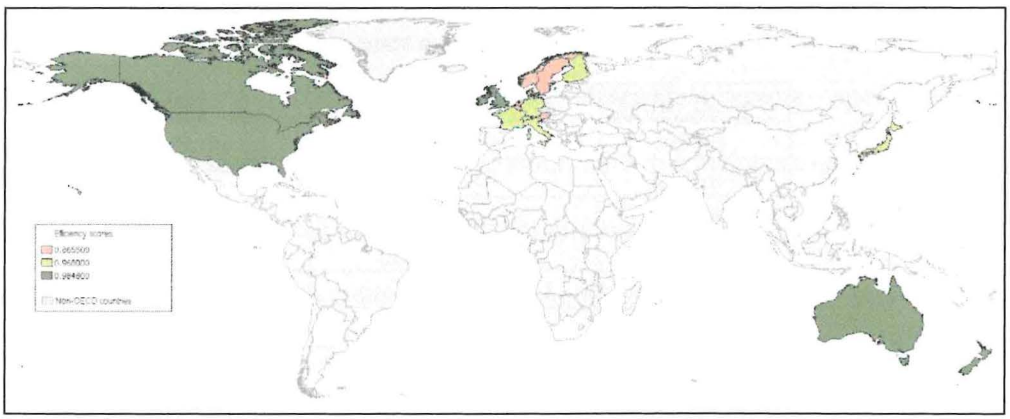


Figure 5.9. Welfare state type efficiency map for OECD nations – specification B

With high tax burdens in social-democratic regimes, there is little room for slack in output variables before a state is deemed inefficient using the DEA methodology. Thus, even though

Denmark and Belgium, for example, outperform the average nations in all welfare state output variables, they still do worse than Norway. As a result, while Norway is deemed to be efficient, Denmark and Belgium show significant efficiency slacks (0.3070 and 0.2740, respectively) in relation to Norway. Other research has also found the higher spending states to be less efficient (Gupta and Verhoeven 2001).

5.4 Specification C: results in three-inputs/three-outputs, VRS model

In order to test the resiliency of the results, the model is now narrowed to three outputs that proxy the educational, health, and poverty-prevention dimensions of welfare state performance. The three variables used are ***total net enrollment***, ***stunting in five-and-under children***, and ***life expectancy at birth***. While this model is less diverse than the three-input, six-output model, it nevertheless has the ability to capture more welfare state efficiency differences. By reducing the number of outputs fewer countries become independently perfectly efficient (see Figure 5.10) and more efficiency comparisons become possible.

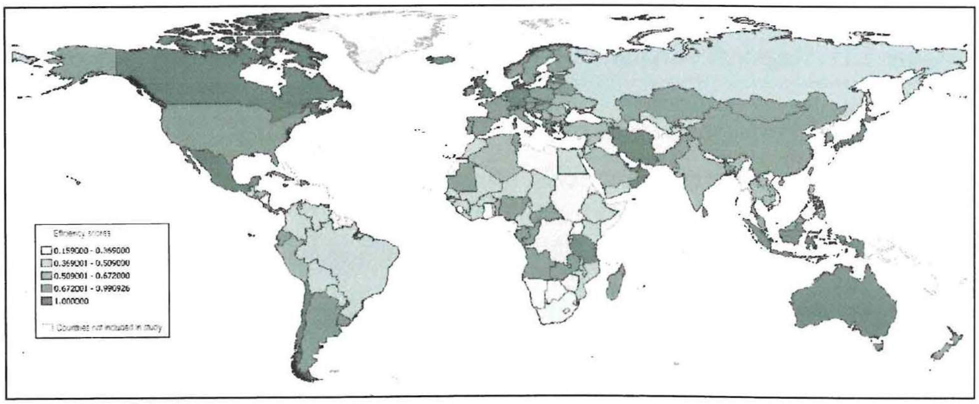


Figure 5.10. DEA results – model specification C (three-input/three-output, VRS)

5.4.1 Regional variations in welfare state efficiencies – specification C

The first thing to note in the narrowed model is the resiliency of regional variability of the efficiency results. The OECD nations and European nations still lead the regional efficiency with Africa, CIS, South-East Asia, and Latin America trailing in efficiency. (It is true that the former CIS nations now rank lower than before in efficiency, but the other regions have kept the efficiency ranking order the same as in the previous model.)

Figure 5.11. Regional efficiency scores and average sample efficiency in model specification C

Perhaps there are region-specific reasons why welfare state efficiency, as measured by the three-output/three-input model is significantly higher in OECD nations than it is in Africa and Latin America. One reason for the apparent inefficiencies in the African and Latin American nation welfare state is the fact that health and education spending reaches only residents in the higher income brackets. With health and education available to the higher income earners it is

possible that the spending succeeds in improving health and educational goals for that sub-population while not impacting the outcomes for the larger, poorer population. Gupta and Verhoeven provide some evidence, "... budgetary allocations for curative care in Bolivia are excessive and there is a high concentration of health facilities in higher-income regions. ... The bottom 20% of the population [of Ghana] received 16% of the benefits of education spending in 1992. Only 11% of health spending went to the poorest 20%, and urban Ghana received 49% of the health budget, despite the fact that only 33% of the population lived in urban areas. Primary education in Togo received 41% of the 1995 education budget, even though primary school enrollment accounted for 83% of the school population." (Gupta and Verhoeven 2001)

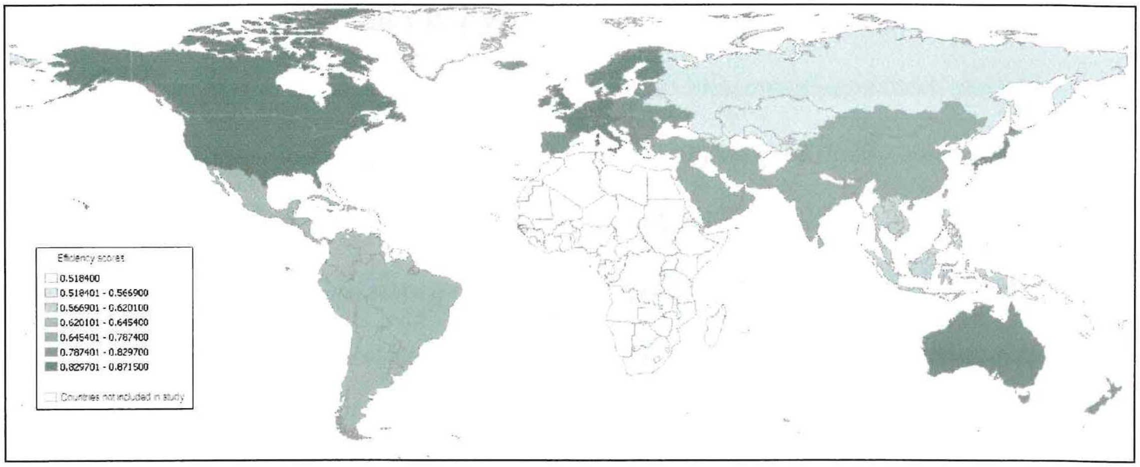


Figure 5.12. DEA results – regional efficiencies in model specification C

5.4.2 Welfare state efficiencies by type of welfare state regime – specification C

Much as in Specification B, there are clear efficiency differences between the welfare regime types, with Conservative and Liberal types outperforming Social-Democratic types.

Figure 5.13. Welfare state type efficiency map for OECD nations – specification B

Even though Norway and Netherlands (Social-Democratic welfare states) do very well with efficiencies of 0.9530 and 0.9350 respectively, the other Social-democratic welfare states – Sweden, Austria, Belgium, and Denmark do not exhibit an ability to convert health spending, education spending, and tax revenue (spent on poverty relief and pensions, among other outlays) into welfare state outcomes with the same efficiency than their Conservative and Liberal welfare state counterparts. Some, but not all, of this inefficiency for Social-Democratic welfare states is attributable to the higher tax burdens.

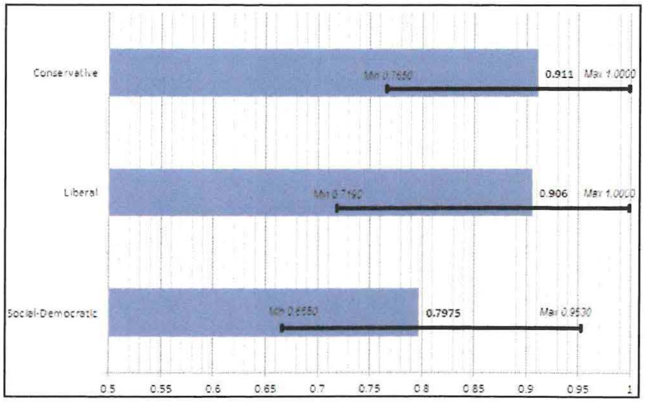


Figure 5.14. DEA results – welfare state type efficiencies in model specification B

5.5 Specification D: DEA results using an HDI-type performance index

When an excessive number of independently efficient DMUs prevents efficiency comparisons, then a common solution is to combine the outputs into an index variable. Instead of evaluating the welfare state performance in multiple output dimensions, this approach combines the normalized values of the given number of output variables into one indicator measure, similar to the way that the UN Human Development Index (HDI) assigns an index value for a nation's 'human development' based on multiple selected indicators. By reducing the number of output dimensions fewer nations would be reported as independently perfectly efficient, allowing for a more in-depth comparison of the welfare state efficiencies in the sample.

Under this approach, the variables are first normalized and then the normalized variables are averaged to arrive at a ranking for the nations' output indicators. (United Nations Development Program 1990) To normalize a variable, I follow the HDI methodology in calculating a ratio where the numerator is the difference between the country's output variable and the minimum variable in the range, while the denominator is the range (for the variable) between the largest and smallest observed variables.

$$x_{ni}^{*} = \frac{x_{ni} - \min_{k}\{x_{nk}\}}{\max_{k}\{x_{nk}\} - \min_{k}\{x_{nk}\}}$$

The resultant value is a value that is by definition between zero and one (inclusive), with the highest (lowest) normalized values reserved for the performance leaders (laggards) in a particular variable. After the values have been normalized, an arithmetic average is found for the normalized variables for a particular nation, with the outcome, some Welfare State Output Index (WSOI) falling between zero and one.

$$WSOI_i = \frac{1}{6}\sum_{n=1}^{6} x^*_{ni}$$

With a WSOI calculated for each nation, it is this index (not the six different outputs) that is used as the proxy for welfare state output. See Appendix 3 for a listing of nations in the sample along with their normalized variables and WSOI values used in this model specification.

Data Envelopment Analysis is used to calculate the relative efficiencies of the 137 nations in the sample in transforming the three inputs (education spending, health spending, tax burden) into the index output. A model respecified along these lines yields results that can be analyzed separately or in tandem with previous specifications to test for durability.

5.5.1 Individual nation welfare state efficiencies – specification D

As expected, the number of independently perfectly efficient nations drops drastically in this specification. Only 7 out of 137 nations (5.1%) report perfect efficiency, since WSOI reduces the number of dimensions in which nations can 'earn' perfect independent efficiency.

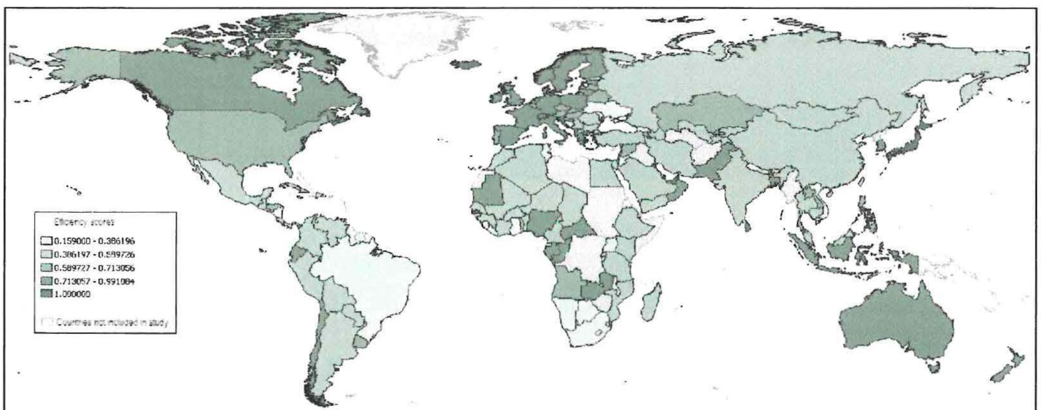


Figure 5.15. DEA results – model specification D (HDI-type performance index)

Among the OECD nations, this specification reveals Japan, Australia, Switzerland, United Kingdom, and Norway to have the most efficient welfare states with efficiencies of 1.000, 0.9700, 0.9630, 0.0.9410, and 0.9400 respectively.

5.5.2 Regional variations in welfare state efficiencies – specification D

Regional efficiency differences are quite durable through the multiple specifications in this research, with OECD, European nations, and Asian nations ranking higher than average and Africa, former Commonwealth of Independent States, Latin America, and South-East Asia ranking lower than the average. Europe and Asia do switch places in efficiency rankings, but the regional averages are nearly identical at 0.6877 and 0.6818. Asia does very well in this specification largely because of the way countries are grouped, with the Arabian peninsula countries included in Asia. Quatar, Kuwait, UAE all have relatively low tax burdens and relatively good provision of welfare state related services, resulting in very high efficiency indicators.

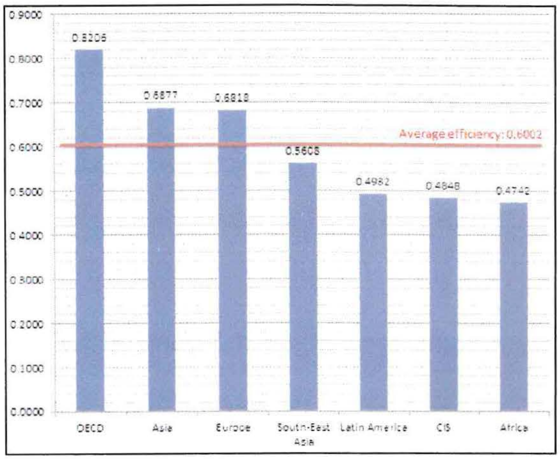


Figure 5.16. Regional efficiency scores and average sample efficiency in model specification C

5.5.3 Welfare state efficiencies by type of welfare state regime - specification D

The types of welfare states exhibit similar efficiencies as in the previous model specifications, providing support for the general resiliency of type specific efficiencies. In Specification D, the Liberal welfare state regimes are the most efficient. The liberal regimes, with efficiencies ranging from 0.6790 in the United States to 0.9700 in Australia, are typified by lower tax burdens than Social-Democratic and Conservative Regimes, but they still manage to generate, on average, better welfare state outcomes than the other welfare state types.

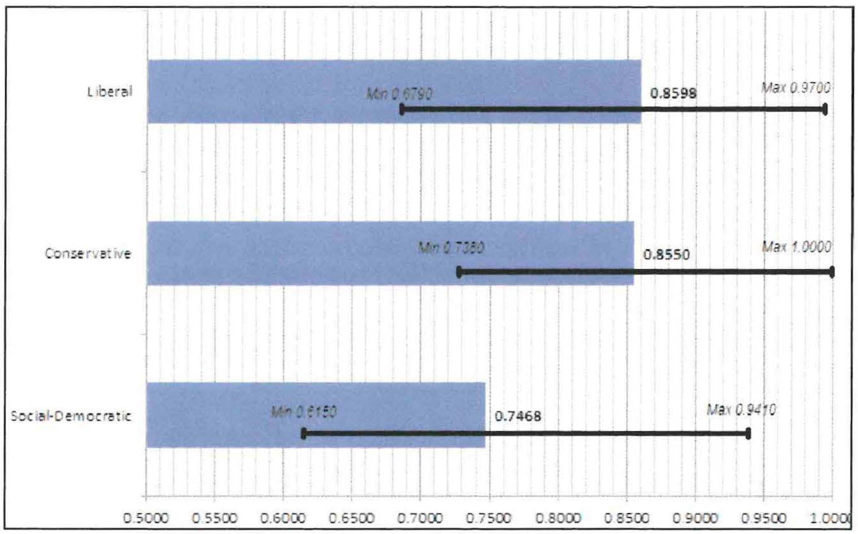


Figure 5.17. DEA results – welfare state type efficiencies in model specification B

Higher taxing and higher spending Social-Democratic states do not reach the outcomes that can be deemed efficient in comparison the observed universe of welfare state input/output combinations. Such lack of efficiency is not entirely surprising given the metrics involved; since the Social-Democratic welfare states are characterized by a largely universal provision of

benefits and by workers' decommodification from labor market then benefits and services are available to recipients regardless of their need or contribution. Such an arrangement may score well on fairness or equity metrics, but its efficiency measures are relatively low. Conservative (corporatist) welfare states with their reliance on social insurance schemes just slightly trail the liberal arrangements which rely heavier on means-testing and selective provision of services.

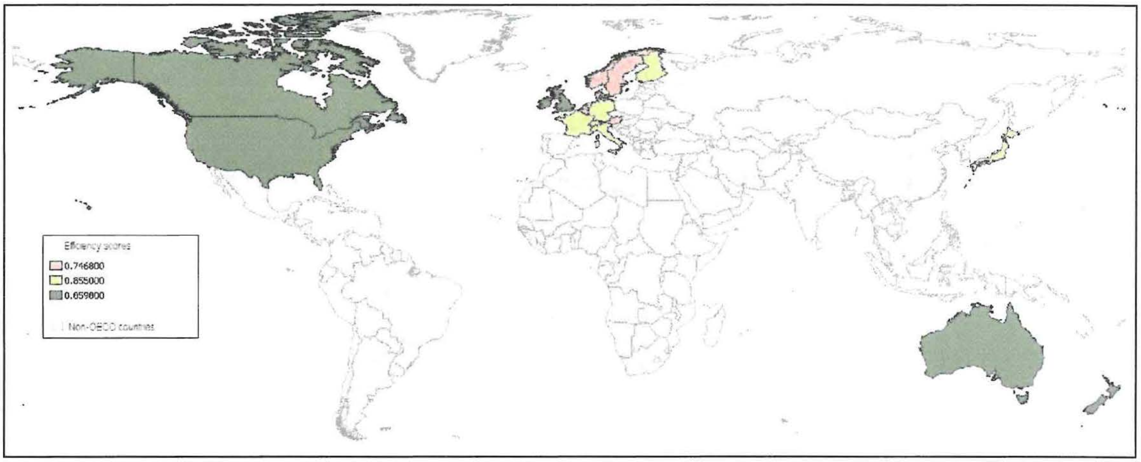


Figure 5.18. Welfare state type efficiency map for OECD nations – specification D

5.6 Consistency of results across model specifications

Welfare state efficiency is somewhat sensitive to the model specification, yet the reassuring finding is that the regional efficiencies and typological efficiencies hold relatively well across specifications.

Out of the three welfare state types, Liberal and Conservative Welfare state types exhibit the highest efficiency in converting scarce inputs into desirable outputs, while Social-Democratic welfare state consistently lags in efficiency in all model specifications. With universalistic insurance coverage and homogenous benefit levels the Social-Democratic welfare state types

tend to rely less on means testing (almost by definition) and less on private market provision of services. As a result, government provided services are a norm that is available by virtue of citizenship and not necessarily contribution.

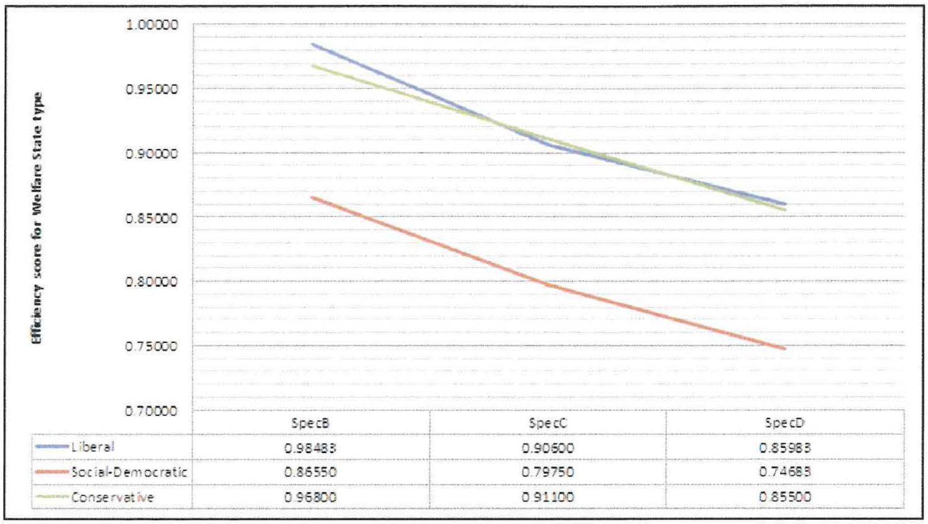
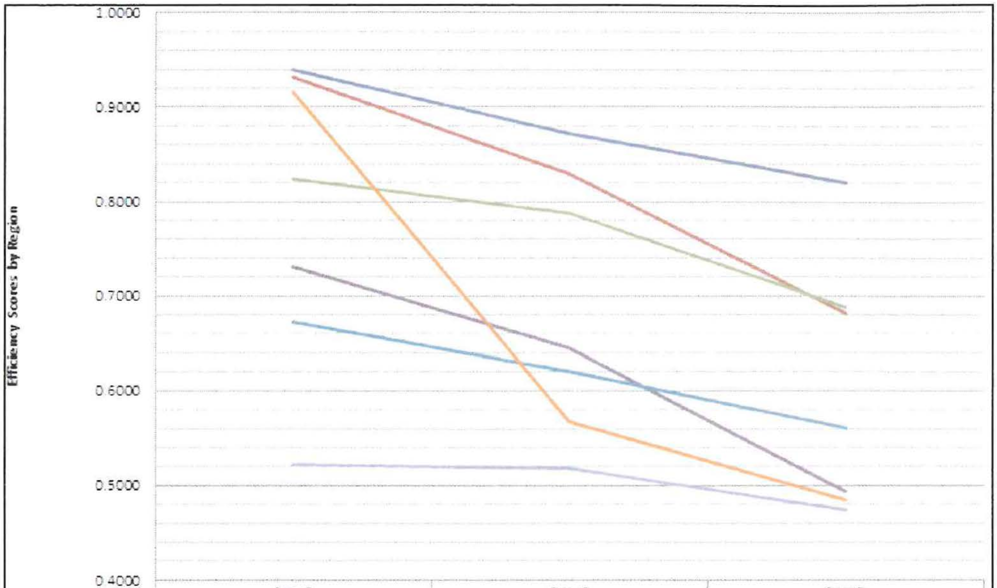


Figure 5.19. Consistency of results across model specifications

A partial explanation for the lower efficiency of the welfare state in Social-Democratic welfare states has to do with the theorized lower efficiency of government provision of services when compared to efficiency of private provision of services.

The regional welfare state efficiencies similarly exhibit a good measure of consistency across model specifications (see Figure 5.20), with the OECD nations consistently leading efficiency regional efficiency scores and African nations lagging in the rankings. The former Commonwealth of Independent States nations display the greatest sensitivity to the model specification, ranking third of seven regions in Specification B and second to last in efficiency in Specification D, but this is largely explained by the inclusion of literacy rates as one of the

educational outputs of the welfare state in Specification B (CIS nations consistently score well in literacy, which is one of selected education outputs of the welfare state in Specification B).



	SpecB	SpecC	SpecD
OECD	0.9394	0.8715	0.8206
Europe	0.9319	0.8297	0.6818
Asia	0.8244	0.7874	0.6877
Latin America	0.7303	0.6454	0.4932
South-East Asia	0.6717	0.6201	0.5608
CIS	0.9160	0.5669	0.4848
Africa	0.5214	0.5184	0.4742

Figure 5.20. Consistency of results across regions

From the regional perspective, African welfare states' inability to show efficiency presents the biggest problem. Even though on average the African nations spend less on education and health than do nations in other parts of the world and (in many cases) their tax rates are relatively low, they are still unable to generate the types of welfare state outputs that would correspond to their relative levels of inputs in an efficient way.

CHAPTER 6

CONCLUSIONS

Efficiency of the welfare state is an elusive concept that is nevertheless increasingly important in the age of the "encroaching Leviathon"[15]. This study makes the case that efficiency of the welfare case can and should be studied, since by uncovering and addressing the inefficiencies the state can be better able to meet its responsibilities toward its residents in a time of fiscal difficulty. The welfare state efficiency investigated here using Data Envelopment Analysis finds efficiency differences between countries, regions, and welfare state types. The study finds that the OECD nations are more efficient than other nations in converting welfare state inputs into outputs, especially when compared with African, Latin American, and South-East Asian nations. Non-OECD European and Asian nations rank above average in welfare state efficiency while former CIS nations are somewhat too sensitive to model specifications to allow a consistent efficiency ranking among other regions.

Not all OECD nations have equally efficient welfare states. Differences in OECD welfare state types have been studied extensively in the three decades since Gosta Esping-Andersen's work in welfare state typology, but not with particular attention to *efficiency* of each type. This

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[15] The term "Leviathan" is borrowed from the usage in the March 17, 2011 edition of the Economist magazine, where an article "Taming Leviathan" made the case that state could and should be made more efficient. "This ... central argument is that Leviathan can be made far more efficient. The state has woefully lagged behind the private sector. Catching up is not just a case of nuts-and-bolts productivity improvements but of liberal principle: too often an institution that, at least in a democracy, was supposed to be the people's servant has become their master." (The Economist 2011)

study adds to the typology discussion by finding that Liberal and Conservative Welfare states outperform the Social-Democratic welfare states in input conversion into outputs. While the task of identifying the sources of (in)efficiency within the particular welfare state types is left for subsequent study, some direction for that work is proposed.

What can be done about efficiency differences in welfare states around the world? Some efficiency gains can be made by making programmatic adjustments and studying the example of the efficiency leaders. For example, while Latin America as a region displays low welfare state efficiency, Chile does quite well across a number of model specifications, so researchers should look into the particular design features of Chile's welfare state policies and institutions to uncover the successful elements. To the extent that such elements can be identified and replicated, efficiency gains can lead to real budgetary savings or outcome improvements in education, health, poverty prevention or income replacement.

Similarly, typological efficiency should be better understood. What are the replicable features of the Liberal or Conservative welfare states in the OECD countries that should be adopted by the efficiency-seeking developing nations? What are the features of the Social-Democratic welfare states that should be avoided?

Of course, not all welfare state output is determined by the endogenous welfare state inputs; there are many exogenous variables that cannot be controlled (at least in the short run) which still effect welfare state outcomes. Weather, diet, exposure to climate events, or cultural attitudes to learning are all variables that affect health outcomes, educational outcomes, and poverty outcomes, while being outside the direct reach of policymakers' influence (at least in the short run).

This study has confirmed that efficiency can be studied and that substantial efficiency differences exist today, but this study has also revealed that the lack of comparable international data prevents a more in-depth analysis at the present time. Data on poverty and income replacement are especially difficult to compare among nations, and creation or systematization of this kind of data would be of invaluable help to welfare state researchers in the future. Without better data, the current findings are somewhat too sensitive to variable inclusion in the model.

Welfare state efficiency will continue to be a topic that demands attention as national budgets shrink and needs grow. Demographic realities will combine with consequences of past profligacy to force policy-makers to do more with less. "The Leviathan" that is the modern welfare state will be tamed eventually through the inevitability of fiscal and economic forces, and to the extent that it will be tamed through efficiency gains instead of indiscriminate cuts, the populations will benefit.

APPENDIX 1

LISTING OF CALCULATED EFFICIENCY SCORES FOR EACH MODEL SPECIFICATION

"SpecA": Specification A. Three-input/Six-output model, constant returns to scale (CRS)

"SpecB": Specification B. Three-input/Six-output model, ***variable*** returns to scale (VRS)

"SpecC": Specification C. Three-input/***three-output*** model, variable returns to scale (VRS)

"SpecD": Specification D. Three-input/***one-index-output*** model, variable returns to scale (VRS)

	SpecA	**SpecB**	**SpecC**	**SpecD**
Albania	0.8140	1.0000	0.8600	0.7480
Algeria	0.4570	0.5680	0.5680	0.4410
Angola	0.5310	0.7100	0.7100	0.7100
Argentina	0.3340	0.9440	0.8530	0.5180
Armenia	0.6910	1.0000	0.6550	0.6280
Australia	0.3510	1.0000	1.0000	0.9700
Austria	0.2810	0.7970	0.7580	0.6980
Azerbaijan	0.6270	1.0000	0.6240	0.5680
Bangladesh	0.6780	0.7220	0.7220	0.7220
Belarus	0.4770	1.0000	0.8970	0.6000
Belgium	0.2580	0.7260	0.6650	0.6530
Benin	0.5380	0.5700	0.5700	0.5700
Bolivia	0.4640	0.4840	0.4840	0.4840
Botswana	0.2770	0.2910	0.2910	0.2910
Brazil	0.3070	0.3920	0.3790	0.2910
Bulgaria	0.3830	0.8820	0.5910	0.5250
Burkina Faso	0.3220	0.4000	0.4000	0.4000
Burundi	0.1900	0.4100	0.4100	0.1880
Cambodia	0.4970	0.5370	0.5370	0.5370
Cameroon	0.4080	0.4540	0.4540	0.4540
Canada	0.3030	1.0000	1.0000	0.8790
Central African Republic	0.7090	0.8510	0.8510	0.8510
Chad	0.3110	0.3910	0.3910	0.3910

Chile	0.3930	1.0000	1.0000	0.8040
China	0.6230	0.8610	0.8610	0.5810
Colombia	0.4170	0.5180	0.4320	0.4010
Congo, Rep.	0.8360	0.8810	0.8810	0.8810
Costa Rica	0.2850	1.0000	0.9180	0.5280
Cote d'Ivoire	0.3830	0.4340	0.4340	0.4340
Croatia	0.3700	1.0000	0.8710	0.6430
Cuba	0.2070	1.0000	0.5960	0.4650
Czech Republic	0.4030	1.0000	0.8400	0.7040
Denmark	0.2740	0.6930	0.6650	0.6150
Dominican Republic	0.5560	0.9380	0.9380	0.5010
Ecuador	0.7900	0.9520	0.8320	0.7640
Egypt, Arab Rep.	0.4870	0.4920	0.4920	0.4920
El Salvador	0.4020	0.4080	0.4080	0.4080
Estonia	0.4450	1.0000	1.0000	0.7580
Ethiopia	0.4470	0.5040	0.5040	0.5040
Finland	0.3180	1.0000	0.7650	0.7980
France	0.2640	0.8710	0.8110	0.7380
Gabon	0.8910	0.9320	0.9320	0.9320
Gambia, The	0.5350	0.5610	0.5610	0.5610
Georgia	0.3920	1.0000	0.5020	0.3580
Germany	0.3070	1.0000	1.0000	0.7860
Ghana	0.2840	0.3100	0.3100	0.3100
Greece	0.3220	0.8710	0.8270	0.7310
Guatemala	0.3800	0.3880	0.3880	0.3880
Guinea	0.4140	0.4890	0.4890	0.4890
Honduras	0.6070	0.6170	0.6170	0.6170
Hungary	0.3770	0.8710	0.7310	0.6540
Iceland	0.2920	1.0000	1.0000	1.0000
India	0.5350	0.5720	0.5720	0.5720
Indonesia	0.9730	1.0000	1.0000	0.9650
Iran, Islamic Rep.	0.4310	1.0000	1.0000	0.4240
Ireland	0.3310	0.9960	0.8330	0.8410
Israel	0.3410	0.8440	0.7520	0.7110
Italy	0.3310	0.9370	0.8900	0.8450
Jamaica	0.5010	0.6580	0.6580	0.4610
Japan	0.3760	1.0000	1.0000	1.0000
Jordan	0.2870	0.4920	0.4800	0.2640
Kazakhstan	0.6900	1.0000	0.8490	0.6200

Kenya	0.4300	0.4820	0.4820	0.4820
Korea, Rep.	0.4110	1.0000	0.7230	0.7500
Kuwait	1.0000	1.0000	1.0000	1.0000
Kyrgyz Republic	0.4340	0.7190	0.3970	0.3970
Lao PDR	0.5770	0.6180	0.6180	0.6180
Latvia	0.4190	1.0000	1.0000	0.7110
Lebanon	0.6260	1.0000	0.8250	0.5830
Lesotho	0.2390	0.2680	0.2680	0.2680
Liberia	0.2940	0.3800	0.3800	0.3800
Lithuania	0.4220	1.0000	0.9750	0.7180
Luxembourg	0.3960	1.0000	1.0000	1.0000
Macedonia, FYR	0.4750	1.0000	0.7160	0.4630
Madagascar	0.5540	0.8630	0.8630	0.5490
Malawi	0.3460	0.3730	0.3730	0.3730
Malaysia	0.5690	0.8050	0.7220	0.5340
Mali	0.3330	0.4210	0.4210	0.4210
Mauritania	0.6930	0.7820	0.7820	0.7820
Mauritius	0.4790	0.6770	0.6110	0.4470
Mexico	0.4130	1.0000	1.0000	0.4010
Moldova	0.2400	0.6170	0.2670	0.2180
Mongolia	0.5950	1.0000	0.9280	0.5570
Morocco	0.4140	0.4250	0.4250	0.4250
Mozambique	0.4380	0.4830	0.4830	0.4830
Namibia	0.3190	0.3360	0.3360	0.3360
Netherlands	0.2990	0.9770	0.9350	0.8320
New Zealand	0.2890	0.9130	0.8840	0.8500
Nicaragua	0.3490	0.3580	0.3580	0.3580
Niger	0.3060	0.4060	0.4060	0.4060
Nigeria	0.6130	0.7510	0.7510	0.7510
Norway'	0.3160	1.0000	0.9530	0.9410
Oman	1.0000	1.0000	1.0000	0.9460
Pakistan	0.7870	0.8630	0.8630	0.8630
Panama	0.3560	0.7420	0.4980	0.3450
Paraguay	0.4260	0.7550	0.4260	0.4060
Peru	0.5430	0.5490	0.5490	0.5490
Philippines	0.6700	0.7660	0.6480	0.6480
Poland	0.3950	0.9730	0.8450	0.7830
Portugal	0.3030	0.8270	0.8090	0.5990
Qatar	1.0000	1.0000	1.0000	1.0000

Romania	0.4710	0.7520	0.5400	0.4350
Russian Federation	0.5390	0.9710	0.5090	0.4900
Rwanda	0.2790	0.2860	0.2860	0.2860
Saudi Arabia	0.5710	0.5770	0.5770	0.5770
Senegal	0.3820	0.3990	0.3990	0.3990
Serbia	0.2880	0.6800	0.6400	0.4600
Sierra Leone	0.2020	0.2740	0.2740	0.2740
Singapore	0.7850	1.0000	1.0000	0.6950
Slovak Republic	0.3920	1.0000	1.0000	0.6700
Slovenia	0.3370	1.0000	0.7440	0.7660
South Africa	0.2770	0.2950	0.2950	0.2950
Spain	0.3230	0.9950	0.9470	0.9200
Sri Lanka	1.0000	1.0000	1.0000	1.0000
Swaziland	0.3240	0.3690	0.3690	0.3690
Sweden	0.2960	1.0000	0.8090	0.7420
Switzerland	0.2750	1.0000	1.0000	0.9630
Syrian Arab Republic	0.6720	0.6730	0.6720	0.6720
Tajikistan	0.5410	1.0000	0.4860	0.4860
Tanzania	0.4670	1.0000	1.0000	0.4610
Thailand	0.5820	0.8260	0.5670	0.5610
Timor-Leste	0.1520	0.1590	0.1590	0.1590
Togo	0.3650	0.4050	0.4050	0.4050
Trinidad and Tobago	0.5720	1.0000	1.0000	0.5100
Tunisia	0.3640	0.8170	0.7650	0.3600
Turkey	0.4390	0.6280	0.5540	0.4140
Uganda	0.3550	0.3600	0.3600	0.3600
Ukraine	0.3920	0.7860	0.6570	0.3470
United Arab Emirates	1.0000	1.0000	1.0000	1.0000
United Kingdom	0.3270	1.0000	1.0000	0.9400
United States	0.2420	1.0000	0.7190	0.6790
Uruguay	0.4210	1.0000	0.7340	0.7110
Uzbekistan	0.5320	0.8530	0.4830	0.4830
Venezuela, RB	0.4660	0.6340	0.4860	0.4480
Vietnam	0.3310	0.3340	0.3300	0.3300
Yemen, Rep.	0.3920	0.4310	0.4310	0.4310
Zambia	0.7370	0.7550	0.7550	0.7550

APPENDIX 2

EXAMPLE OF REDUCTION IN INDEPENDENTLY EFFICIENT DMUS RESULTING FROM ELIMINATION OF ONE OUTPUT VARIABLE

Albania	0.866	France	0.871
Algeria	0.568	Gabon	0.932
Angola	0.71	Gambia, The	0.561
Argentina	0.853	Georgia	0.633
Armenia	0.655	Germany	1
Australia	1	Ghana	0.31
Austria	0.797	Greece	0.871
Azerbaijan	0.624	Guatemala	0.388
Bangladesh	0.722	Guinea	0.489
Belarus	0.991	Honduras	0.617
Belgium	0.726	Hungary	0.83
Benin	0.57	Iceland	1
Bolivia	0.484	India	0.572
Botswana	0.291	Indonesia	1
Brazil	0.392	Iran, Islamic Rep.	1
Bulgaria	0.671	Ireland	0.97
Burkina Faso	0.4	Israel	0.79
Burundi	0.41	Italy	0.937
Cambodia	0.537	Jamaica	0.658
Cameroon	0.454	Japan	1
Canada	1	Jordan	0.48
Central African Republic	0.851	Kazakhstan	0.924
Chad	0.391	Kenya	0.482
Chile	1	Korea, Rep.	1
China	0.861	Kuwait	1
Colombia	0.432	Kyrgyz Republic	0.397
Congo, Rep.	0.881	Lao PDR	0.618
Costa Rica	0.918	Latvia	1
Cote d'Ivoire	0.434	Lebanon	1
Croatia	0.992	Lesotho	0.268
Cuba	0.625	Liberia	0.38
Czech Republic	0.917	Lithuania	0.976

Denmark	0.685	Luxembourg	1
Dominican Republic	0.938	Macedonia, FYR	0.87
Ecuador	0.832	Madagascar	0.863
Egypt, Arab Rep.	0.492	Malawi	0.373
El Salvador	0.408	Malaysia	0.805
Estonia	1	Mali	0.421
Ethiopia	0.504	Mauritania	0.782
Finland	0.837		
Mauritius	0.677	Slovak Republic	1
Mexico	1	Slovenia	0.869
Moldova	0.267	South Africa	0.295
Mongolia	0.928	Spain	0.995
Morocco	0.425	Sri Lanka	1
Mozambique	0.483	Swaziland	0.369
Namibia	0.336	Sweden	1
Netherlands	0.977	Switzerland	1
New Zealand	0.896	Syrian Arab Republic	0.673
Nicaragua	0.358	Tajikistan	0.486
Niger	0.406	Tanzania	1
Nigeria	0.751	Thailand	0.648
Norway	1	Timor-Leste	0.159
Oman	1	Togo	0.405
Pakistan	0.863	Trinidad and Tobago	1
Panama	0.498	Tunisia	0.817
Paraguay	0.426	Turkey	0.628
Peru	0.549	Uganda	0.36
Philippines	0.648	Ukraine	0.666
Poland	0.909	United Arab Emirates	1
Portugal	0.827	United Kingdom	1
Qatar	1	United States	0.876
Romania	0.54	Uruguay	0.829
Russian Federation	0.509	Uzbekistan	0.483
Rwanda	0.286	Venezuela, RB	0.486
Saudi Arabia	0.577	Vietnam	0.33
Senegal	0.399	Yemen, Rep.	0.431
Serbia	0.68	Zambia	0.755
Sierra Leone	0.274		
Singapore	1		

APPENDIX 3

WELFARE STATE OUTPUT INDICATOR FOR MODEL SPECIFICATION D

	WSOI[16]
Iceland	**0.99**
Australia	**0.98**
Canada	**0.98**
Switzerland	**0.98**
Norway	**0.98**
France	**0.98**
Germany	**0.98**
Japan	**0.98**
Netherlands	**0.98**
New Zealand	**0.98**
United Kingdom	**0.98**
Spain	**0.98**

[16] Welfare state Output indicator is calculated in a manner similar to the United Nations' Human Development Indicator HDI. Based on values in Appendix 1 "Countries and Variables Included in the Study", the welfare state output variables are normalized across variables and averaged across country, so that the i-th output variable x* for country n is normalized as

$$x^*_{ni} = \frac{x_{ni} - \min_k \{x_{nk}\}}{\max_k \{x_{nk}\} - \min_k \{x_{nk}\}}$$

and averaged into a Welfare State Output Indicator WSOI for country I as

$$WSOI_i = \frac{1}{6} \sum_{n=1}^{6} x^*_{ni}$$

.

Luxembourg	**0.97**
Sweden	**0.97**
Austria	**0.97**
Italy	**0.97**
Finland	**0.97**
Belgium	**0.97**
Ireland	**0.97**
Slovenia	**0.96**
Denmark	**0.96**
Greece	**0.96**
United States	**0.95**
Israel	**0.95**
Portugal	**0.95**
Poland	**0.95**
Cuba	**0.95**
Chile	**0.94**
Korea, Rep.	**0.94**
Latvia	**0.94**
Croatia	**0.94**
Slovak Republic	**0.94**
Czech Republic	**0.94**
Lithuania	**0.94**
Hungary	**0.94**
Estonia	**0.94**
Argentina	**0.93**
Serbia	**0.93**
Uruguay	**0.93**
Costa Rica	**0.92**
Belarus	**0.92**
Bulgaria	**0.92**
Qatar	**0.91**
Malaysia	**0.90**
Macedonia, FYR	**0.90**
United Arab Emirates	**0.90**
Singapore	**0.90**
Georgia	**0.89**
Ukraine	**0.88**
Trinidad and Tobago	**0.88**
Mexico	**0.88**

Armenia	0.87
Jordan	0.87
Brazil	0.87
Mauritius	0.87
Thailand	0.87
Panama	0.86
Kuwait	0.86
Kazakhstan	0.86
Turkey	0.86
Sri Lanka	0.86
Colombia	0.86
China	0.86
Moldova	0.86
Albania	0.85
Lebanon	0.85
Russian Federation	0.85
Ecuador	0.85
Tunisia	0.84
Venezuela, RB	0.83
Iran, Islamic Rep.	0.83
Jamaica	0.82
Paraguay	0.82
Kyrgyz Republic	0.81
Vietnam	0.81
Oman	0.81
Dominican Republic	0.81
Syrian Arab Republic	0.81
Uzbekistan	0.81
Egypt, Arab Rep.	0.80
El Salvador	0.80
Romania	0.79
Saudi Arabia	0.79
Peru	0.78
Philippines	0.78
Algeria	0.78
Mongolia	0.77
Honduras	0.77
Nicaragua	0.77
Azerbaijan	0.75

Indonesia	**0.73**
Tajikistan	**0.72**
Bolivia	**0.72**
Morocco	**0.69**
Gabon	**0.69**
Namibia	**0.69**
Guatemala	**0.68**
South Africa	**0.67**
Botswana	**0.63**
India	**0.59**
Ghana	**0.56**
Cambodia	**0.55**
Bangladesh	**0.55**
Gambia, The	**0.54**
Pakistan	**0.53**
Uganda	**0.52**
Lao PDR	**0.52**
Congo, Rep.	**0.52**
Togo	**0.52**
Senegal	**0.52**
Cameroon	**0.52**
Kenya	**0.50**
Tanzania	**0.50**
Timor-Leste	**0.49**
Lesotho	**0.49**
Malawi	**0.49**
Swaziland	**0.46**
Benin	**0.46**
Madagascar	**0.44**
Rwanda	**0.44**
Mauritania	**0.43**
Burundi	**0.42**
Yemen, Rep.	**0.42**
Cote d'Ivoire	**0.40**
Zambia	**0.38**
Guinea	**0.38**
Nigeria	**0.34**
Central African Republic	**0.33**

Mozambique	**0.32**
Burkina Faso	**0.31**
Ethiopia	**0.30**
Mali	**0.28**
Liberia	**0.23**
Angola	**0.22**
Chad	**0.21**
Sierra Leone	**0.18**
Niger	**0.15**

APPENDIX 4

SPECIFICATION B VRS EFFICIENCY SCORES (N=137)

Country	Efficiency Score	Scale Efficiency
Dubai (UAE)	1	1
Kuwait	1	1
Oman	1	1
Qatar	1	1
Sri Lanka	1	1
Indonesia	1	0.973
Albania	1	0.814
Singapore	1	0.785
Armenia	1	0.691
Kazakhstan	1	0.69
Azerbaijan	1	0.627
Lebanon	1	0.626
Mongolia	1	0.595
Trinidad and Tobago	1	0.572
Tajikistan	1	0.541
Belarus	1	0.477
Macedonia, FYR	1	0.475
Tanzania	1	0.467
Estonia	1	0.445
Iran, Islamic Rep.	1	0.431
Lithuania	1	0.422
Uruguay	1	0.421
Latvia	1	0.419
Mexico	1	0.413
Korea, Rep.	1	0.411
Czech Republic	1	0.403
Luxembourg	1	0.396
Chile	1	0.393
Georgia	1	0.392
Slovak Republic	1	0.392

Japan	1	0.376
Croatia	1	0.37
Australia	1	0.351
Slovenia	1	0.337
United Kingdom	1	0.327
Finland	1	0.318
Norway	1	0.316
Germany	1	0.307
Canada	1	0.303
Sweden	1	0.296
Iceland	1	0.292
Costa Rica	1	0.285
Switzerland	1	0.275
United States	1	0.242
Cuba	1	0.207
Ireland	0.996	0.332
Spain	0.995	0.325
Netherlands	0.977	0.306
Poland	0.973	0.406
Russian Federation	0.971	0.555
Ecuador	0.952	0.829
Argentina	0.944	0.354
Dominican Republic	0.938	0.593
Italy	0.937	0.354
Gabon	0.932	0.956
New Zealand	0.913	0.317
Bulgaria	0.882	0.434
Congo, Rep.	0.881	0.948
Hungary	0.871	0.432
Greece	0.871	0.37
France	0.871	0.304
Pakistan	0.863	0.913
Madagascar	0.863	0.641
China (China-Shanghai)	0.861	0.723
Uzbekistan	0.853	0.624
Central African Repub.	0.851	0.833
Israel	0.844	0.404
Portugal	0.827	0.366
Thailand	0.826	0.705
Tunisia	0.817	0.446

Malaysia	0.805	0.708
Austria	0.797	0.352
Ukraine	0.786	0.499
Mauritania	0.782	0.886
Philippines	0.766	0.874
Zambia	0.755	0.976
Paraguay	0.755	0.564
Romania	0.752	0.627
Nigeria	0.751	0.816
Panama	0.742	0.48
Belgium	0.726	0.356
Bangladesh	0.722	0.94
Kyrgyz Republic	0.719	0.603
Angola	0.71	0.747
Denmark	0.693	0.395
Serbia	0.68	0.423
Mauritius	0.677	0.707
Syrian Arab Republic	0.673	0.999
Jamaica	0.658	0.761
Venezuela, RB	0.634	0.736
Turkey	0.628	0.7
Lao PDR	0.618	0.933
Honduras	0.617	0.984
Moldova	0.617	0.39
Saudi Arabia	0.577	0.989
India	0.572	0.934
Benin	0.57	0.944
Algeria	0.568	0.805
Gambia, The	0.561	0.954
Peru	0.549	0.989
Cambodia	0.537	0.927
Colombia	0.518	0.806
Ethiopia	0.504	0.887
Egypt, Arab Rep.	0.492	0.99
Jordan	0.492	0.584
Guinea	0.489	0.846
Bolivia	0.484	0.959
Mozambique	0.483	0.908
Kenya	0.482	0.891
Cameroon	0.454	0.898

Cote d'Ivoire	0.434	0.882
Yemen, Rep.	0.431	0.909
Morocco	0.425	0.976
Mali	0.421	0.791
Burundi	0.41	0.462
El Salvador	0.408	0.984
Niger	0.406	0.754
Togo	0.405	0.902
Burkina Faso	0.4	0.804
Senegal	0.399	0.957
Brazil	0.392	0.784
Chad	0.391	0.797
Guatemala	0.388	0.981
Liberia	0.38	0.774
Malawi	0.373	0.927
Swaziland	0.369	0.878
Uganda	0.36	0.986
Nicaragua	0.358	0.974
Namibia	0.336	0.949
Vietnam	0.334	0.993
Ghana	0.31	0.917
South Africa	0.295	0.939
Botswana	0.291	0.95
Rwanda	0.286	0.973
Sierra Leone	0.274	0.736
Lesotho	0.268	0.891
Timor-Leste	0.159	0.956

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