Energy Policy 86 (2015) 123–132

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Dynamic properties of energy affordability measures

Peter Heindl [a,*], Rudolf Schuessler [b]

[a] Centre for European Economic Research, Department of Environmental and Resource Economics, L7 1, 68161 Mannheim, Germany
[b] University of Bayreuth, Department of Philosophy and Economics, Universitätsstraße 30, 95447 Bayreuth, Germany

HIGHLIGHTS

- We investigate changes in fuel poverty measures as result from changes in income and expenditure.
- More generally, we investigate dynamic behavior of affordability measures using microsimulation.
- We propose axioms regarding dynamic behavior of affordability measures.
- Some measures which are used in practice show unintuitive dynamic behavior.
- Inappropriate dynamic behavior causes a risk of false policy implications.

ARTICLE INFO

Article history:
Received 24 March 2015
Received in revised form
29 June 2015
Accepted 30 June 2015

JEL classification:
I32
D63
Q48

Keywords:
Affordability measures
Energy poverty
Fuel poverty
Energy affordability

ABSTRACT

Measures of affordability and of fuel poverty are applied in practice to assess the affordability of energy services, for example, or of water or housing. The extensive body of literature on affordability measures has little overlap with the existing literature on poverty measurement. A comprehensive assessment of the response of affordability measures as a result of changes in the distribution of income or expenditure (the dynamic properties) is missing. This paper aims to fill this gap by providing a conceptual discussion on the 'dynamics' of both energy affordability measures and fuel poverty measures. Several types of measures are examined in a microsimulation framework. Our results indicate that some measures exhibit odd dynamic behavior. This includes measures used in practice, such as the low income/high cost measure and the double median of expenditure share indicator. Odd dynamic behavior causes the risk of drawing false policy recommendations from the measures. Thus, an appropriate response of affordability measures to changes in relevant variables is a prerequisite for defining meaningful measures that inform about affordability or deprivation in certain domains of consumption.

1. Introduction

Measures of affordability are applied in practice and discussed as indicators of deprivation in different domains of consumption. Examples include the assessment of 'fuel poverty' (viz. affordability measures with respect to energy services) in the United Kingdom (UK) (Boardman, 2012; Liddell et al., 2012), affordability of water (García-Valiñas et al., 2010; Gawel et al., 2013), and housing (Bourassa, 1996; Hancock, 1993). Affordability measures are a distinct form of poverty measure that focus on a specific domain in consumption. Many affordability measures are defined on the basis of disposable household income and expenditure, thereby assuming the notion of a bivariate poverty measure which is simultaneously determined by two variables (e.g. expenditure *and* income) rather than by a single variable (e.g. income only). The measures often allow the assessment of a 'poverty gap' (or a weighted poverty gap) and are decomposable using methods such as the one proposed by Foster et al. (1984).

The role of affordability measures in poverty research and their practical use for policy-making is disputed. The practice of assessing fuel poverty in the UK based on affordability measures is criticized for lacking scientific foundation (Healy, 2004), and the existing literature on the issue seems to have little overlap with the general literature on poverty. Despite this criticism, poverty in certain domains of consumption (e.g. energy and housing) has caught the attention of policymakers and the general public. The reasons for this trend are the persistent and partly growing inequality in Europe and beyond (OECD, 2011) and the pronounced

* Corresponding author.
E-mail addresses: heindl@zew.de (P. Heindl), rudolf.schuessler@uni-bayreuth.de (R. Schuessler).

http://dx.doi.org/10.1016/j.enpol.2015.06.044
0301-4215/

(partly temporary) increases in prices for certain goods. There are considerable differences in the level of protection achieved across EU member states, in particular with respect to the affordability of energy services (Bartl, 2010).

Any definition of affordability should clearly rest upon a rigorous empirical assessment of deprivation in the relevant domains. Well-established methods for such assessments exist, for instance, relative focal points for deprivation as described by Halleröd (2006). Given a consensus on which aspects of deprivation in consumption need to be represented, it should be possible to define a meaningful poverty line based on a proper empirical foundation. Most of the literature on fuel poverty or energy poverty in developed countries focuses precisely on this 'static' aspect of affordability, raising the question of how to define deprivation in energy consumption.

The surprisingly large body of literature on the issue neglects one important aspect: the question of how affordability measures respond to changes in underlying variables, such as income or expenditure. This is related to highly policy-relevant questions such as: 'does affordability increase or decrease over time?' or 'does fuel poverty increase or decrease as a result of specific policies?' This 'dynamic perspective' of poverty is well developed for univariate aggregated poverty measures (Kakwani, 1980; Sen, 1976; Zheng, 1997). However, the relevant axioms cannot be directly adapted to affordability measures due to the measures' bivariate nature. It is nevertheless necessary to translate the spirit if not the letter of the axioms of poverty measures into those of affordability measures to assess their fundamental dynamic properties. In the absence of reasonable dynamic properties, affordability measures would be of little use in the domain of energy consumption or in any other domain.

The aim of this paper is to establish certain conditions to emulate the role of axioms of aggregated poverty measures for affordability measures. Section 2.1 presents a brief literature review. Section 2.2 discusses the relevant *normative requirements* for energy poverty measurement in a dynamic perspective. Against the backdrop of well-established axioms in univariate aggregate poverty measurement, two propositions are made of how affordability measures should behave in the dynamic perspective. The proposed requirements are tested based on microsimulation (Section 2.3). The two scenarios we are mainly interested in are a) an increase in expenditure for energy services with implicit ex-post redistribution, and b) increasing income inequality in society.

Our results show that some affordability measures have counter-intuitive dynamic properties. This includes measures such as the 'low-income/high-cost measure' or the 'two-times median expenditure share measure'. The measures remain unchanged or even indicate an increase of affordability in situations in which income is decreased or expenditure is increased. This could lead to a situation in which false policy implications are drawn from indicators of affordability or from measures of energy poverty, respectively.

2. Methods

2.1. Literature on energy poverty measures

The literature on fuel poverty or energy poverty pivots around two branches of measurement techniques. *Consensual measures* take a number of variables related to household energy efficiency and energy affordability into account to derive a measure of energy-related deprivation. This approach was first applied by Healy (2004). A more recent pan-European study using consensual measures was presented by Snell and Thomson (2013). Consensual measures depict energy poverty as an interplay between low income and poor residential energy efficiency. That is, consensual measures take aspects of affordability into account, such as the ability to keep the home adequately warm or to make ends meet, along with aspects of energy efficiency, such as leaking roofs or damp walls. This effectively is a combination of subjective (e.g. ability to keep the home warm) and objective (e.g. leaking roof or damp walls) indicators of energy-related deprivation.

The second family of measures is *affordability measures*. These focus on expenditure on energy services and disposable household income. An abundance of definitions of affordability measures exists (Heindl, 2015). The most well-known energy affordability measure is Brenda Boardman's *Ten Percent Rule* (TPR) (1991). The TPR was long used as the official measure of fuel poverty in the UK (Department of Energy and Climate Change, 2013). The TPR defines a household as fuel poor if it needs to spend ten percent or more of its disposable income on all housing-related energy services (electricity, space heating, water heating). The TPR is criticized for lacking scientific foundation and international comparability (Healy, 2004, p. 35), and several alternatives to measure energy poverty have been suggested. Alternative definitions of energy poverty based on median expenditure are discussed in the literature (Liddell et al., 2012, p. 27–29).

In a report commissioned in the UK by the Department of Energy and Climate Change, Hills (2012) presented the *Low Income/High Cost* indicator (LIHC) as an alternative to the TPR. The LIHC defines a household as energy poor if its expenditure on all energy services is above the median expenditure of all households and when that household falls below the official income poverty line after expenditure on all energy services (Hills, 2012, 2011). As proposed by Moore (2012), definitions of energy poverty could also be based on a *Minimum Income Standard* (*MIS*). A household is defined as energy poor if disposable income after expenditure on all energy services falls below the minimum income standard. Minimum income standards or budget standards exist, e.g. in Australia (Saunders, 2004, 1999), and have also been put forward for the UK (Bradshaw et al., 2008). In Germany, basic income under the social security scheme (SGBII rates) is determined by a minimum income standard that reflects the average expenditure of low-income households on several groups of goods.

To the best of our knowledge, no contribution has to date been made to the literature on the *dynamic properties* of affordability measures. Moore (2012) briefly discusses the issue by comparing TPR and 2M in the context of fuel poverty in the UK. He concludes that "*the current 10% of income definition can also exaggerate the impact of fuel prices.* […]" (Moore, 2012, p. 22). Moore's statement on the exaggerated impact of price changes under TPR is derived from a comparison to 2M. However, as it is unclear whether 2M has desirable dynamic properties, Moore's argument is weak.

2.2. Dynamic properties of measures of energy poverty

This paper examines how measures of energy poverty—the specific affordability measures we focus on here—behave under a variation of key parameters, such as income and expenditure. Before proceeding to the simulation, some guiding theoretical considerations seem in order. A few well-known indicators (or their standard interpretations) stand in a problematic relationship with the conditions postulated as axioms in the literature on poverty measurement, or they violate requirements that appear to be as plausible as these axioms. In general, measures of poverty should be plausible irrespective of a variation of income or expenditure in a society, and the same holds true for indicators of energy poverty. Indicators that fail this test should be discarded or modified. It is undisputable that poverty measures and energy poverty indicators should also satisfy certain ethical requirements, which can be derived from theories of distributive (or social)