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JEVONS' PARADOX AND THE IMPLICATIONS FOR EUROPE

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Overview

Natural resource consumption has increased considerably in the past two hundred years despite more efficient technology advancements. This correlation between increased natural resource consumption and increased efficiency is known as Jevons' Paradox. Since all the inputs to economic production come from the environment, increased resource consumption and ecosystem destruction should be of concern. Furthermore, the expenditure of natural resources to provide energy and other consumer goods is an irreversible process, worsening the human condition instead of improving human welfare as neoclassical theory would have one to believe. Therefore, sustainable development policies need to be considered to end the continued excess consumption, beyond sustainable levels, of natural resources and the potential resulting conflicts. To design environmentally sustainable policies, the effect of economic activity, of resource utilization, and increased efficiency must be understood. In this paper, we attempt to illustrate how human consumption of natural resources alters the natural state of the economy and the environment. Further, using energy data from the *Energy Information Administration* we develop models that provide empirical support that Jevons' Paradox may exist on a macro level for the countries of Europe. Specifically, twenty countries from Western Europe and five countries from Eastern Europe will be examined. Finally, the resulting policy implications and the applications for an ecological economic approach are explored.

Methods

To perform the analyses to determine if Jevons' Paradox may exist for the countries of Europe, three levels of investigation are performed. The first level of analysis is conducted on the regional level. In this paper, three regions are examined: (1) Western Europe, (2) Eastern Europe, and (3) the whole of Europe. In the regional analysis stage, time-series cross-sectional (TSCS) models are used. TSCS data eliminates heterogeneity and provides more informative data by eliminating the need for lengthy time series by utilizing the information available on the dynamic reactions of each subject (Kennedy 2003). TSCS data permits both spatial and temporal effects to be examined, allowing a subject to be studied over multiple sites and observed over a defined time frame; in this case energy consumption for four countries. Using time-series with cross-sections enhances the quality and quantity of data that would be impossible using only one of these two dimensions (Gujarati 2003). However, heteroscedasticity and autocorrelation are likely to exist. To correct for these problems maximum likelihood estimators are calculated by iterating the Generalized Least Squares method. Furthermore, if, as expected, correlation is present in the variables chosen for this study this technique provides unbiased estimators (Greene 2000). It is important to note that this technique does not produce a goodness-of-fit measure.

The second level of analysis that is performed is on the national level. To conduct these investigations a GARCH (1,1) model was used to analyze the time-series data. Time-series data allows for a sequence of observations to be examined to predict the future values of the variables. However, time-series data is likely to have heteroscedasticity and autocorrelation. The GARCH model, an alternative to standard time-series processes, was

used to correct for these problems, imposing a special structure on heteroscedastic disturbances to obtain OLS best linear unbiased estimators (Murray 2006). Maximum likelihood estimation of the GARCH model was used to determine if autocorrelation was present and to obtain estimators that are unbiased and error terms that are randomly distributed.

The third level of analysis is conducted on the sector level to obtain a better understanding of economic activity in each individual country. To perform these analyses the Multi-Scale Integrated Analysis of Societal Metabolism (MSIASM) approach is used. MSIASM allows for the different sectors of an economy to be disaggregated into various levels of economic and human activity to obtain a more comprehensive understanding of changes within an economy; in other words a hierarchical analysis. The conceptual parameters of the MSIASM approach were developed by Giampietro and Mayumi (2000a, 2000b), and we encourage the reader to refer to these papers for an in-depth explanation of MSIASM.

Results

Analysis finds that Jevons' Paradox may be in existence for the regions, as well as for the majority of the individual countries. The MSIASM model found that in some countries there have been structural changes to economies that have cause this result to occur. Furthermore, the results confirm, for the most part, that the variables that critics of Jevons' Paradox like to cite as reasons for its occurrence, such as population increases, are not a primary factor for the increases in energy consumption. However, energy intensity, used as a proxy for energy efficiency, is shown to be the major component in energy consumption.

Conclusions

Jevons' Paradox is of prime importance, especially in current times. Citizens around the world have to deal with the problems related to pollution. Energy blackouts, while rare, occur and will likely happen more often as energy demand increases. Every day the news reports on higher energy costs and a diminishing supply of natural resources to use for energy production. Policy-makers, scientists, economists, etc. around the world tell their countrymen not to worry, that new technological advances will take care of any future energy problems.

However, this paper has presented results that provide empirical analysis that the policy-makers, as well as others, are likely to be incorrect. If the proponents of technological improvements are correct, one would expect that efficiency gains would offset increases in population. But that is not the case. In fact, as Jevons' predicted so many years ago, energy usage tends to increase with new energy efficient technological advances. The likely reason for increased consumption is that increased efficiency decreases the cost of using the product (energy), thus promoting more consumption.

Then, the question remains, how the world's energy needs and problems can be solved. As has been shown in this paper, technology, unfortunately, is likely not the answer. The answer lies in changing the behavior of those that demand energy. Behavioral changes will not be easy, as it will require people around the world to alter their consumption habits. If consumption behaviors change then production patterns will also have to change, assuming the demand is not induced. Only through the recognition that technology will not solve the energy problem will new solutions be created.

References

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