



Household fuel use in developing countries: Review of theory and evidence

Christophe Muller^{a,*}, Huijie Yan^b^a Aix-Marseille Univ, CNRS, EHESS, Ecole Centrale, Greqam, Marseille, France^b Institut d'Asie orientale, Ecole Normale Supérieure de Lyon, 15 Parvis René Descartes, 69342 Lyon, Cedex 07, France

ARTICLE INFO

Article history:

Received 11 April 2016

Received in revised form 25 October 2017

Accepted 28 January 2018

Available online 31 January 2018

JEL classification:

Q41

Q42

R22

Keywords:

Household decisions

Fuel transition

Energy consumption

ABSTRACT

Owing to recent concerns about the negative externalities of traditional fuel use on the environment and health, the issue of the household fuel transition in developing countries, from dirty fuels towards clean fuels, is receiving growing research attention. This paper provides an up-to-date survey of the economic literature on household fuel use in these countries. We first present the conceptual and theoretical frameworks. Then we discuss the empirical results that show the wide range of factors that drive the household fuel transition and can be understood better by linking them with theory.

© 2018 Elsevier B.V. All rights reserved.

1. Introduction

Currently, around 2.7 billion people still rely primarily on traditional biomass for cooking and heating in developing countries (Yao et al., 2012). This is a cause of severe environmental and health problems. For example, the incomplete burning of these fuels is responsible for indoor air pollution, mostly associated with carbon monoxide, particulate matter, sulphur dioxide and nitrogen dioxide. These pollutants play a major role in generating respiratory diseases and cardiovascular mortality. The consumption of these fuels also spurs climate change by releasing carbon dioxide into the atmosphere. In turn, climate change damages agricultural production and subsequently threatens the nutritional health of human beings.

Because of these concerns, the issue of household fuel transition in developing countries, from dirty and traditional fuels to clean and modern fuels, is receiving growing research attention. A number of studies published over the past three decades investigate the factors driving the transition. Even though some studies are merely based on simple descriptive statistics, one can see the emergence of econometric methods to quantify the patterns and factors of household fuel use.

Despite intensive research, the knowledge about the determinants of household fuel use remains limited. For example, the actual impact of fuel prices on fuel substitution is still debated in the literature. Different conclusions are often reached concerning the effects of the social-economic

factors that drive fuel substitution. These divergences among authors translate into uncertainties when designing adequate energy policies.

In this context we review a wide body of literature on the subject. Our purpose is to identify the knowledge gaps regarding the factors that drive the fuel transition. Our survey complements and extends the contributions of Barnes and Floor (1996), Kowsari and Zerriffi (2011), Lewis and Pattanayak (2012), Malla and Timilsina (2014) and van der Kroon et al. (2013) in several respects¹. First, it presents a more comprehensive² and updated review of the existing empirical

¹ Barnes and Floor (1996), Kowsari and Zerriffi (2011), Lewis and Pattanayak (2012), Malla and Timilsina (2014) and van der Kroon et al. (2013) attempt to summarize some of the determinants of household fuel use in developing countries. Without referring to theoretical and empirical works, Barnes and Floor (1996) discuss some policies and strategies in the energy sector that can promote the transition to modern fuels in rural households. The literature reviewed by Kowsari and Zerriffi (2011) includes contributions from psychology, sociology and economics. Kowsari and Zerriffi (2011) provide a brief discussion on some of the main empirical findings by listing the factors affecting household energy use. The discussion is based primarily on analyses of descriptive statistics, while many econometric studies – our emphasis – are ignored in the discussion, such as An et al. (2002), Chen et al. (2006) and Israel (2002). Malla and Timilsina (2014) survey 34 empirical studies on households' cooking fuel choices, conducted over the period 1987–2013. However, many papers, like those by Démurger and Fournier (2011), Guta (2012), Lay et al. (2013), Lee (2013), Link et al. (2012) and Özcan et al. (2013), are not included. In the study by van der Kroon et al. (2013), a 'meta-analysis' is carried out, although it is only based on 7 studies. Lewis and Pattanayak (2012) provide an extensive review of household energy choice from 22 empirical studies that appeared between 1987 and 2011, while they miss important papers of the period 2012–2016.

² We discuss 65 papers, of which only 34 are mentioned in the previously surveyed literature.

* Corresponding author.

E-mail address: Christophe.muller@univ-amu.fr (C. Muller).

findings on household fuel transition in developing countries, detailing for the first time the related econometric and theoretical issues. Second, it reviews the current state of knowledge about the theory of household fuel use, a relatively little treated question. Third, it provides novel results of a synthetic analysis of this literature.

The remainder of the paper is organized as follows. Section 2 provides a review of the theoretical research, for which Table 1 reports model specimens. Section 3 discusses the empirical determinants of household fuel use. Finally, Section 4 concludes.

2. Theoretical literature

2.1. The “energy ladder” theory

The “energy ladder” is a commonly used concept in explaining household fuel use in developing countries. The energy ladder depicts a process by which households, as their income rises, move away from traditional fuels (e.g., biomass), first to adopt intermediate fuels (kerosene, coal) and then to use modern fuels (gas, electricity)³. In that sense the energy ladder concept serves as a stylized extension of the typical income effect of consumer economic theory that explains how consumers substitute necessary goods and luxury goods for inferior goods as their income rises. A subjacent assumption is that households are faced with an array of fuel choices that can be arranged according to increasing technological sophistication and that this is reflected in household preferences⁴. As a consequence, as their income increases, households shift to more sophisticated energy carriers and simultaneously give up less sophisticated alternatives.⁵ Although empirically such a hypothesis still has to be validated fully, it fits well with the common observations of the strong income dependency of household fuel use.

2.2. The ‘fuel stacking’ theory

However, Masera et al. (2000) criticize the energy ladder theory on the grounds that it cannot adequately describe the dynamics of households’ fuel use. Instead, they note that fuel stacking is common in both urban and rural areas of developing countries. Fuel stacking corresponds to multiple fuel use patterns, whereby households choose a combination of fuels from both lower and upper levels of the ladder. Indeed, modern fuels may serve only as partial, rather than perfect, substitutes for traditional fuels (van der Kroon et al., 2013, 2014). Multiple fuel use arises for several reasons, such as occasional shortages of modern fuels (Hosier and Kipondya, 1993; Kowsari and Zerriffi, 2011), the high cost of appliances associated with using exclusively modern fuels (Davis, 1998), fluctuations of commercial fuel prices (Leach, 1992) and preferences inducing households not to adopt modern fuels fully (Masera et al., 2000). The complexity of the fuel-switching process thus suggests that there is a multiplicity of factors, besides income, that may affect fuel use. This leads some authors to delve into more sophisticated modelling approaches.

2.3. Urban household models

Edwards and Langpap (2005) and Gupta and Köhlin (2006) set up household consumer models to describe the simultaneous consumption of non-commercial and commercial fuels in urban areas. They model households’ fuel consumption by following standard consumers’ utility maximization principles subject to a budget constraint, which brings

about the driving role of prices. Even in this narrow setting, the considered consumption goods vary with the studied contexts and the authors. For example, Edwards and Langpap (2005) suppose that households maximize their utility through the consumption of fuels, market goods and stoves. Instead, Gupta and Köhlin (2006) assume that utility can be defined as including the consumption of fuels, food, health and other goods. These diverse specifications correspond to implicit assumptions of separability in preferences to allow for two-stage budgeting focusing on some goods of interest only. In all cases fuel consumption is seen as being fully determined by income, market prices and household preferences. However, this approach makes it hard to understand how non-market fuels, such as firewood and straw, may be included in household decisions and how the interaction with agricultural activities involving these products occurs.

2.4. Agricultural household models

As a response to these limitations, a few authors propose a more complex theoretical framework, which is particularly well suited to rural households. It is well recognized that rural households in developing countries often face absent or incomplete markets, not only for fuels (e.g., firewood) but also for agricultural products, labour and credit. In the absence of market failure, a rural household may be seen as behaving first as a profit-maximizing producer and then as a utility-maximizing consumer given the profit realized in the first stage. Instead, under market failure the allocation decisions for production and consumption are made jointly in a non-separable fashion.

Different types of market failures may lead to non-separabilities that matter for the analysis of fuel use. For example, Heltberg et al. (2000) consider the market failures for crop residues, animal dung and labour. They study the substitution of private non-marketed fuels (animal dung and crop residues) for firewood in response to increasing firewood scarcity. In that case diverse rural households’ decisions relating to energy supply, energy demand and farm and off-farm labour supply are made simultaneously. In this framework rural households are modelled as maximizing their utility subject to leisure and budget constraints, an agricultural production function, a residue and dung production function and finally a fuelwood collection function. Even under separability the household total income is endogenous, since it depends on production decisions that generate farm profits. A further complication brought by non-separability is that the production constraints, or other non-budget constraints, have to be considered explicitly in the determination of consumption decisions instead of merely summarizing their effects through an extended income variable in the budget. The fuel use decisions may thus be seen as being guided by the household-specific shadow prices of fuels, which depend on the household and community characteristics associated with preferences and all the constraints.

Chen et al. (2006) extend the approach of Heltberg et al. (2000) by introducing the missing market for firewood and emphasize the substitution between firewood and coal. Manning and Taylor (2014) consider rural labour market failures and substitutions between firewood and gas. Finally, Muller and Yan (2014) propose a fully fledged non-separable decision model that simultaneously links fuel use decisions with agricultural production, domestic technology, fuel collection technology and fuel rationing.

2.5. Assessment

The theoretical frameworks discussed above rely heavily on consumer theory, which provides the prominent explanation for household fuel transition in developing countries. These approaches have progressively integrated the way in which fuel decisions occur as part of household activities. However, the challenge is still significant in obtaining sophisticated and tractable explanations for fuel uses in less developed countries. Detailed descriptions of market failures, domestic technologies,

³ Chambwera and Folmer (2007), Heltberg (2005) and Lay et al. (2013).

⁴ Chambwera and Folmer (2007), Hosier and Dowd (1987) and Link et al. (2012).

⁵ Kowsari and Zerriffi (2011) and Rahut et al. (2014).

Download English Version:

<https://daneshyari.com/en/article/7350940>

Download Persian Version:

<https://daneshyari.com/article/7350940>

[Daneshyari.com](https://daneshyari.com)