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# Personality traits and renewable energy technology adoption: A policy case study from China

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ABSTRACT

This paper examines the role played by personality traits on the adoption decision of renewable energy technologies. As a case study, we examine a policy for biogas technology adoption in rural China, and implement a large in-person farm-household survey. We find that farmers with a higher level of openness to experience are more likely to adopt the biogas technology. In contrast, farmers with a lower level of confidence in influencing outcomes they experience are less likely to adopt the biogas technology. In addition, we find that openness seems to affect adoption through the perceived ease of use of the technology. Our findings indicate that including personality traits into adoption models of renewable energy technologies can give us a better understanding of individual differences in the adoption decision, and highlight the importance of energy policies that aim to improve the perception of the ease of use of these technologies.

## 1. Introduction

In recent years, the adoption of renewable energy technologies has been seen as a promising way to achieve sustainable development. The use of renewable energy technologies may address several problems such as energy shortage, air pollution, and climate change (Dincer, 2000; Panwar et al., 2011). How to promote the adoption of renewable energy technologies and what factors affect the adoption decision have gained importance over time for the implementation of energy policies. Previous empirical studies on technology adoption mainly focused on standard demographic, socioeconomic, political, and technical factors (e.g., Arkesteijn and Oerlemans, 2005; Mills and Schleich, 2009; Walekhwa et al., 2009; Rebane and Barham, 2011; Sardianou and Genoudi, 2013). This paper goes beyond standard analysis and answers the questions on whether and how individuals' personality traits affect the decision on whether to adopt renewable energy technologies.

In this study, the renewable energy technology of interest is a biogas technology used by rural households in China and promoted by the Chinese government. Biogas is produced in a pool of 6–8 m using organic materials such as animal manure (CRESP, 2008; Weiland, 2010). As a renewable energy source, biogas is able to substitute traditional energy materials such as firewood and coal, and thus, it can have several benefits such as reducing carbon emissions and levels of air pollution (Katuwal and Bohara, 2009; Panwar et al., 2011). Rapid economic development has led to a dramatic increase in energy consumption in China. In 2013, the total energy consumption was 3.75 billion tons of standard coal equivalent, and coal, oil, and natural gas accounted for 90% of the total energy consumption.[1] The Chinese government seeks to use renewable energy sources to substitute for non-renewable energy sources. In China's 13th Five Year Plan for Energy Development (2016–2020), the share of non-fossil fuels in total primary energy consumption is set at 15% by 2020.[2]

According to China's Renewable Energy Medium and Long Term Planning, the government's objective is to have about 80 million households using biogas by 2020.[3] To speed up the adoption of biogas technology in rural China, the central Chinese government has started a rural biogas program through all the provinces of mainland China in 2003. The biogas program annually receives a governmental investment of ¥2.5 billion and subsidizes participants to build biogas pools (MOA, 2007).[4] However, less than half of the suitable households have

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[1] Source: National Bureau of Statistics of China (http://data.stats.gov.cn/index.htm, last accessed March 13, 2017).
[2] Source: Central Chinese government (http://www.gov.cn/zwgk/2013-01/23/content_2318554.htm, last accessed March 13, 2017).
[3] Source: Central Chinese government (http://www.gov.cn/zwgk/2013-01/23/content_2318554.htm, last accessed March 13, 2017).
[4] One U.S. Dollar ≈ Six Chinese Yuan.

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built biogas pools in rural China by 2015 (MOA, 2007; Feng et al., 2012), and there is still room for significant further development.[5] Therefore, it is important to understand what factors drive farmers' adoption of the biogas technology.

Technology adoption theory suggests that personality may be an important determinant of adoption (Rogers, 1995). Personality refers to individual differences in patterns of behavior, thought, and emotion (Funder, 2001). In particular, a widely used and well-established framework to model individuals' personality is the Big Five personality model. This model suggests that there are five basic factors capturing an individual's personality structure: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Costa and McCrae, 1992a; McCrae and John, 1992). Open individuals, for example, prefer more novelty over familiarity and so might be more likely to adopt a new technology while neurotic individuals are more anxious and negative about new experiences and so might be less likely to adopt new technologies. Costa and McCrae (1992a) argue that the Big Five model captures the basic structure of personality because the Big Five personality traits are stable over time (especially in adulthood); are developed based on the analysis of natural languages and personality theories; are found across sexes, races, and cultures; and have some biological foundation.[6]

The locus of control is another popular indicator of personality capturing individuals' beliefs on whether results of events they experience are determined by factors internal or external to themselves (Rotter, 1966). Individuals with an internal locus of control tend to think that their own behavior and skills determine the results, while individuals with an external locus of control tend to believe that external factors such as luck and fate, which are beyond their control, determine the results. Individuals characterized by a more external (less internal) locus of control are less confident in handling new technologies and influencing outcomes, so they are expected to be less likely to adopt the biogas technology.

Empirical studies have investigated the effect of personality on several outcomes such as earnings (Heineck and Anger, 2010), life satisfaction (Boyce and Wood, 2011), employment and social status (Viinikainen and Kokko, 2012; Fletcher, 2013; Bucciol et al., 2015), household finances (Brown and Taylor, 2014), energy conservation (Shen et al., 2015) as well as software tool adoption (Svendsen et al., 2011). This paper aims to provide the first empirical evidence on the relationship between personality traits and renewable energy technology adoption. In addition, this study contributes to the limited literature on the role played by personality traits for technology adoption in general. There are very few studies testing this effect empirically, and they all focus on information system technologies or crop management technologies (e.g., Maybery and Crase, 2004; Devaraj et al., 2008; Svendsen et al., 2011; Hsia et al., 2012; Barnett et al., 2015).

We find that farmers who are more open to new experiences are more likely to adopt the biogas technology while farmers with a more external locus of control are less likely to adopt the biogas technology. In addition, we show that openness seems to affect adoption through the perceived ease of use of the new technology. Our findings indicate that including personality traits into the adoption models of renewable energy technologies can give us a better understanding of individual differences in the adoption decision, and highlight the importance of energy policies that aim to improve the perception of the ease of use of these technologies.

The paper is organized as follows. Section 2 reviews the literature on the Big Five personality traits and the locus of control, their effects on technology adoption, and proposes some hypotheses to test empirically. Section 3 describes the survey and the data used in the analysis. Section 4 presents the estimation results. Section 5 concludes by offering some final remarks.

## 2. Conceptual framework and hypotheses

Costa and McCrae (1992b) group major personality traits into five domains (also called the Big Five): (i) openness to experience, (ii) conscientiousness, (iii) extraversion, (iv) agreeableness, and (v) neuroticism. (i) Openness captures individual differences in attitudes towards new experiences. Open individuals are creative, perceptive, and imaginative. (ii) Conscientiousness measures how individuals are governed and organized by themselves. Conscientious individuals are thorough, efficient, and organized. (iii) Extraversion describes how individuals interact with others. Extraverted individuals are talkative, sociable, and outgoing. (iv) Agreeableness presents how individuals care for others. Agreeable individuals are kind, caring, and considerate. (v) Neuroticism refers to differences in emotions when individuals experience stressors. Neurotic individuals tend to show negative emotions (e.g., anxiety, nervousness, and depression).

Locus of control is another personality variable widely used for explaining individual behaviors. As proposed by Rotter (1966), locus of control refers to the extent to which individuals think they can have control over their lives. It is a one-dimensional concept that treats internal and external locus of control as opposite ends of the spectrum. Individuals with a strong internal locus of control tend to think that internal factors such as their own behaviors or personal characteristics determine the outcomes, while individuals with a strong external locus of control tend to think that external factors beyond their control such as fate, chance, luck, or other individuals determine the outcomes.[7]

In technology adoption theory, personality is considered an important factor affecting the adoption of new technologies (Rogers, 1995). For instance, individuals differ in openness to experience, which implies that they may have different attitudes toward adopting a new technology that is a new experience to them. More open individuals may favor the experience of using a new technology. However, empirical studies testing this hypothesis are scarce, and they mainly focus on crop management or information system technologies. Maybery and Crase (2004) find that openness has a positive effect on farmers' actual and intended adoption of recommended practices in crop management, while agreeableness has a negative effect. Devaraj et al. (2008) find that openness and agreeableness have positive effects on students' intentions to use a collaborative information system, while neuroticism has a negative effect. Svendsen et al. (2011) find that extraversion and openness have positive effects on individuals' intentions to use a new software tool, while neuroticism has a negative effect. Hsia et al. (2012) show that individuals having a more internal (less external) locus of control are more likely to accept e-learning systems. In addition, openness and locus of control are found to affect the adoption decision by affecting individuals' perceived ease of use of the technology (Svendsen et al., 2011; Hsia et al., 2012).

Openness refers to individuals' propensity to try new things and experiences. Open individuals are likely to be more willing to change and try new technologies. In our case study, the biogas technology is a new technology for farmers in rural China. We expect that openness

[5] Source: National Energy Administration of China (http://nea.gov.cn/2015-04/23/c_134177383.htm, last accessed March 13, 2017).

[6] Some researchers such as Digman (1997) and Musek (2007) find significant correlations between the Big Five factors and suggest using the Big Two or the Big One instead of the Big Five. However, using higher-order factors of the Big Five may generate biased results especially when the effects of the Big Five differ in size and sign (Wichert and Pohlmeier, 2010). Like most studies, we use the original definition and use the Big Five personality traits.

[7] Some studies such as Collins (1974), Gatz and Good (1978) suggest independent traits based on factor analysis. However, factor analysis does not necessarily capture the true structure of the locus of control, and it is more appropriate to assume that individuals switch from internal to external locus of control with different degrees, not different kinds (Rotter, 1975, 1990). Therefore, we treat the locus of control as a one-dimensional concept as in the original definition.