

Bindera, Martin; Broekel, Tom

**Working Paper**

## The neglected dimension of well-being: Analyzing the development of "conversion efficiency" in Great Britain

Jena Economic Research Papers, No. 2010,067

**Provided in Cooperation with:**  
Max Planck Institute of Economics

*Suggested Citation:* Bindera, Martin; Broekel, Tom (2010) : The neglected dimension of well-being: Analyzing the development of "conversion efficiency" in Great Britain, Jena Economic Research Papers, No. 2010,067, Friedrich Schiller University Jena and Max Planck Institute of Economics, Jena

This Version is available at:  
<http://hdl.handle.net/10419/56858>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



# JENA ECONOMIC RESEARCH PAPERS



# 2010 – 067

## **The Neglected Dimension of Well-Being: Analyzing the Development of “Conversion Efficiency” in Great Britain**

by

**Martin Binder  
Tom Broekel**

[www.jenecon.de](http://www.jenecon.de)

ISSN 1864-7057

The JENA ECONOMIC RESEARCH PAPERS is a joint publication of the Friedrich Schiller University and the Max Planck Institute of Economics, Jena, Germany. For editorial correspondence please contact [markus.pasche@uni-jena.de](mailto:markus.pasche@uni-jena.de).

Impressum:

Friedrich Schiller University Jena  
Carl-Zeiss-Str. 3  
D-07743 Jena  
[www.uni-jena.de](http://www.uni-jena.de)

Max Planck Institute of Economics  
Kahlaische Str. 10  
D-07745 Jena  
[www.econ.mpg.de](http://www.econ.mpg.de)

© by the author.

# The Neglected Dimension of Well-Being: Analyzing the Development of “Conversion Efficiency” in Great Britain<sup>☆</sup>

Martin Binder<sup>a</sup>, Tom Broekel<sup>b</sup>

<sup>a</sup>*Max Planck Institute of Economics, Evolutionary Economics Group, Kahlaische Str.10, 07745 Jena, Germany*

<sup>b</sup>*Department of Economic Geography, Faculty of Geosciences, Utrecht University, The Netherlands*

---

## Abstract

In Amartya Sen’s capability approach, policy makers can focus on different levels to influence the well-being of a society. We argue that improving capability to function as well as absolute levels of functioning achievement should be complemented by attention given to improving individuals’ “conversion efficiency”, i.e. the efficiency with which individual resources are converted into well-being. In order to examine effects of policies on conversion efficiency and to better understand the trajectories of human well-being over time, it is necessary to measure the development of conversion efficiency. We suggest an intertemporal index of conversion efficiency estimated via a nonparametric order- $m$  approach borrowed from the production efficiency literature to analyze this development of our welfare measure. We exemplify this approach using micro level data from the British Household Panel Survey (BHPS), tracking conversion efficiency for a set of basic functionings in Great Britain from 1991 to 2006. We find that under 30% of the British populace were efficient in their conversion of resources into functionings during the sample horizon. Moreover, age, education and self-employment increase an individual’s conversion efficiency, while living in London, being disabled and being separated, divorced or widowed all decrease conversion efficiency. Being married also decreases the conversion efficiency and we find few evidence of gender disparities in conversion efficiency.

*Key words:* capability approach, conversion efficiency, efficiency analysis, intertemporal development

JEL-classification: I12, I31, D60

---

## 1. Introduction

The capability and functionings approach offers a normative framework to guide policy makers in increasing individuals’ well-being (Sen, 1984, 1985a,b, 1992). The primary aim

---

<sup>☆</sup>The authors are grateful for having been granted access to the BHPS data set, which was made available through the ESRC Data Archive. The data were originally collected by the ESRC Research Centre on Micro-Social Change at the University of Essex (now incorporated within the Institute for Social and Economic Research). Neither the original collectors of the data nor the Archive bear any responsibility for the analyses or interpretations presented here. We thank Ulrich Witt for helpful comments. Remaining errors are ours.

*Email address:* binder@econ.mpg.de (Martin Binder)

of such welfare policies should be to increase individuals' capability to function, i.e. their opportunities to achieve valuable states of doing and being. Of course, policies also could directly increase individuals' states of doing and being (the outcome side). Examples for such policies that centre on influencing the levels of individual functioning could be improving education or health in a society.<sup>1</sup> Most research within the capability literature deals with these two levers, capability to function and individual functioning achievement. There is, however, an additional lever for policy makers which has not gained as much attention in the literature. This lever is not concerned with the absolute levels of functioning or capability but with the relative level of achievement individuals can gain given fixed resources. This lever operates on the level of individual conversion of resources into well-being.

Our paper contributes to the empirical functioning measurement literature in focussing on the "*conversion efficiency*" with which individual resources are transformed into achieved functioning. Individual differences in converting resources into achieved functioning have been stressed in theoretical contributions to the approach (in the form of "conversion factors") but are notoriously difficult to capture empirically (see, e.g. Chiappero-Martinetti and Salardi, 2007). A natural approach to deal with differences in conversion factors would be measuring how efficiently individuals convert resources into functionings by drawing on the efficiency analysis methodology used in production theory (Lovell et al., 1994; Deutsch et al., 2003; Ramos and Silber, 2005; Binder and Broekel, 2008). The present paper contributes to this strand of literature and extends the approach of Binder and Broekel (2008) to the intertemporal context. The order- $m$  efficiency method we suggest allows us to compute for a given sample of individuals, and track over time, an efficient frontier on which are individuals who are most efficient in converting their resources into achieved functioning. The distribution of individual efficiency scores relative to that frontier allows some additional insights regarding the assessment of welfare in the space of achieved functionings. Based on the idea that inefficiencies are undesirable also in the context of the capability approach, we argue that a measure of conversion efficiency reflects the effects of diverse welfare-reducing institutional constraints on the individuals. Moreover, the development of conversion efficiency over time allows to assess the impact of policies aiming at mitigating the contingencies related to the diverse conversion factors.

What we want to argue here is that both ways of increasing well-being in functioning space are legitimate concerns for policy makers. While it is certainly most desirable to increase the absolute levels of well-being of individuals in a society, there exist reasons to also value increases in relative levels (understood as increased efficiency in converting resources into well-being). One reason lies in the existence of upper bounds for certain dimensions of well-being: if individuals have reached maximum functioning achievement (in a certain dimension of well-being), absolute levels cannot further be increased by policies. What might be increased, however, is the efficiency with which these individuals reach these absolute levels of functioning achievement, thus freeing resources that can be used in other dimensions of well-being. This certainly is also of value not only when reaching upper boundaries in one well-being dimension but also on lower levels: individuals in poverty being able to more

---

<sup>1</sup>Policies targeting the resource side would ultimately also be considered to fall within this category since resources are used to achieve increased functioning achievement and thus are instrumental to functioning achievement.

efficiently reach their (admittedly low) level of functioning achievement similarly profit in effectively being able to improve their well-being in other dimensions if their conversion efficiency is increased.<sup>2</sup>

A second rationale for also targeting conversion efficiency lies in the relative costs that might be associated with increasing absolute functioning levels beyond a certain threshold. By elevating well-being in a certain dimension through policy measures, a society might well face decreasing returns to absolute policy investments: with a given budget it might be realistic, for instance, to provide a health system where society scores a high level of health, such as in most Western societies. Improving this health level to be excellent might be associated with prohibitively high costs, however, since as in most things, the last extra ten percent cost proportionately more than second highest decile in achievement. In cases such as these, increasing the rate of achievement per resource might be a more cost effective route to choose. In order to be able to assess the effects of such policies targeting conversion efficiency, it is thus necessary to examine the *development* of conversion efficiency of individuals in a society, i.e. to track the changes in this measure of well-being over time.

The paper is structured as follows. Section 2 gives a short overview of the capability and functionings approach. In Section 3, we discuss our idea of conversion efficiency and its development over time. We then proceed to discuss the nonparametric efficiency analysis approach and how conversion efficiency developments can be measured in Section 4. We are using a non-convex order- $m$  frontier estimation in a two-stage framework. In Section 5 we employ the suggested method for set of “basic functionings” (Sen, 1993), namely for the functionings “being happy”, “being healthy”, “being nourished”, “moving about freely”, and “being well-educated”. Working with micro level data, we use the efficiency method to assess the development of conversion efficiency of this basket of functionings for the British Household Panel Survey (BHPS) data set over nearly two decades (BHPS, 2009; Taylor, 2009). Section 6 concludes.

## 2. The capability approach

Amartya Sen’s capabilities and functionings approach is an evaluative framework to assess individual welfare (Sen, 1984, 1985a,b, 1992). In this account, living is seen as consisting of a set of functionings, which could be described as different aspects of life, or the achievements of an individual. They give us information about what a person is and what she does. For an assessment of a person’s well-being, Sen proposes not only “being happy” (as in the utilitarian tradition) but other intrinsic values as well: other functionings are, for example, “being nourished”, “avoiding premature mortality” (Sen, 1992, p. 39) or “being in good health”, “being well-sheltered”, “being educated” or “moving about freely” (Kuklys, 2005, p. 10), making the approach multi-dimensional as a person’s state of being (and her individual activities) is a vector of functionings. This intuition has been formalized by Sen (1985a):<sup>3</sup> a vector of functionings can be described in set-theoretic notation as

$$\vec{b} = f_i(c(\vec{x})|\vec{z}_i, \vec{z}_e, \vec{z}_s) \quad (1)$$

---

<sup>2</sup>The case of the efficient poor should make clear that this relative view has to be seen as complementing the absolute measurement of well-being.

<sup>3</sup>We follow Kuklys (2005) in notation.

where  $\vec{b}$ , the vector of functionings is defined by the following elements:  $\vec{x} \in X$  is a vector of commodities out of the set of all possible commodities (or more generally: resources)  $X$ . This includes *expressis verbis* non-market goods and services as well.  $\vec{x}$  is mapped into the space of characteristics (Lancaster, 1966) via the conversion function  $c(\bullet)$  so that  $\vec{c} = c(\vec{x})$  would be a characteristics vector of a given commodity vector  $\vec{x}$ . The characteristics of a commodity do not vary across individuals, i.e. they are the same for everyone. What does vary, however, is the way individuals can benefit from the characteristics of a commodity. Think of a person who possesses a loaf of bread. Someone suffering from a parasitic disease would benefit less from the characteristic “caloric content” than someone being well-fed (Sen, 1985a, p. 9). This is reflected by the conversion function of an individual  $f_i \in F_i$  that maps a vector of characteristics into the space of functionings ( $F$  is the set of all possible conversion functions). This conversion is influenced by the conversion factors  $\vec{z}_k$ , where we can distinguish individual ( $\vec{z}_i$ ), social ( $\vec{z}_s$ ) and environmental ( $\vec{z}_e$ ) influences (Kuklys, 2005, p. 11). Individual factors could be gender, intelligence, physical (dis)abilities, etc. Social influences are legal regulations, population density, etc. Examples for environmental factors include climate, environmental pollution and so on. These conversion factors can be seen as non-monetary constraints an individual faces. Note that selection of some of the conversion functions is part of an individual’s capability to function while, of course, some conversion functions are just not eligible, e.g. being female or male, and thus outside an individual’s control (Sen, 1985a). In this respect, a policy maker might have very different possibilities of affecting conversion factors and functions of individuals. The most obvious policy targets certainly pertain to social (institutional) and environmental conversion factors, but also individual factors such as disability can be the target of welfare policies. By this we understand that a policy maker can try to mitigate the effects of these conversion factors. While some conversion factors are clearly outside of the control of the individuals, being contingencies of life, there are policies conceivable that mitigate the effects of such conversion factors (think of the case of disability, where disability might not be reduced or cured, but measures might be taken to offset its welfare-decreasing effects). While the concept of conversion factors is theoretically quite clear, it is much more difficult to address empirically (Brandolini and D’Alessio, 1998). Due to difficulties of measurement, the empirical examination of conversion factors and functions has not received much attention in the literature (but see, e.g., Binder and Broekel, 2008; Deutsch et al., 2003).

When choosing what way of life to live, a person chooses, depending on her idiosyncratic preferences, from different functioning vectors. The set of all feasible functioning vectors for a person  $i$  is this person’s *capability set*  $Q_i$ . It is a derived notion and represents the person’s opportunities to achieve well-being, reflecting the various functionings that are potentially achievable (given her constraints  $X_i, \vec{z}_k$ ). This set can now be defined as

$$Q_i(X_i) = \left\{ \vec{b}_i \mid \vec{b}_i = f_i(c(\vec{x}_i) \mid \vec{z}_i, \vec{z}_e, \vec{z}_s) \forall f_i \in F_i \wedge \forall \vec{x}_i \in X_i \right\} \quad (2)$$

Measuring the actual *capability* to function empirically has proven to be nontrivial and few studies attempt to do so (but see Anand et al., 2005; Anand and Hees, 2006; Anand et al., 2009). But there are also difficulties associated with the measurement of functionings as the capability approach has been devised with a certain openness regarding their selection. While Sen favours this openness and stresses the deliberative social dimension that is involved in

choosing a set of valuable functionings, other authors have promoted lists of functionings that supposedly reflect a common consensus of what is valuable (e.g. Nussbaum, 2000) or at least methodologies how to select functionings (Robeyns, 2005). Note that this indeterminacy of the approach has resulted in an empirical measurement literature that often measures welfare over an *ad hoc* range of different functionings. We try to circumvent this difficulty in the empirical part of the paper by focussing on a set of “basic functionings” (Sen, 1993), which can be justified in a naturalistic fashion (Binder, 2010). These basic functionings are central to human flourishing regardless of context. They also reflect a broad consensus about functionings within the capability literature (Qizilbash, 2002, p. 474). Basic functionings can be argued to be part of everyone’s chosen functionings vector and (consequently) everyone should be interested in the efficient conversion of resources into these functionings.

### 3. Conversion efficiency and its development over time

The present paper contributes to operationalizing the measurement of conversion factors and provides the policy maker with an additional lever to improve citizens’ well-being in the space of functionings. There exist some studies on measuring conversion factors (e.g., Chiappero-Martinetti and Salardi, 2007; Lelli, 2005) and some studies using efficiency analysis (Deutsch et al., 2001, 2003), but these studies do not engage in a theoretical discussion of the interpretation and policy relevance of conversion efficiency. We think that the most natural approach to deal with differences in conversion factors would be to directly measure how efficiently individuals convert resources into functionings by drawing on the efficiency analysis methodology used in production theory (Lovell et al., 1994; Deutsch et al., 2003).<sup>4</sup>

One contribution of our paper lies thus in providing an argument for its relevance and putting conversion efficiency measurement into an intertemporal context (thus extending the argument of Binder and Broekel, 2008). We focus on nonparametric efficiency analyses that allow us to compute for a given sample of individuals an efficient frontier on which are individuals who are most efficient in converting their resources into achieved functioning. This concept builds on the assumption that individuals need resources (which can be income and market goods but also public goods and social services) to increase their levels of functioning achievement. The efficient frontier we suggest reflects at a given time the societal optimum, which can be reached for given levels of resources (i.e. some individuals have actually reached it). This idea of relative efficiency means we are evaluating individuals’ efficiency not with respect to a theoretically derived maximum, but to the maximum of functioning achievement observed in the sample population given a certain level of resources. In light of the difficulties in defining the theoretical maximal functionings achievement for a certain level of resources this seems to be a sound approach. On such a relative frontier can be individuals with low functioning achievement and low resources (but these low resources are converted very efficiently) and individuals with high achievements and high resources (but also with an efficient conversion). Individuals on the efficiency frontier constitute in this case the best-practice in conversion efficiency. Other, less efficient individuals are now evaluated relative

---

<sup>4</sup>Analogies from production theory have been used fruitfully in the present context (see Ramos, 2008; Farina et al., 2004; Dasgupta, 1990).

to these role models and their distance to the frontier is interpreted as a measure of how inefficient these individuals are in converting their resources into achieved functioning.

The more individuals are falling short of this efficiency (as measured by the distribution of the efficiency scores for a group of individuals and their distance to the frontier), the less favourable are the overall societal conditions for the conversion of given resources into functioning achievement.<sup>5</sup> In that respect, a distribution of efficiency scores offers the analyst valuable information (regarding the number of efficient individuals as well as the mean distance to the frontier of the inefficient individuals) whether there exist obstacles in the conversion of resources into functionings achievement. Based on the idea that inefficiencies are undesirable also in the context of the capability approach, we argue that a measure of conversion efficiency reflects the effects of diverse welfare-reducing constraints on the individuals. Controlling for known differences in the conversion process (i.e. using control variables for individual conversion factors), we can interpret the remaining inefficiencies as reflecting institutional (and environmental) shortcomings that create a barrier for a certain group of people. While there may exist constraints for all individuals, from the point of view of our approach, we are interested in these constraints that result in inequality, i.e. in constraints which affect only subgroups of people (and here rather the less well-off subgroups).

One caveat applies: it is conceivable that very poor individuals, who have very low levels of functioning achievement, are nonetheless efficient in terms of resource conversion. This case would be problematic in a restricted view solely centred on conversion efficiency because absolute poverty would be masked behind relative efficiency. Therefore it is important to keep in mind that conversion efficiency can only be a complement to the absolute functioning measures. What we claim is that focusing only on the absolute levels of functioning achievement neglects important welfare information that could be put to good use. Basically, low scores in conversion efficiency can show sub-groups of individuals that are vulnerable in the sense that they need more resources to achieve similar functionings levels as less vulnerable individuals. This relative measure complements the use of absolute measures in analyzing how these absolute levels of resources are used (or possibly wasted). Such a measure can be tracked over time to monitor progress in abolishing existing inequalities or to examine progress being made by instituted policies. It also offers insights to the policy maker how conversion factors exactly influence the conversion process, so that, for example, if absolute resource levels cannot be changed, policies can influence conversion factors that would at least increase the conversion efficiency of given resources. While some conversion factors might be directly susceptible to policy measures, some are contingencies of human life and

---

<sup>5</sup>One could imagine a case where an individual scores low in efficiency for the set of functionings selected because that individual has chosen a different functioning vector from his capability set. The individual's chosen vector might be efficient in the overall conversion of resources into achieved functioning but not regarding the subset of functionings examined in the analysis (for example one could imagine a person being focused on one functioning and pouring inefficient amounts of resources here). Therefore, this type of analysis works best when focussing on a large number of functionings as well as these types of functionings where individuals can be assumed to be interested in regardless of their situation. If we can assume that in the case of basic functionings everyone has the same preferences for them, the differences in conversion efficiency can be attributed to constraining factors such as argued above. In such a case, the analyst would not need to fear that someone would achieve low efficiency scores because that individual is not interested in (efficiently) converting given resources into achieved functioning.



can only be indirectly influenced by policies, or their effects on conversion efficiency might be mitigated via policies.

Both ways of increasing well-being in functioning space are legitimate concerns for policy makers. While it is certainly most desirable to increase the absolute levels of well-being of the individuals in a society, there exist reasons to also value increases in the relative levels (understood as increased efficiency in converting resources into well-being). One reason lies in the existence of upper bounds for certain dimensions of well-being: if individuals have reached maximum achievement (in a certain dimension of well-being), absolute levels cannot further be increased by policy measures. What might be increased, however, is the efficiency with which these individuals might reach these absolute levels of functioning achievement, thus freeing resources that can be spend in other dimensions of well-being. This certainly is also of value not only when reaching upper boundaries in a well-being dimension but also on lower levels: individuals in poverty being able to more efficiently reach their (admittedly low) absolute level of functioning achievement similarly profit in effectively being able to improve their well-being if their conversion efficiency is increased.

The second rationale for also targeting conversion efficiency lies in the relative costs that might be associated with increasing absolute functioning levels beyond a certain threshold. By elevating well-being in a certain dimension through policy measures, a society might well face decreasing returns to absolute policy levels: it might be realistic, for instance, to provide a health system where society scores a high level of health, such as in most Western societies. Increasing this health level even more might be associated with prohibitively high costs, since as in most things, achieving optimal results might cost proportionately much more than “just” good results. In cases such as these, increasing the rate of achievement per resource might be a more cost effective route to choose. In order to be able to assess the effects of such policies targeting conversion efficiency, it is thus necessary to examine the development of conversion efficiency in a society, i.e. to track the changes in this measure of well-being over time.

Another reason why conversion efficiency can change over time are learning processes and technological change. Regarding the latter, scarce resources might be utilized more efficiently, leading to higher levels of functionings achievement over time. This can take place on the level of individuals as well as on more aggregate levels. For instance, if a patent protection of a particular drug runs out, generic drugs may offer the same effect at lower prices. In this case, an individual suffering from the disease treated with the drug will experience the same level of achieved functionings as the new drug simply substitutes the old one. However, thanks to the price reduction the individual needs to spend less income on the treatment and might choose to expand another functioning achievement level. Conversion efficiency for that individual increases accordingly. Similarly, individuals may learn to use certain resources more efficiently (e.g. learning a more healthy life-style by replacing fast food with healthy diets) or change their perception of specific functionings. In short, whenever the levels of achieved functioning increase without an expansion of the resource vector, conversion efficiency changes. The same applies to any reduction in the resource vector and a stable or increasing functioning achievement. It is beyond the scope of the paper to identify causes for intertemporal changes in conversion efficiency. In contrast, our paper represents a first step to a deeper understanding of conversion efficiency developments by focussing on which individual characteristics tend to be correlated to an increasing or decreasing conversion

efficiency.

#### 4. A nonparametric approach to intertemporal efficiency measurement

Having discussed the theoretical foundations of the capability approach and the idea of a “conversion efficiency” measure in an intertemporal context, we now turn to the empirical measurement. We use a two-stage approach: first, we estimate individuals’ conversion efficiencies. The cross-sectional as well as longitudinal variance of this measure is subsequently analyzed in a second stage regression framework.

Following Deutsch et al. (2003) and Binder and Broekel (2008), we transfer the idea of efficiency from production theory to the measurement of welfare. In production theory efficiency means to produce a maximum of output from a certain level of input (Farrell, 1957).<sup>6</sup> In the context of welfare measurement, conversion efficiency refers to the relationship between an individual’s resource vector (inputs) and its achieved level of functionings (output). In order to evaluate if an individual is efficient it is essential to define an appropriate benchmark. In the best case there are either theoretical intuitions of a maximum level of achieved functionings that can be derived from a given set of resources, or at least some commonly accepted standards. This is rarely the case in welfare evaluation, though.

For this reason, we define conversion efficiency in relative terms. To assess an individual’s relative conversion efficiency, the person’s level of achieved functioning is not compared to a theoretical maximum, but to that of other similar individuals with similar resource sets.<sup>7</sup> For the empirical assessment we apply the robust nonparametric approach developed by Cazals et al. (2002). In comparison to parametric approaches, its main advantage is that the functional relationship between resource set and achieved functioning vector does not need to be explicitly modeled.<sup>8</sup> Instead, the relation is fitted by linear programming techniques and hence derived from the empirical data.

The robust nonparametric frontier approach applied in this paper is a modified version of the well-known Free Disposal Hull (FDH) developed by Deprins et al. (1984). The FDH represents a deterministic approach, implying that all potential stochastic noise in the data will be part of the derived efficiency measure. This renders the estimations highly sensitive to potential outliers and noise in the data, which is empirically not desirable (see, e.g., Wilson, 1993). Robust nonparametric frontier approaches offer a remedy for this problem (Daraio and Simar, 2007).

Robust nonparametric frontier approaches conceive of the transformation of inputs into outputs as a probabilistic process. The interest lies in the probability with which an observation is dominated by other observations. According to Cazals et al. (2002), an observation’s

---

<sup>6</sup>A different way of defining efficiency is to look for the minimum of inputs used to produce a given level of output (input-orientation). We argue that the output-orientation is more appropriate because our aim is to identify obstacles that hinder people in achieving “maximal” functioning achievement. It is hence evaluated whether they score lower in terms of functioning achievement than what can be expected given their resources.

<sup>7</sup>It is beyond the scope of the paper to compare different approaches for measuring such relative efficiency (for a more detailed discussion, see Ravallion, 2005; Binder and Broekel, 2008).

<sup>8</sup>For an extensive discussion on the (dis-) advantages of parametric and nonparametric approaches see Coelli and Perleman (1999) and Daraio and Simar (2007).

benchmark (frontier) can be the average of the maximal value of achieved functionings of  $m$  randomly drawn observations with equal or less levels of resources (output-oriented order- $m$  frontier). Practically, this means that we examine for each individual whether there is any individual among the randomly drawn  $m$  individuals (including the same individual) that has equal or less resources available and achieves an equal or higher level of functioning achievement.<sup>9</sup> The comparison of resource and achieved functionings vectors is done on the basis of the principle of weak dominance. The efficiency measure is then defined as the necessary (relative) increase in the achieved functionings component, whose value is closest to the value of the frontier (best-practice) individual.

The efficiency measure of order- $m$  can be computed in the following way:  $Y^1, \dots, Y^m$  are the  $m$  random observations (individuals) drawn from the conditional distribution function of  $Y$  given  $X \leq x_0$ , i.e. only individuals with equal or less resources than individual  $(x_0, y_0)$  are considered. The output-oriented order- $m$  efficiency measure  $\tilde{\lambda}_m(x_0, y_0)$  is defined for observation  $(x_0, y_0)$  as

$$\tilde{\lambda}_m(x_0, y_0) = \max_{i=1, \dots, m} \left\{ \min_{j, \dots, q} \left( \frac{Y_i^j}{y_0^j} \right) \right\} \quad (3)$$

with  $Y_i^j(y_0^j)$  being the  $j^{\text{th}}$  component of  $Y^i$  (of  $y_0$  respectively). Note that  $\tilde{\lambda}(x_0, y_0)$  is a random variable because the  $Y_i$ , individuals against which  $(x_0, y_0)$  is compared are randomly drawn. In order to obtain the final  $\hat{\lambda}_m(x_0, y_0)$ , Cazals et al. (2002) suggest a simple Monte-Carlo algorithm in which  $\tilde{\lambda}_m(x_0, y_0)$  is estimated  $B$  times, where  $B$  is large (200). The order- $m$  efficiency measure of individual  $(x_0, y_0)$  is then defined as

$$\hat{\lambda}_m(x_0, y_0) = E[\tilde{\lambda}_m(x_0, y_0) | X \leq x_0] = \frac{1}{B} \sum_{b=1}^B \tilde{\lambda}_m^b(x_0, y_0) \quad (4)$$

Since not all observations are enveloped, the order- $m$  frontier function is a partial frontier making it less sensible to outliers and statistical noise. The resulting order- $m$  efficiency scores are strictly positive and range from  $> 0$  to  $+\infty$ . Values smaller or equal to one indicate efficiency, while values larger than one represent inefficiency.

One remark remains to be made. As a result of the weak dominance principle used in the comparison, in the order- $m$  approach it is assumed that the frontier function is concave. This implies that resource and achieved functioning quantities cannot be arbitrarily divided. In other words, a lack of functioning achievement in one dimension cannot be substituted with an excess in another dimension. Accordingly, a comparison is made only on the basis of actually existing observations, i.e. only empirically observed resource/functioning achievement combinations are considered.<sup>10</sup>

---

<sup>9</sup>The value of  $m$  has to be specified by the researcher. It can be seen as a “trimming parameter” defining the sensibility of the estimation with respect to outliers in the data. We follow Bonaccorsi et al. (2005) in setting the level of robustness to below ten percent. This means that ten percent of the observations have efficiency values smaller than one. A sensible value in our case would be  $m = 1,500$ .

<sup>10</sup>If one wants to impose the assumption of convexity, it is possible to create measures that allow for substitutability among input and output vectors (see Daraio and Simar, 2005). In this case, individuals are also compared to linear combinations of observed resource/functioning achievement relations.

In the present paper we are interested in two things. First, we extend the analysis by Binder and Broekel (2008) from cross-section to panel regressions, investigating if individuals' levels of conversion efficiency are impacted by a number of individual characteristics. Additionally, we then explore which characteristics relate to intertemporal changes in individuals' conversion efficiency. More precisely, individuals are identified (in terms of their characteristics), whose distance to the conversion efficiency frontier decreases or increases over time. We pointed out above that it is beyond the scope of the paper to analyze the exact societal mechanisms for the changes in conversion efficiency. Rather, our aim is to highlight particular individual characteristics that are associated with an increasing and decreasing conversion efficiency.

For the first part of our analysis, we use the order- $m$  efficiency measure as dependent variable in a (second stage) regression. As the efficiency scores are not truncated, continuous, and always positive, we apply a standard (fixed effects) regression model. For the second part of the analysis, we turn to a common approach in production theory and use the so-called "Malmquist index", focusing on the dynamics of conversion efficiency (the formalism for the index can be found in the appendix). The index was first developed by Caves et al. (1982) and extended to multiple input and output scenarios by Färe et al. (1992) and Färe et al. (1994). Wheelock and Wilson (2003) discuss the corresponding index for the order- $m$  approach used in this paper. In the context of this paper, the Malmquist index captures the change in an individual's conversion efficiency between two periods of time. However, various effects can cause intertemporal change in relative efficiencies. To isolate particular effects, it is therefore common to decompose the index into a number of components (for an overview, see Zofio, 2006). The decomposition by Wheelock and Wilson (2003) of the order- $m$  Malmquist index into four different parts is especially valuable for our study. In the following, we focus on only one of the four components, namely the measure of the change in the order- $m$  "technical" conversion efficiency, denoted by  $\Delta M\_Eff$ . It estimates the "movement" of an individual relative to the benchmark frontier and shows if the individual is able to decrease or increase its conversion efficiency relative to the order- $m$  best-practice individuals (catching-up or falling behind). We argue that this is the most relevant part of conversion efficiency change because it abstracts from (potentially biasing) processes at aggregate levels, e.g. technological progress, economy wide shocks, economies of scale, etc.<sup>11</sup>  $\Delta M\_Eff$  serves as dependent variable in the second regression with which we explore the impact of individual characteristics on conversion efficiency change.

## 5. Data and findings

### 5.1. Data set and functioning selection

For our analysis, we use the British Household Panel Survey (BHPS), a longitudinal survey of private households in Great Britain that contains information on various areas of the respondents' lives, ranging from income to jobs, household consumption, education,

---

<sup>11</sup>If the latter are in the focus of the investigation, the other three parts of the decomposition need to be studied. These concern the existence of scale effects and the movements of the benchmark frontier function over time (for more details see the Appendix and Wheelock and Wilson (2003)).

health, but also social and political values.<sup>12</sup>

Table 1: Summary statistics of variables

Variable	Mean	Std. Dev.	Min.	Max.	N
happiness	25.826	5.399	1	37	154300
income (equiv.)	23155.723	15448.076	0.644	840158.75	154300
health	0.006	1.328	-7.988	1.666	154300
food	6.079	2.183	1	12	154300
mobility	1.226	0.847	0	3	154300
age	45.185	18.501	15	99	154300
gender	1.532	0.499	1	2	154300
education	2.975	1.738	1	7	154300
d_disabled	0.075	0.264	0	1	154300
d_selfemployed	0.069	0.253	0	1	154300
d_unemployed	0.038	0.192	0	1	154300
d_sepdivwid	0.181	0.385	0	1	154300
d_London	0.067	0.251	0	1	154300

We have already hinted at the theoretical problems related to selecting a list of functionings. From an empirical point of view, it has to be noted that there is quite a large amount of overlap between the different lists of functionings that are suggested in the literature; what often differs are indicators selected to capture functioning achievement, due to different data availability (Qizilbash, 2002).<sup>13</sup> The BHPS offers a rich variety of indicators for different functionings, but many indicators for functionings have not been elicited in many different waves. We have chosen to examine a model specification that tracks individuals and their functionings achievement in a number of functionings over the full sample horizon.

To construct a set of “basic functionings” (for the output side) we chose different indicators for the five functionings “being happy”, “being healthy”, “being nourished”, “moving about freely”, and “being well-educated” (we here use the same indicators as Binder and Coad, 2010). All of these have been prominent candidates in empirical studies on the capability approach and figure in many multidimensional welfare measures (Alkire, 2002; Anand et al., 2005). On the input side, we examine income as a proxy for the commodity vector in the capability framework (see Section 2).

We will now discuss the indicators chosen to reflect our functionings as well as control

<sup>12</sup>The survey is undertaken by the ESRC UK Longitudinal Studies Centre with the Institute for Social and Economic Research at the University of Essex, UK (BHPS, 2009). Its aim is to track social and economic change in a representative sample of the British population (for more information on the data set, see Taylor, 2009). The sample comprises about 15,000 individual interviews. Starting in 1991, up to now, there have been 17 waves of data collected with the aim of tracking the individuals of the first wave over time (there is a percentage of rotation as some individuals drop out of the sample over time and others are included, but attrition is quite low, see Taylor, 2009).

<sup>13</sup>This might also explain the finding by Ramos and Silber (2005) that the exact specification of a set of functionings does not seem overly critical for the resulting multidimensional welfare measure. The authors have demonstrated a great (empirical) similarity of the different approaches in their study (also using the BHPS data set).

variables that represent different conversion factors which we use in the second step of our procedure. Table 1 gives an overview of the descriptive statistics. As we are using unbalanced panel data from 1991 to 2006 (waves 1 to 16), we have a total of 154,300 observations after cleaning the panel: we had to drop one year because the coding of one of the variables was changed, and we discarded individuals who have not reported the indicators we use, leaving us effectively with 15 waves of data.

To assess “being happy” (*happiness*), we have decided on using the well-known GHQ-12 measure which tracks the individual’s assessment of “mental well-being” as a proxy of happiness or subjective well-being. This concept of mental well-being is relatively similar to the better known happiness measures. It is, however, more encompassing as it also relates to mental health. It is an index from the “General Health Questionnaire” of the BHPS, composed of the answers to 12 questions that assess happiness, mental distress (such as existence of depression or anguish), and well-being. This subjective assessment is measured on a Likert scale from 0 to 36, which we have recoded to values of one (lowest well-being) to 37 (highest scores in mental well-being). This proxy is widely used in the psychological literature (for more details on this indicator see, e.g., Gardner and Oswald, 2007; Shields and Wheatley Price, 2005; Clark and Oswald, 2002).

To measure “being healthy” (*health*), we have chosen to use a mixture of subjective and objective indicators of health. For the former, we focus on an individual’s subjective assessment of health (during the last 12 months). This is ordinally scaled on a five point Likert scale, ranging from “excellent” (five) to “very poor” (one).<sup>14</sup> In order to account for more objective aspects of individual health, we also included the number of days spent in hospital, the number of visits to a general practitioner as well as the number of serious accidents in the previous year (see the extensive descriptive statistics in Table 5 in the appendix). While the aggregation of different indicators into one comprehensive functioning achievement measure is by no means trivial, we have opted for a simple Principal Component Analysis (PCA) for the aggregation exercise. Such a type of analysis has been used in the capability literature to aggregate functioning indicators as well as multiple functionings (e.g., Binder and Coad, 2010; Roche, 2008; Lelli, 2005). Using this type of analysis is very convenient in our context, as this econometric procedure allows the data to determine the weights when aggregating the indicators for our functionings, thus not forcing us to stipulate *ad hoc* some artificial weighting scheme about which indicators should be given which weight. Via PCA, we can summarize the information of different indicators into one measure that contains the largest possible part of the variance of the indicators; in other words, it accounts for the (empirically) largest share of variation in all components.<sup>15</sup> The overall functioning “being healthy” is thus a

---

<sup>14</sup>As in the case of well-being, we have reversed the numerical order of the Likert scale to consistently use higher values for higher “achievement” in these domains. The original coding in the BHPS codes a value of one to be excellent health and five to be very poor health. Note further that in the 1999 wave, a different coding of this indicator has been used. Since comparability between the different scalings is nontrivial, we have chosen to discard the observations of this wave to have a more consistent panel at our disposal.

<sup>15</sup>While we are aware of possible drawbacks of such a procedure, viz. neglecting parts of the variance inherent in the indicators, we feel justified on ignoring these concerns in the present context. The main aim of our paper lies elsewhere, and we allow ourselves to remain agnostic on the concrete aggregation of indicators. Moreover, we follow the reasoning of Kolenikov and Angeles (2009), who argue that using polychoric correlations in PCA is unnecessary in the case of ordinal variables, especially when the number of

continuous variable, derived from a PCA. With this measure, we can account for  $\rho = 44.43\%$  of the underlying indicators' variance. To further explore its goodness of fit, we calculated the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for the indicator (0.6227), which is acceptable. These proxies are similar to the ones employed in other studies on functioning achievement (e.g., Lelli, 2001; Kuklys, 2005).

The functioning "being nourished" (*food*) can be approximated by the household weekly expenditure on food and grocery items. In the BHPS, this is measured in 12 categories (ranging from "under 10" to "160 or over" in GBP).<sup>16</sup> This is admittedly a crude indicator, but it nevertheless offers a first approximation of this functioning which is otherwise not easily captured in this data set (on the relevance of this functioning see also Qizilbash, 2002, p. 468).

The functioning "moving about freely" (*mobility*) can be approximated by information on whether the household members have access to a car or van to move about at leisure. The number of cars available to household members is measured quasi-cardinally on a scale from 0 to 3, where numbers correspond to numbers of cars except for the highest category, which denotes three or more cars. (see similarly, Robeyns, 2006, p. 262).

For the functioning "being educated" we chose an individual's highest level of education as an indicator. This is measured ordinally, ranging from one ("none of these") to seven ("higher degree"), giving intermediate values to the middle education levels.<sup>17</sup> This scale is widely used in the literature and education certainly seems to be an important functioning (Kuklys, 2005; Chiappero-Martinetti and Salardi, 2007; Ramos, 2008), the fact of which is highlighted by its prominent role of being one of the indicators of development in the HDI (UNDP, 2006).<sup>18</sup>

Turning to the input side of our measurement exercise, we focus on an individual's income (*income*), which we here understand as a resource. We have decided to use net equivalised annual household income (in British Pound Sterling), before housing costs and deflated to price level of 2008, as provided and detailed by Levy and Jenkins (2008). As equivalence scales, we have opted for applying the widely accepted McClements scale (McClements, 1977). Such an income measure has been extensively discussed in our context of the BHPS (Burchardt, 2005; Kuklys, 2005).

The last category of variables concerns the (mostly individual) conversion factors, which we include in our second step of the analysis. These comprise of gender, age, and age<sup>2</sup> (we use the squared difference between age and mean-age instead of age<sup>2</sup> in order to avoid problems of multicollinearity) as well as some dummies regarding disability, being unemployed

---

ordinal categories is five or more. Empirically, there tend to be only small differences between using a PCA with polychoric correlations and just treating ordinal variables as cardinal in a PCA. We therefore did the calculations with a standard (Pearson) PCA.

<sup>16</sup>In the first year, these expenditures were asked in continuous amounts of GBP, which could be easily transformed into these 12 categories by the authors, however.

<sup>17</sup>For more information see Taylor (2009), App. 2, pp. 18-9.

<sup>18</sup>The coding of this variable is arguably quite "crude" (Robeyns, 2006, p. 256). Moreover, there is not much variance to be found in this functioning in our sample, which focuses on British adults: education levels were empirically quite stationary and did not change much. This might be interpreted to imply that education would be better understood as a conversion factor, not a functioning, in the present context (Binder and Coad, 2010).

Table 2: Contemporaneous correlations in levels

Variables	happiness	income (equiv.)	health	food	mobility	education	age	gender
happiness	1.0000							
obs.								
income (equiv.)	0.0683 (0.0000)	1.0000						
obs.	154300							
health	0.3487 (0.0000)	0.1208 (0.0000)	1.0000					
obs.	154300	154300						
food	0.0512 (0.0000)	0.1724 (0.0000)	0.1265 (0.0000)	1.0000				
obs.	154300	154300	154300					
mobility	0.0871 (0.0000)	0.3036 (0.0000)	0.1898 (0.0000)	0.4545 (0.0000)	1.0000			
obs.	154300	154300	154300	154300				
education	0.0658 (0.0000)	0.3227 (0.0000)	0.1848 (0.0000)	0.1683 (0.0000)	0.2670 (0.0000)	1.0000		
obs.	154300	154300	154300	154300	154300			
age	-0.0461 (0.0000)	-0.0604 (0.0000)	-0.1792 (0.0000)	-0.2175 (0.0000)	-0.2349 (0.0000)	-0.3424 (0.0000)	1.0000	
obs.	154300	154300	154300	154300	154300	154300		
gender	-0.1299 (0.0000)	-0.0552 (0.0000)	-0.1301 (0.0000)	-0.0609 (0.0000)	-0.0993 (0.0000)	-0.0739 (0.0000)	0.0353 (0.0000)	1.0000
obs.	154300	154300	154300	154300	154300	154300	154300	

and individual marriage status, as a selection of some of the most important individual factors influencing achieved functioning (a similar set of factors was used also by Chiappero-Martinetti and Salardi, 2007). We have also added year dummies and a regional control variable for environmental conversion factors (the regional control variable distinguishes former Metropolitan Counties and Inner and Outer London areas). Of our sample, 53.2% were female. The mean age is 45.185 years (s.d. 18.501) with maximum age at 99 years and minimum age at 15.

In Table 2, we report pairwise correlations between our indicators for the main and some control variables. The correlations of our indicators are highly statistically significant. The highest correlations are between mobility and being nourished ( $r = 0.4545$ ) and between health and happiness ( $r = 0.3487$ ), possibly due to the incorporation of some (mental) health aspects in the concept of mental well-being.<sup>19</sup> It is noteworthy that all correlations between our main variables (happiness, health, income, being nourished and mobility) are positively associated. The pairwise correlations in levels are quite similar to those found in other studies (on the same data set, see Deutsch et al., 2003; Ramos and Silber, 2005). The low correlation of log equivalised income with some of the other variables shows that these other dimensions of well-being do indeed capture important information on individuals' well-being that cannot be captured by income variables. Such low correlation also suggests that income might not be an important resource for many relevant other functionings (however, income and both food and mobility functionings show high positive correlation, of which at least the former correlation might be explained by the way we measure functioning achievement

<sup>19</sup>The other comparatively high correlation in that table is between education and age ( $r = -0.3424$ ). An explanation why age is negatively associated with education could be that the sample contains a large proportion of older individuals who do not hold as many high academic degrees as might be usual today.



	(1)		(2)		(3)		(4)
	mean (all)		mean (inefficient)		mean (efficient)		percentage efficient
ordermt							
1	1.109***	(616.34)	1.155***	(528.32)	0.986***	(1645.20)	27
2	1.110***	(586.06)	1.160***	(495.71)	0.986***	(1660.96)	29
3	1.109***	(630.56)	1.159***	(549.14)	0.985***	(1560.64)	29
4	1.108***	(633.02)	1.156***	(550.69)	0.985***	(1644.26)	28
5	1.110***	(598.77)	1.158***	(513.58)	0.987***	(1699.21)	28
6	1.112***	(648.94)	1.156***	(570.91)	0.988***	(1980.40)	26
7	1.123***	(646.05)	1.167***	(573.85)	0.987***	(1961.39)	24
8	1.126***	(621.41)	1.170***	(553.36)	0.986***	(1757.23)	24
10	1.119***	(755.85)	1.165***	(670.62)	0.983***	(1868.72)	25
11	1.120***	(794.22)	1.168***	(697.71)	0.984***	(2099.29)	26
12	1.123***	(743.88)	1.168***	(660.31)	0.986***	(2163.56)	25
13	1.119***	(747.04)	1.165***	(654.99)	0.987***	(2166.90)	26
14	1.117***	(741.13)	1.166***	(644.09)	0.988***	(2284.66)	27
15	1.119***	(762.68)	1.166***	(671.13)	0.989***	(2540.10)	26
16	1.119***	(735.90)	1.170***	(634.75)	0.990***	(2680.25)	28
Observations	154300		113513		40787		

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Table 3: Development of efficiency scores

“being nourished”, i.e. via food expenditures). Due to the simplistic nature of this correlation analysis, this can be only a first approximation and one should probably not put too much emphasis on these correlations. For instance, these simple correlations do not include the relevant control variables.

### 5.2. Results and discussion

A first impression of the results of the efficiency analysis is given in Table 3 that lists the development of the order- $m$  efficiency scores over the years. The first column shows the mean efficiency score of all individuals over time which ranges from 1.109 in year 1 to 1.119 in year 16. Column two shows the mean of all inefficient individuals. A value of 1.155 in year 1 means that the average inefficient individual in 1991 achieves 15.5% less well-being with the same level of resources as the efficient individuals in this year. The third column shows the development of means of the efficient individuals and the fourth column depicts the percentage of efficient individuals each year. This number fluctuates over the time horizon of our analysis between 24% and 29%. This means that roughly one fourth to one third of the British populace are efficient in the transformation of their resources into well-being during our sample period. A first result of our analysis is that despite high levels of absolute well-being in the UK, the conversion of resources into well-being (as measured by our functionings) is still quite inefficient and subject to institutional and environmental constraints.<sup>20</sup>

To further illustrate these results, Figure 1 shows a histogram of the efficiency scores for the first sample year. It reveals that the distribution of efficiency scores is highly skewed and has a long tail. The largest group of inefficient individuals lies between 1.0 and 1.5, somewhat above the mean. The long tail of efficiency scores that is larger than 1.5 comprises

<sup>20</sup>These means are based on the assumption that a lack of functioning achievement in one dimension cannot be substituted with an excess in another dimension. The efficiency measure is quite robust to relaxing this assumption and allowing for substitutability in functionings: the correlation of efficiency scores with and without substitutability is  $r = 0.972$ .

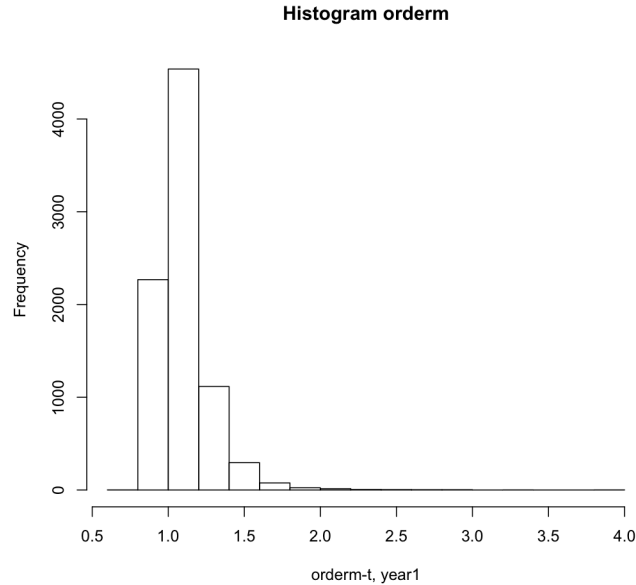


Figure 1: Conversion efficiency, year 1 (1991)

of only 2.8% of individuals in the first sample year. The degree of large inefficiency is rather small, thus. This observation is repeated in the other years of the sample period. What we can conclude from these results is that inefficiency in the UK has remained relatively stable over the last two decades.

Beyond these results, it is also of interest to find out more about the causes and influences of these inefficiencies. We have discussed in Section 2 that obstacles in the conversion of resources into achieved functionings can be of personal, environmental or social types. These conversion factors determine why one individual achieves higher functioning output than someone else with the same commodities (or why someone achieves a similar output with lower resources). These inefficiencies can be caused by a wide range of other factors not included into the analysis. As pointed out before, we use second-stage regressions to evaluate the effect of some individual conversion factors that are most commonly argued to influence an individual’s ability to convert resources into achieved functionings. However, opposed to the analysis in Binder and Broekel (2008), the regression framework here makes use of the panel data properties of the BHPS data set: we are using a fixed effects regression to control for individual-specific time-invariant factors that might influence individual (in)efficiency, such as for example genetic factors or stable personality traits. A Hausman test suggests that the fixed effects model is more efficient ( $\chi^2(9) = 3200.40; p = 0.0000$ ). Accordingly, we control for individual-specific time-invariant effects. In addition, time dummies are included to capture population-wide time-specific effects, e.g. economic shocks or boom phases.

Table 4 shows the results for the first type of second-stage FE regressions, where we explore the relationship between the levels of conversion efficiency and individual characteristics. In the table we report coefficients for age,  $age^2$ , education, as well as dummies for the different years, for being self-employed, being unemployed, being married, being separated, divorced or widowed (“d\_sepdivwid”), as well as being disabled and living in the London area.

Column one shows the results for the full data set, while columns two and three repeat the analysis disaggregated by gender to test the robustness of our findings. In the table, positive regression coefficients indicate a positive effect of the independent variables in question on the efficiency score.<sup>21</sup> The year dummies exhibit negative significant coefficients in all models suggesting that compared to the first year, conversion efficiency is reduced in all subsequent years. With the exception of unemployment, all coefficients are significant (and except for the linear age component, which is only significant at the  $p < 0.01$  level, all coefficients are also highly significant at the  $p < 0.001$  level). In detail, this means that age, education and self-employment increase an individual's conversion efficiency, while living in London, being disabled and being separated, divorced or widowed all decrease conversion efficiency. Quite interestingly, being married also decreases the conversion efficiency.

It is instructive to compare the gender disaggregation exercise (columns 2 and 3) as we cannot include the gender dummy in a FE model. Largely, there seem to be only minor gender differences. In terms of education, self-employment, separation/divorce/widowhood, disability and city life, there are no gender differences on conversion efficiency. The only gender differences seem to relate to age (where females do not exhibit a significant age coefficient) and marriage, where conversion efficiency is not significantly decreased for males but for females. While our analysis also shows that the mean of inefficient females is higher than that of inefficient males (i.e. of these who are inefficient, females are comparably less efficient than males), this should not be taken at face value since such a mean comparison of efficiency scores does not control for other influences such as education, and so on, and such a gender gap is not borne out in the fixed effects regression framework.<sup>22</sup> Other studies report that female individuals score lower in absolute functioning achievements (Sen, 1985a; Chiappero-Martinetti, 2000), and it has also been reported that females are overall more efficient in converting resources into health, educational and living safely functioning achievement (Chiappero-Martinetti and Salardi, 2007, although not all of the results for subgroups in this study were significant). Our analysis for Great Britain cannot corroborate such (extensive) gender inequalities in conversion efficiency.

The finding regarding self-employment validates the cross-sectional analysis in Binder and Broekel (2008): being self-employed has a positive impact on the conversion of income into achieved functioning. Self-employed persons usually are reported to be happier (Benz and Frey, 2004). Our findings show in a complementary fashion that regarding two individuals with the same resources, the one being self-employed is also more efficient in the conversion of his resources into achieved functioning.

Similarly straightforward is the case of the negative coefficient for being separated, divorced or widowed. The negative experiences of being separated, divorced, or widowed are likely to be an obstacle in the conversion of the given commodities into achieved functioning (however Deutsch et al., 2001, could find no effects for an Israelian sample). What is more puzzling is why marriage also should have a negative effect on conversion efficiency (this contradicts the cross-sectional findings in Binder and Broekel, 2008).

In the literature, one can also find that elder individuals score lower in the achievement

---

<sup>21</sup>We transformed the efficiency scores here so that positive coefficients refer to an increase in efficiency values (i.e., the individual becomes more efficient).

<sup>22</sup>We do not report the means by gender due to this concern.

	(1)	(2)	(3)	(4)	(5)	(6)
	order_m (FE)	male	female	$\Delta$ order_m	male	female
age	0.00197** (2.75)	0.00264* (2.52)	0.00144 (1.49)	0.00176 (1.23)	0.00361 (1.75)	0.000288 (0.15)
age2	-0.0000393*** (-16.59)	-0.0000275*** (-8.27)	-0.0000494*** (-14.83)	-0.000000393 (-0.19)	-0.00000283 (-1.01)	0.00000146 (0.47)
education	0.0151*** (21.18)	0.0150*** (15.74)	0.0151*** (14.61)	0.00238** (2.85)	0.00207 (1.89)	0.00262* (2.14)
d_selfemployed	0.0101*** (7.80)	0.0106*** (6.77)	0.00977*** (4.20)	0.00414* (2.46)	0.00533** (2.61)	0.00130 (0.44)
d_unemployed	-0.00236 (-1.58)	-0.00169 (-0.90)	-0.00403 (-1.65)	0.000708 (0.26)	-0.00148 (-0.46)	0.00391 (0.80)
d_married	-0.00641*** (-3.83)	-0.00343 (-1.66)	-0.00908*** (-3.48)	0.000717 (0.37)	-0.000533 (-0.23)	0.00187 (0.60)
d_sepdivwid	-0.0234*** (-10.54)	-0.0179*** (-6.08)	-0.0280*** (-8.54)	0.00208 (0.78)	0.00141 (0.41)	0.00271 (0.68)
d_disabled	-0.0250*** (-15.44)	-0.0285*** (-12.24)	-0.0219*** (-9.74)	-0.00601* (-2.43)	-0.00835* (-2.45)	-0.00406 (-1.14)
d_London	-0.0131*** (-4.17)	-0.00863* (-2.23)	-0.0178*** (-3.70)	-0.00650* (-2.07)	-0.00413 (-0.94)	-0.00890* (-1.98)
year2	-0.00497*** (-4.23)	-0.00605*** (-3.75)	-0.00402* (-2.37)	0.0242 (1.21)		
year3	-0.0108*** (-6.19)	-0.0129*** (-5.21)	-0.00895*** (-3.68)	0.0220 (1.18)	-0.00384 (-1.15)	-0.00104 (-0.28)
year4	-0.0132*** (-5.54)	-0.0166*** (-4.83)	-0.0103** (-3.13)	0.0233 (1.36)	-0.00476 (-1.01)	0.00215 (0.44)
year5	-0.0187*** (-6.14)	-0.0225*** (-5.07)	-0.0155*** (-3.71)	0.0171 (1.09)	-0.0112 (-1.68)	-0.00402 (-0.62)
year6	-0.0248*** (-6.68)	-0.0298*** (-5.53)	-0.0205*** (-4.04)	0.0142 (0.98)	-0.0178* (-2.12)	-0.00394 (-0.47)
year7	-0.0291*** (-6.61)	-0.0357*** (-5.57)	-0.0234*** (-3.90)	0.0139 (1.07)	-0.0203 (-1.94)	-0.00237 (-0.23)
year8	-0.0334*** (-6.59)	-0.0395*** (-5.34)	-0.0282*** (-4.09)	0.0128 (1.11)	-0.0211 (-1.69)	-0.00383 (-0.32)
year10	-0.0325*** (-5.07)	-0.0413*** (-4.40)	-0.0250** (-2.87)			
year11	-0.0360*** (-5.00)	-0.0451*** (-4.27)	-0.0283** (-2.90)	0.00759 (1.04)	-0.0311 (-1.67)	-0.00538 (-0.30)
year12	-0.0445*** (-5.64)	-0.0550*** (-4.74)	-0.0358*** (-3.34)	-0.00148 (-0.25)	-0.0439* (-2.15)	-0.0113 (-0.57)
year13	-0.0449*** (-5.19)	-0.0577*** (-4.55)	-0.0341** (-2.90)	0.00661 (1.47)	-0.0385 (-1.70)	-0.00105 (-0.05)
year14	-0.0471*** (-5.03)	-0.0603*** (-4.39)	-0.0360** (-2.84)	0.00243 (0.76)	-0.0430 (-1.74)	-0.00508 (-0.21)
year15	-0.0545*** (-5.41)	-0.0686*** (-4.64)	-0.0427** (-3.12)	-0.00521* (-2.42)	-0.0535* (-2.00)	-0.0104 (-0.40)
year16	-0.0562*** (-5.22)	-0.0718*** (-4.55)	-0.0431** (-2.95)		-0.0504 (-1.75)	-0.00346 (-0.12)
Constant	0.833*** (31.42)	0.819*** (21.42)	0.844*** (23.14)	0.904*** (12.01)	0.860*** (10.95)	0.985*** (12.72)
Observations	154300	72224	82076	112765	52657	60108
R <sup>2</sup>	0.037	0.042	0.035	0.001	0.002	0.001
F-statistic	96.06	48.71	51.53	5.392	4.159	2.424
corr(u.i, Xb)	-0.1658	-0.4385	0.0538	-0.7051	-0.9083	-0.2161
R <sup>2</sup> _within	0.0368	0.0423	0.0346	0.0012	0.002	0.001
R <sup>2</sup> _between	0.0208	0.0000	0.0934	0.0018	0.0024	0.0017
R <sup>2</sup> _overall	0.0513	0.007	0.124	0.0003	0.0004	0.0001
rho	0.6993	0.7547	0.6512	0.2938	0.4721	0.2265
sigma_u	0.0986	0.1039	0.0943	0.0675	0.0875	0.0618
sigma_e	0.0647	0.0592	0.069	0.1046	0.0925	0.1142
Deg. of Freedom	26535	12567	13967	20909	9821	11087

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Table 4: FE regression framework: influences on conversion efficiency

of absolute functionings levels (Chiappero-Martinetti, 2000). Our results add that being older nevertheless means being more efficient in the conversion of resources into functioning achievement to a certain extent. The quadratic age-term in the regression shows that the efficiency-age relationship follows an inverted-u-shape. Such a finding could be explained with reference to individuals learning over their life-time to more fully use their eligible resources and hence achieve their functionings more efficiently. But this only works up to a point when older age reverses the efficiency gains of experience (but see, Deutsch et al., 2001, who found that age decreases conversion efficiency to a certain point: in their study, ages above 57 led to an increase in conversion efficiency).

It is perhaps not very surprising to see that an individual conversion factor such as being disabled decreases the ability to efficiently convert resources into functioning achievement. This complements the findings that disabled individuals score lower in absolute functioning achievement than healthy individuals (Kuklys, 2005). Their absolutely lower levels could be explained in terms of a decreased efficiency of conversion, i.e. they score lower because their conversion is inefficient.

The last conversion factor examined is living in the area of London, and we find that this decreases conversion efficiency. While this influence was positive in a cross-sectional context, it seems the FE regression reverses this effect, so that city life diminishes the efficiency of converting one's resources into well-being (Deutsch et al., 2001, also investigated the effects of living in a city but did not find a significant effect in their sample). There are studies giving evidence that subjective well-being in cities is lower than outside of cities and our findings complement this type of result in adding that also the conversion efficiency is decreased by living in a big city such as London (e.g. Hudson, 2006; Gerdtham and Johannesson, 2001). Further research could explore whether this extends to other, not as big cities, as London.

To conclude we would like to point out that an  $R^2$  (within) of 0.037 indicates that a large part of the variance of conversion efficiency is yet unexplained, demanding further future research (a comparable level of  $R^2$  of 0.04 is reported by Deutsch et al., 2001).

### *5.3. Dynamics of conversion efficiency*

A final contribution of our paper lies in exploring the dynamics of conversion efficiency. More precisely, we analyze the development of conversion efficiency, i.e. the changes in efficiency scores and the factors influencing these changes. In Table 4 we report models, where the dependent variable is the growth rate of conversion efficiency for the overall sample (model 4) and then, again, a disaggregation by gender (models 5 and 6).

Self-employed (“d\_selfemployed”) persons are able to realize higher growth rates of conversion efficiency. This is interesting insofar as they also show higher levels of conversion efficiency. Coming already from high levels of conversion efficiency self-employed individuals are still able to outpace wage earners (control group). Accordingly, the gap between these groups should increase over time. This applies only to males who are self-employed. While self-employed females also show higher levels of conversion efficiency, the development of their conversion efficiency over time is not systematically different from that of the control group.

In contrast, females profit from increasing levels of education, which improve their conversion efficiency (“education” variable). This points towards the existence of a catch-up process, in which females are able to decrease their gap to the conversion efficiency frontier by obtaining higher degrees of education. There is no similar effect for males.

Similar gender differences are observable for disabled persons (“d\_disabled”) and living in London (“d\_London”). Disabled males not only have a significantly lower conversion efficiency, they also tend to fall behind the conversion efficiency frontier. Or, in other words, their situation is already bad and in most instances it is even spiraling downward. In contrast, if one is female and disabled, one seems to be able to keep at least a constant gap to the conversion efficiency frontier.

Last but not least, we find a gender specific effect for residence in the London area. We have shown earlier that living in London is detrimental to conversion efficiency irrespective of gender. The dynamic analysis reveals that females in London additionally are not able to increase their conversion efficiency. In fact, we observe the opposite pattern: most females in London fall further behind the conversion efficiency frontier. We can only speculate about the reasons for this development, which may be induced by a worsening of the situation in the London area or an increasing attractiveness of the other British regions.

While these processes are surely interesting, most of the variance in the change rate of conversion efficiency remains unexplained (the  $R^2$  (within) is as low as 0.001). The presented investigation can therefore be only the first step to a more substantial understanding of the intertemporal development of conversion efficiency in Great Britain.

## 6. Conclusion

The paper has contributed to the empirical functioning measurement literature in focussing on the “*conversion efficiency*” with which individual resources are transformed into achieved functioning. Individual differences in converting resources into achieved functioning have been stressed in theoretical contributions to the approach (in the form of “conversion factors”) but are notoriously difficult to capture empirically. A natural approach to deal with differences in conversion factors would be measuring how efficiently individuals convert resources into functionings by drawing on the efficiency analysis methodology used in production theory. The order- $m$  efficiency method we applied allowed us to compute for a given sample of individuals, and track over time, an efficient frontier on which are individuals who are most efficient in converting their resources into achieved functioning. The distribution of individual efficiency scores relative to that frontier allows some additional insights regarding the assessment of welfare in the space of achieved functionings. Based on the idea that inefficiencies are undesirable also in the context of the capability approach, we argue that a measure of conversion efficiency reflects the effects of diverse welfare-reducing institutional constraints on the individuals. Moreover, the development of conversion efficiency over time allows to assess the impact of policies targeting the diverse conversion factors.

Both ways of increasing well-being in functioning space are legitimate concerns for policy makers. While it is certainly most desirable to increase the absolute levels of well-being of individuals in a society, there exist reasons to also value increases in the relative levels (understood as increased efficiency in converting resources into well-being). One reason lies in the existence of upper bounds for certain dimensions of well-being: if absolute levels cannot further be increased by policies, one could target the efficiency with which these absolute levels of functioning achievement are reached. A second rationale for also targeting conversion efficiency lies in the relative costs that might be associated with increasing absolute functioning levels beyond a certain threshold. In order to be able to assess the effects of such

policies targeting conversion efficiency, it is thus necessary to examine the *development* of conversion efficiency of individuals in a society over time.

We have analyzed the development of conversion efficiency for a set of basic functionings, namely for the functionings “being happy”, “being healthy”, “being nourished”, “moving about freely”, and “being well-educated”. We have used the efficiency method to assess the development of conversion efficiency of this basket of functionings for the British Household Panel Survey (BHPS) data set over nearly two decades and found that under 30% of the British populace were efficient in their conversion of resources into functionings during the sample horizon. Moreover, age, education and self-employment increase an individual’s conversion efficiency, while living in London, being disabled and being separated, divorced or widowed all decrease conversion efficiency. Being married also decreases the conversion efficiency and we find few evidence of gender disparities in conversion efficiency. Further work could extend the measurement exercise to other countries or a more comprehensive set of functionings, as well as linking the development of conversion efficiency to diverse policy measures that were instituted during the sample period.

*Date: September 22, 2010; ca. 9,000 words*

## Appendix A

Changes in the order- $m$  efficiency over time are evaluated using the Malmquist index. In the context of our paper, the output-oriented order- $m$  Malmquist index measures the efficiency change relative to (the conical hull of) the frontier of the expected functioning achievement set of order- $m$  ( $\mathcal{P}_m^t$ ). Following Wheelock and Wilson (2003), this can be written as

$$\mathcal{M}_m(x^{t_1}, y^{t_1}, x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_1}, \mathcal{P}_m^{t_2}) = \left[ \frac{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_1}))}{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_1}))} \times \frac{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_2}))}{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_2}))} \right]^{\frac{1}{2}}, \quad (5)$$

where  $x^{t_1}, y^{t_1}$  are an individual’s resource and functioning achievement vectors,  $D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_1}))$  the Shephard order- $m$  output distance function, and  $\mathcal{V}(\mathcal{P}_m^t)$  defines the convex cone of conversion possibility set in period  $t_1$  and period  $t_2$ , respectively.

In order to analyze in more detail how an individual’s efficiency changes over time, it is common to decompose the index into a number of components (see for an overview Zofio, 2006). Here we follow Wheelock and Wilson (2003) in decomposing the order- $m$  Malmquist index into four parts.

$$\begin{aligned} \mathcal{M}_m(x^{t_1}, y^{t_1}, x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_1}, \mathcal{P}_m^{t_2}) &= \underbrace{\left( \frac{D(x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_2})}{D(x^{t_1}, y^{t_1} | \mathcal{P}_m^{t_1})} \right)}_{=\Delta M.Eff} \times \\ &\underbrace{\left( \frac{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_2})) / D(x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_2})}{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_1})) / D(x^{t_1}, y^{t_1} | \mathcal{P}_m^{t_1})} \right)}_{=\Delta M.SEff} \times \underbrace{\left( \frac{D(x^{t_1}, y^{t_1} | \mathcal{P}_m^{t_1})}{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_1}))} \times \frac{D(x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_1})}{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_1}))} \right)^{\frac{1}{2}}}_{=\Delta M.Fron} \times \\ &\underbrace{\left\{ \left[ \frac{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_1})) / D(x^{t_1}, y^{t_1} | \mathcal{P}_m^{t_1})}{D(x^{t_1}, y^{t_1} | \mathcal{V}(\mathcal{P}_m^{t_2})) / D(x^{t_1}, y^{t_1} | \mathcal{P}_m^{t_2})} \right] \times \left[ \frac{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_1})) / D(x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_1})}{D(x^{t_2}, y^{t_2} | \mathcal{V}(\mathcal{P}_m^{t_2})) / D(x^{t_2}, y^{t_2} | \mathcal{P}_m^{t_2})} \right] \right\}^{\frac{1}{2}}}_{=\Delta M.SFron} \end{aligned} \quad (6)$$

$\Delta M\_Eff$  is the measure of the change in the order- $m$  conversion efficiency. It shows whether the individual was able to decrease/increase its conversion efficiency gap (catching-up or falling behind) to the order- $m$  best-practice individuals.  $\Delta M\_SEff$  is an estimate of an individual's change in the order- $m$  scale efficiency. It indicates the extent to which an individual increases its efficiency because of a change in its magnitude of resources or functioning achievement that yield benefits (or not) from economies of scale.  $\Delta M\_Fron$  represents the change in the order- $m$  frontier between the two points in time due to technological change, and  $\Delta M\_SFron$  captures the effect of economies of scale on the order- $m$  frontier (for a more detailed discussion, see Wheelock and Wilson, 2003).

Given the type of data an evaluation of economies of scale seems to be of little use because most indicators of functioning achievement are measured on fixed ordinal scales. The terms  $\Delta M\_SEff$  and  $\Delta M\_SFron$  are therefore not relevant. The movement of the efficiency frontier  $\Delta M\_Fron$ , however, seems to be interesting, as it implies that a large number of individuals change their efficiency levels simultaneously. This may be induced by economic shocks, significant changes in the institutional framework, technological change, or any other type of change that influences large groups of individuals. While beyond the scope of the present paper,  $\Delta M\_Fron$  is interesting to study as it allows to assess advancements in the (national) social conditions for converting resources into functioning achievement.

## Appendix B

Table 5: Summary statistics of variables in PCA (BHPS variable name in brackets)

Variable	Mean	Std. Dev.	Min.	Max.	N
health	0.006	1.328	-7.988	1.666	154300
health status over last 12 months (hlstat)	3.827	0.943	1	5	154300
no. of visits to gp since 1.9.2005 (hl2gp)	3.587	1.2	1	5	154300
no. of serious accidents since 1.9.2005 (nxdts)	4.878	0.39	1	5	154300
log(days in hospital)	0.186	0.616	0	5.802	154300



## References

- Alkire, S. (2002). *Valuing Freedoms - Sen's Capability Approach and Poverty Reduction*. Oxford University Press, Oxford.
- Anand, P. and Hees, M. v. (2006). Capabilities and achievements: An empirical study. *Journal of Socio-Economics*, 35:268–284.
- Anand, P., Hunter, G., Carter, I., Dowding, K., Guala, F., and Hees, M. v. (2009). The development of capability indicators. *Journal of Human Development and Capabilities*, 10(1):125–152.
- Anand, P., Hunter, G., and Smith, R. (2005). Capabilities and well-being: Evidence based on the Sen-Nussbaum approach to welfare. *Social Indicators Research*, 74:9–55.
- Benz, M. and Frey, B. S. (2004). Being independent raises happiness at work. *Swedish Economic Policy Review*, 12:95–134.
- BHPS (2009). British Household Panel Survey. <http://www.iser.essex.ac.uk/ulsc/bhps/>.
- Binder, M. (2010). *Elements of an Evolutionary Theory of Welfare*. Routledge, London.
- Binder, M. and Broekel, T. (2008). Applying a robust non-parametric efficiency analysis to measure conversion efficiency in Great Britain. SSRN Working Paper No. 1104430; accepted for publication in: *Journal of Human Development and Capabilities*.
- Binder, M. and Coad, A. (2010). Disentangling the circularity in Sen's capability approach - an analysis of the co-evolution of functioning achievement and resources. *Papers on Economics & Evolution #1004*, accepted for publication in: *Social Indicators Research*.
- Bonaccorsi, A., Daraio, C., and Simar, L. (2005). Advanced indicators of productivity of universities. An application of robust nonparametric methods to Italian data. *Scientometrics*, 66(2):389–410.
- Brandolini, A. and D'Alessio, G. (1998). Measuring well-being in the functioning space. Mimeo.
- Burchardt, T. (2005). Are one man's rags another man's riches? Identifying adaptive expectations using panel data. *Social Indicators Research*, 74:57–102.
- Caves, D., Christensen, L., and Diewert, E. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica*, 50(6):1393–1414.
- Cazals, C., Florens, J.-P., and Simar, L. (2002). Nonparametric frontier estimation: A robust approach. *Journal of Econometrics*, 106(1):1–25.
- Chiappero-Martinetti, E. (2000). A multi-dimensional assessment of well-being based on Sen's functioning theory. *Rivista Internazionale di Scienze Sociali*, 108(2):207–231.
- Chiappero-Martinetti, E. and Salardi, P. (2007). Well-being process and conversion factors: An estimation of the micro-side of the well-being process. Mimeo.

- Clark, A. E. and Oswald, A. J. (2002). A simple statistical method for measuring how life events affect happiness. *International Journal of Epidemiology*, 31:1139–1144.
- Coelli, T. and Perleman, S. (1999). A comparison of parametric and non-parametric distance functions: With application to European railways. *European Journal of Operational Research*, 117:326–339.
- Daraio, C. and Simar, L. (2005). Conditional nonparametric frontier models for convex and non convex technologies: A unifying approach. *LEM Working Paper Series*, 12.
- Daraio, C. and Simar, L. (2007). *Advanced Robust and Nonparametric Methods in Efficiency Analysis - Methodology and Applications*. Kluwer Academic Publishers, Boston / Dordrecht / London.
- Dasgupta, P. (1990). Well-being and the extent of its realisation in poor countries. *The Economic Journal*, 100(400):1–32.
- Deprins, D., Simar, L., and Tulkens, H. (1984). Measuring labor efficiency in post offices. In Marchand, M., Pestieau, P., and Tulkens, H., editors, *The Performance of Public Enterprises: Concepts and Measurements*, pages 345–367. Elsevier.
- Deutsch, J., Ramos, X., and Silber, J. (2003). Poverty and inequality of standard of living and quality of life in Great Britain. In Sirgy, M. J., Rahtz, D., and Samli, A. C., editors, *Advances in Quality-of-Life Theory and Research*, chapter 7, pages 99–128. Kluwer Academic Publishers, Dordrecht.
- Deutsch, J., Silber, J., and Yacouel, N. (2001). On the measurement of inequality in the quality of life in Israel. Mimeo.
- Färe, R., Grosskopf, S., Lindgren, B., and Roos, P. (1992). Productivity changes in Swedish pharmacies 1980-1989: A nonparametric Malmquist approach. *Journal of Productivity Analysis*, 3:85–101.
- Färe, R., Grosskopf, S., Lindgren, B., and Roos, P. (1994). Productivity developments in Swedish hospitals: A Malmquist output approach. In Charnes, A., Cooper, W., Lewin, A., and Seiford, L., editors, *Data Envelopment Analysis: Theory, Methodology and Applications*. Kluwer Academic Publishers, Boston / Dordrecht / London.
- Farina, F., Peluso, E., and Savaglio, E. (2004). Ranking opportunity sets in the space of functionings. *Journal of Economic Inequality*, 2:105–116.
- Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 120(3):253–290.
- Gardner, J. and Oswald, A. J. (2007). Money and mental wellbeing: A longitudinal study of medium-sized lottery wins. *Journal of Health Economics*, 26:49–60.
- Gerdtham, U.-G. and Johannesson, M. (2001). The relationship between happiness, health, and socio-economics factors: Results based on Swedish microdata. *Journal of Socio-Economics*, 30:553–557.

- Hudson, J. (2006). Institutional trust and subjective well-being across the EU. *Kyklos*, 59(1):43–62.
- Kolenikov, S. and Angeles, G. (2009). Socioeconomic status measurement with discrete proxy variables: Is principal component analysis a reliable answer? *Review of Income and Wealth*, 55(1):128–165.
- Kuklys, W. (2005). *Amartya Sen's Capability Approach - Theoretical Insights and Empirical Applications*. Springer, Berlin et al.
- Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74(2):132–157.
- Lelli, S. (2001). Factor analysis vs. fuzzy sets theory: Assessing the influence of different techniques on Sen's functioning approach. Center for Economic Studies Discussion Paper Series 01.21.
- Lelli, S. (2005). Using functionings to estimate equivalence scales. *Review of Income and Wealth*, 51(2):255–284.
- Levy, H. and Jenkins, S. P. (2008). Documentation for derived current and annual net household income variables, BHPS waves 1-16. Institute for Social and Economic Research, University of Essex, Colchester.
- Lovell, C. A. K., Richardson, S., Travers, P., and Wood, L. (1994). Resources and functionings: A new view of inequality in Australia. In Eichhorn, W., editor, *Models and Measurement of Welfare and Inequality*. Springer-Verlag, Heidelberg.
- McClements, L. D. (1977). Equivalence scales for children. *Journal of Public Economics*, 8(2):191 – 210.
- Nussbaum, M. C. (2000). *Women And Human Development*. Cambridge University Press, Cambridge.
- Qizilbash, M. (2002). Development, common foes and shared values. *Review of Political Economy*, 14(4):463–480.
- Ramos, X. (2008). Using efficiency analysis to measure individual well-being with an illustration for Catalonia. In Kakwani, N. and Silber, J., editors, *Quantitative Approaches to Multidimensional Poverty Measurement*, chapter 9, pages 155–175. Palgrave Macmillan, Basingstoke.
- Ramos, X. and Silber, J. (2005). On the application of efficiency analysis to the study of the dimensions of human development. *Review of Income and Wealth*, 51(2):285–309.
- Ravallion, M. (2005). On measuring aggregate “social efficiency”. *Economic Development and Cultural Change*, 53(2):273–292.
- Robeyns, I. (2005). Selecting capabilities for quality of life measurement. *Social Indicators Research*, 74:191–215.

- Robeyns, I. (2006). Gender inequality in functionings and capabilities: Findings from the British Household Panel Survey. In Bharati, P. and Pal, M., editors, *Gender Disparity: Its Manifestations, Causes and Implications*, chapter 13, pages 236–277. Anmol, Delhi.
- Roche, J. M. (2008). Monitoring inequality among social groups: A methodology combining fuzzy set theory and principal component analysis. *Journal of Human Development and Capabilities*, 9(3):427–452.
- Sen, A. K. (1984). Rights and capabilities. In *Resources, Values and Development*, pages 307–324. Harvard University Press, Cambridge/Mass.
- Sen, A. K. (1985a). *Commodities and Capabilities*. North-Holland, Amsterdam.
- Sen, A. K. (1985b). Well-being, agency and freedom: The Dewey lectures 1984. *The Journal of Philosophy*, 82(4):169–221.
- Sen, A. K. (1992). *Inequality Reexamined*. Clarendon Press, Oxford.
- Sen, A. K. (1993). Capability and well-being. In Nussbaum, M. C. and Sen, A. K., editors, *The Quality of Life*, pages 30–53. Clarendon Press, Oxford.
- Shields, M. A. and Wheatley Price, S. (2005). Exploring the economic and social determinants of psychological well-being and perceived social support in England. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 168(3):513–537.
- Taylor, M. F. E. (2009). British Household Panel Survey User Manual Volume A: Introduction, Technical Report and Appendices. edited with John Brice, Nick Buck and Elaine Prentice-Lane. Colchester: University of Essex.
- UNDP (2006). Human Development Report. <http://hdr.undp.org/hdr2006/report.cfm>.
- Wheelock, D. C. and Wilson, P. W. (2003). Robust nonparametric estimation of efficiency and technical change in U.S. commercial banking. *The Federal Reserve Bank of St. Louis Working Paper Series*, 37A:1–34.
- Wilson, P. W. (1993). Detecting outliers in deterministic nonparametric frontier models with multiple outputs. *Journal of Business & Economic Statistics*, 11(3):319–323.
- Zofio, J. L. (2006). Malmquist productivity index decompositions: A unifying framework. *Economic Analysis Working Paper Series of the University of Madrid*, 12.