# *Electricity Pricing and the Propensity to Purchase Dirty Fuels: Empirical Evidence from a Natural Experiment.*

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## Overview

The supply of energy below the market value is usually implemented by the countries to ensure that all people (both poor and non-poor) have access to affordable energy sources. This type of pricing strategy, however, is not without its drawbacks. Adequate pricing of energy needs to allow for cost recovery to minimize the power sector's negative macroeconomic, fiscal, environmental, and social impacts. More precisely, the low energy prices usually result in such negative consequences like the deterioration of energy infrastructure due to a lack of investments in this sector, low quality of the supplied energy, and rolling blackouts (Huenteler et al., 2017).

Many developing and transition countries recognize these issues and try to implement a more liberal market approach for pricing energy. The energy pricing that enables the cost recovery, however, can also lead to a number of undesired outcomes like deforestation, and high income shocks, especially among the poor and vulnerable segments of the population (Kaiser, 2000; Lampietti et al., 2007; Gassmann, 2014; Gassmann and Tsukada, 2014; Krauss, 2016). Some authors suggest that the effects of energy price increases on the poor could be mitigated by supplying some quantities of energy at a lower price (Freund and Wallich, 1997; Lampietti et al., 2007). This can be achieved essentially by implementing an increasing-block-tariffs (IBT) for the main energy sources, like gas, electricity, and the like.

Implementing IBT pricing, also, however, can be complicated by consumer inattentiveness (Borenstein, 2009; Ito, 2014), and cognitive bias (Lin and Zhu, 2021; Liu and Lin, 2020) which in turn may decrease the effectiveness of the IBT policies. Following the above arguments this paper investigates how the propensity to purchase dirty fuels was affected by the IBT electricity pricing in Russia, a transition economy, and one of the major exporters and consumers of world energy sources (IEA, 2021).

We employ the "Russian Longitudinal Monitoring Survey by Higher School of Economics (RLMS-HSE)", a household-level panel dataset, which among others also records whether the household has purchased some selected types[2] of dirty fuels during the last 30 days prior to the interview. The IBT tariff schemes were introduced in seven regions of Russia as an experiment in 2013. This was done as an attempt to introduce a cross-subsidizing scheme, where households with relatively higher electricity consumption subsidize part of the cost of supplying households that consume less electricity (Samofalova, 2014). Unlike, in many other countries, however, the consumption cut-offs of the higher-priced consumption blocks are household-specific, and are based, among others, on such factors as household size, whether the household is located in the urban or rural area, and whether it receives any social benefits (Veretennikova, 2014).

In particular, following Turdaliev (2021a, 2021b), where the author, using the same dataset, shows that the introduction of the IBT pricing scheme resulted in the increased propensity to purchase major home electrical appliances, and Turdaliev (2021c) where the author shows that the consumers are aware of the prescribed households specific block-cut-offs, we show that the IBT pricing schemes also resulted in the increased purchase of dirty fuels in these regions. This indicates that the effects of the IBT energy pricing schemes in Russia are quite complex, and may have both positive and negative environmental aspects.

## Methods

To estimate the effect of the introduction of the IBT electricity pricing on the purchase of dirty fuels by households this paper utilizes standard difference-in-differences (DD) (see, for instance, Angrist and Pischke, 2008) empirical specification. Our empirical model can be represented by Equation 1 below:

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[2] More specifically, firewood, coal, peat, or kerosene.

$$PurchDF_{it} = a_i + \tau_t + \boldsymbol{X}_{it}b_1 + ln\boldsymbol{W}_{it}b_2 + ln\boldsymbol{S}_{it}b_3 + (treatment * post)b_4 + \varepsilon_{it} \quad (1)$$

In particular, Equation 1 estimates the effects of the introduction of IBT pricing of electricity on the propensity to purchase dirty fuels (*PurchDF)* in the context of DD.
The variables on the right-hand side (RHS) consist of the time-varying vector *(X)* of household characteristics, such as total household income (in 2019 rubles), and household size. The vector S stands for the amount (in 2019 rubles) of any subsidies or discounts received by the household, while vector (*W)* controls for the weather conditions of the region. [3]
The $b_i$ are the parameters to be estimated. The parameter of interest is the parameter on the interaction term $(treatment * post)$, which stands for the interaction of the treatment region with its observation in the post-treatment period. This parameter is represented by $b_4$, which is the conventional DD parameter, that researcher tries to estimate in order to capture the effects of the treatment. The terms $a_i$ and $\tau_t$ stand for the household fixed effects, and the year fixed effects respectively.
We estimate the equation above using Ordinary Least Squares (OLS) with Fixed effects to take full advantage of the panel nature of the data. As indicated in Section 3 our dependent variable in Equation 1 is a binary choice variable, taking a value of one ($PurchDF_{it} = 1$) if the household has purchased firewood, coal, peat, or kerosene within the last 30 days, and taking a value of zero ($PurchDF_{it} = 0$) otherwise.
The binary nature of the dependent variable means that in the context of OLS, Equation 1 is estimated via a Linear Probability Model (LPM). The LPM model has several advantages compared to its nonlinear counterparts as Probit or Logit models. More specifically LPM is more convenient, computationally tractable, and may have less bias than other nonlinear model alternatives, especially in the context of panel data (see, for instance, Friedman & Schady, 2012).

## Results

Across all specifications, the IBT has a positive and statistically significant effect on the propensity to purchase dirty fuels. On average, IBT results in the 3.9 percentage points, or about 90%, increase in the propensity to purchase dirty fuels within the full sample of the households. The estimates of the LPM combined with the coarsened exact matching (cem) technique prior, results in the slightly smaller coefficient, indicating an increase of about 70%. Both estimates, however, are statistically significant at 1%.
Restricting the sample to the households which do not have access to the district heating, show that the propensity to purchase dirty fuels has increased by more than 15-percentage points (about 90% increase), and to more than 13-percentage points increase (or about 80% increase) in case of a prior cem application. As in the case of a full sample, the estimates for the households without district heating are statistically significant at 1%.

## Conclusions

To ensure access to affordable energy sources developing and transition countries often supply energy at below the market prices. However, this may lead to a number of negative outcomes like energy-intensive consumption and overconsumption of energy, which in turn leads to negative environmental impacts.
Literature often suggests supplying small amounts of energy at a lower price (Freund and Wallich, 1997; Lampietti et al., 2007), in order to minimize possible negative social impacts of the increased energy prices on the poor and negative environmental impacts resulting from the heavily subsidized energy pricing. This policy proposition can be achieved by implementing an increasing-block-tariff (IBT) for the main energy sources.
In this paper, we combine RLMS-HSE, a panel household data, with the introduction of the IBT schemes for residential electricity in three experimental regions of Russia to analyze the effects of the IBT schemes on the propensity of households to purchase dirty fuels. Using differences-in-differences empirical specifications we find that the propensity to purchase dirty fuels has increased in the regions where the IBT schemes were introduced. Depending on the specification, and the type of household we find that the size of the increase varies from more than 3-percentage points in the case of households connected to the central heating networks to about 15-percentage points increase among the households that do not have access to the central heating networks. This accounts for a roughly 70% increase, and 90% increase respectively compared to the households in the regions that did not implement IBT pricing. The empirical evidence from this paper suggest that the related environmental benefits that result from the implementation of the IBT pricing schemes (for example, in terms of the increased propensity to invest in energy efficiency, as reported in Turdaliev, (2021a, 2021b)) may be overstated if the possible negative environmental impacts resulting from switching to more affordable, but hazardous energy sources by the population as a response to the tariff-shifts is not taken into account by the policy makers.

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[3] In particular, we control for the log of degree days, log of precipitation, log of wind speed, and log of humidity levels across all 38 regions under the study. The weather data was provided by www.meteoblue.com.