Investment in Energy Efficiency, Adoption of Renewable Energy and Household Behavior: Evidence from OECD countries

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Executive summary

Most of the world's electricity (60%) is consumed in residential and commercial buildings (IEA, 2008a). Specifically, residential buildings contribute 23% to global final energy demand (IEA, 2007) and 17% to world CO2 emissions (OECD/IEA, 2015). Therefore, there is great potential to reduce overall energy demand in the residential sector. There are some possible synergies between energy efficiency measures and renewable energy adoption in the sense that the former reduces energy demand so that the latter can further cut future GHG emissions. The IRENA (2014) report states that emissions savings from renewable energy deployment combined with energy-efficiency gains, would be sufficient to set the world on a path to prevent catastrophic climate change. Furthermore, Dato (2016) shows that it favours full transition to the sole use of renewable energy. There is considerable literature on either demand for clean energy (Gerpott and Mahmudova, 2010; Sardianou and Genoudi, 2013; Zhai and Williams, 2012) or investment in energy efficiency (Dietz et al., 2009; Heslop et al., 1981; Howarth, 1997; Urban and Ščasn`y, 2012) in the residential sector. To our knowledge, there is no specific study that investigates household behavior with respect to joint adoption of renewable energy and investment in energy efficiency; and the relationship between the two.

This paper fills a gap in the literature and aims to analyze (i) the relationship between adoption decisions of renewable energy and energy efficient technologies and (ii) the differential impact of the factors across the two decisions. We use a simple theoretical model to investigate the possible relationships between the decisions to invest in energy efficiency and in renewable energy. The level of the non-clean energy service and that of the renewable energy service depend on the level of investment in energy efficiency. The household may also gain some additional environment-related satisfaction due to the contribution of the investments in energy efficiency and in renewable energy in protecting the environment. This may depend on the cross effect of the two decisions. The theoretical model is followed by empirical investigations of the relationship between the two decisions. We explore whether the decision to adopt renewable energy and to invest in energy efficiency in the residential sector are related. We use a bivariate probit (biprobit) model for the joint decision. The biprobit model allows us to analyze the differential impact of the factors across the two decisions. Additionally, we investigate the determinants of the joint adoption of renewable energy and energy efficient technologies by computing a joint probability of adoption from the results of the biprobit model. For the two empirical investigations, we use the survey on Environmental Policy and Individual Behavior Change (EPIC) from the Organisation for Economic Co-operation and Development (OECD).

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The paper makes four contributions. First, we theoretically show that there is a cross effect threshold below (resp. above) which investment decisions in energy efficiency and in renewable energy of the household are substitutes (resp. complements). As a consequence, there are relationships between the two decisions. Second, the results of the biprobit model show that there is a positive interrelation between the decision of the household to invest in energy efficiency and to adopt renewable energy due to unobserved characteristics such as environmental motivations.

Third, the paper provides evidence about factors that affect the probability of adopting renewable energy and that of investing in energy efficiency. Notably, people living in poorer households are less likely to invest in energy efficiency and may end up using a high share of their income to pay for electricity. This is referred to as energy poverty in the literature. Unexpectedly, income has no significant effect on the adoption of renewable energy technologies. This can be explained by the existence of various financial supports among OECD countries to promote renewable energy. There is evidence of split incentives regarding decisions to invest in energy efficiency and to invest in renewable energy. Environmental motivations and commitment have mixed effects on both investments in energy efficiency and adoption of renewable energy. Trust in researchers, scientists and experts, has a positive effect on the two decisions.

Fourth, regarding the joint adoption, we find that the influence of income becomes less important in the decision of the household to go further when it has undertaken any of these investments. We also find that tenants are less likely to combine the two investments due to split incentives. Also, a household that has already undertaken one of the investments and is living in a detached dwelling is more likely to make additional efforts to invest in the second, while size of the residence has no significant effect. This limitation can be overcome by environmental motivations. In this sense, people who have already undertaken one of the investments and for whom environmental issues are generally more important than non-environmental issues, are more likely to have an additional motivation to address barriers that could prevent them from fully contributing to the energy transition.

With respect to policy, one should first consider the two decisions when designing incentive instruments for renewable energy adoption and for energy efficiency investment. Policies that rely on factors that jointly affect the two decisions would benefit from the synergies that may exist between them. For example, promoting a net zero-energy building by investing in both energy efficiency measures and renewable energy would facilitate reliance solely on renewable energy sources. Energy demand would therefore be markedly reduced due to efficiency gains, so that the remaining energy needs would be satisfied by means of renewable energy. Second, regulation of housing markets could help address split incentives by offering incentives to tenants to undertake investments in energy efficiency and in renewable energy as well. Financial support to reduce the costs of dismantling and re-installation of renewable energy equipment could provide incentives to tenants to undertake such investments as well. Third, policies targeting investment in energy efficiency need to be improved. It is necessary to set green grants, which should be interest-free targeting only energy-poor households. Fourth, it may be of great interest to work with existing charitable, environmental and local organisations to communicate with their members on the importance of energy transition. They are predisposed to better understanding the crucial contribution of the energy transition in protecting the environment.

Keywords: Energy efficiency; renewable energy; household behavior bivariate; probit.

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