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Communication

Persistence in natural gas consumption in the US: An unobserved component model

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ABSTRACT

This article re-examines the persistence in natural gas consumption using an alternative methodology. In particular we report estimates of an unobserved components model, in which hysteresis exists if cyclical and natural gas consumptions do not evolve independently. In addition, this framework is also extended by using the nonlinear approach, in which nonlinearities are introduced by allowing past cyclical component to have a different impact on the natural component depending on the regime. In a linear framework our results seem to indicate that hysteresis does not exist. However, when non-linearity is taken into account, we provide evidence in favor of hysteresis in natural gas consumption when the variations in natural gas consumption are above the threshold value. We also selectively survey the empirical literature that examines the long-term properties of energy series in order to put our contribution in perspective.

1. Introduction[1]

Natural gas is now at the heart of the debate about the present and future of energy in the US. There are several reasons behind this growing interest in natural gas. Firstly, US authorities have regarded natural gas as a means of reducing the dependence on other fuels fossils. Moreover, natural gas is considered as a promising candidate for meeting future demand under carbon dioxide (CO_2) emissions constraints (Apergis and Payne, 2010a). As a recent report from the MIT states natural gas may become a bridge to a low carbon future.[2]

Secondly, over the past few years, the US has new disposals of low cost gas that provide an enormous potential benefit to the nation—remember that the US has particularly large reserves of shale gas.

Finally, the US natural gas industry has been subject to several regulatory reforms with the aim of converting the natural gas market into a more competitive and efficient one (see Apergis et al., 2010b, p. 4735). As a result, not only efficiency gains appear but also increases volatility and the economy's susceptibility to external shocks (see, Mohammadi, 2011).[3] In this way, the dramatic increase in energy prices associated with the wave of popular uprisings that have swept over the Middle East and North Africa is a "hot" political issue at the time of writing. If tensions spread, the global economic recovery will be affected dramatically.[4] Some countries have reacted quickly, devising new conservative energy policies and promoting energy efficiency; others are rethinking the role currently played by alternative energy sources. In the US, the Obama administration regards the promotion of natural gas consumption as a promising candidate in this respect.[5] In fact, the existence of national large reserves of shale gas may be considered as a means of reducing the dependence on other fossil fuels and natural gas price volatility.

In this context, to know the long term properties of natural gas consumption should be a key question (Aslan, 2011; Apergis et al., 2010b) for several reasons.

If natural gas consumption is trend-stationary, policy shocks can be regarded as transitory: natural gas consumption eventually reverts to its underlying, long-run level. Then, policy makers should not adopt unnecessary targets (Hasanov and

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[2] Chapter 8. MIT Energy initiative, 2010. The Future of Natural Gas. An Interdisciplinary MIT Study. 〈http://web.mit.edu/mitei/research/studies/naturalgas.html〉.

[3] This fact advises taking into account the potential existence of regime shifts.

[4] Apergis and Payne (2010a) provide evidence of bidirectional causality between natural gas consumption and economic growth.

[5] In the last State of Union address (2011), the President Obama recognized the role of natural gas in clean energy future. Although natural gas is the cleanest of the fossil fuels, much of the enthusiasm in the United States and Europe for natural gas comes from its relative abundance and its location in places friendly to the West. The United States in particular has plentiful supplies.

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Telatar, 2011, p. 7726). If natural gas consumption is stationary, the shock dies away once the policy has been implemented, and energy consumption settles up at its new level. By contrast if the natural gas consumption is non-stationary, such shocks can have permanent effects.

On the other hand if natural gas consumption is non-stationary, then the past behavior of this variable cannot be used in formulating forecasts (Apergis et al., 2010b; Aslan, 2011; Barros et al., 2011,2012).

Finally, if natural gas consumption is non-stationary, then the unit root is transferred to other macroeconomic variables (Hsu et al., 2008, p. 2318; Narayan and Smyth, 2007, p. 338).

In our opinion, the lack of robust evidence associating energy policies with long term effects on the consumption is particularly striking and to provide robust evidence on how energy consumption evolves should be a key question in order to enhance the effectiveness and consistency of energy policies.

By using the definition of hysteresis of Blanchard and Summers (1986) we can initially describe hysteresis in energy consumption as a high degree of dependence of the current consumption level on the past. Using this definition, it is sufficient that the sum of the autoregressive coefficients in a linear model is close to – but not necessarily equal to – one. That is, hysteresis arises when energy consumption series has a unit root. The presence of a unit root in the process means it is path dependent. That is, any shock is entirely incorporated into the series level. Therefore, the easiest way to determine whether a hysteresis effect exists focuses on testing for the existence of a unit root (see Røed (1997) for a survey). In order to test the hypothesis of non-stationarity in this way, scholars have applied a wide range of tests: from the most widely used unit root tests, to the most recent tests which take into account possible structural breaks and non-linearities (Sollis, 2004).

However, in a time-series context, hysteresis can be defined and measured in various ways. An alternative approach proposed by Jaeger and Parkinson (1990, 1994) posits a more demanding criterion: hysteresis exists if shocks affect the natural rate of a variable, which itself follows a unit root process. In this case, temporary shocks have permanent effects while the cycle does not evolve independently of the natural component; it then follows that a unit root is a necessary but not a sufficient condition for hysteresis. In this article, we adopt Jaeger and Parkinson's (1990, 1994) definition of hysteresis in order to conduct a searching test and to explore whether energy policies on natural gas consumption have long-term effects.

To test for hysteresis in this way, we decompose natural gas consumption into two unobservable components: a non-stationary "natural" component, and a stationary "cyclical" component. These components can be estimated by maximum likelihood.[6] To the best of our knowledge its application to energy economics is novel.

On the other hand, and since the failure in detecting persistence may be attributed to non-linearity (see Maslyuk and Smyth, 2009; Aslan, 2011; Aslan and Kum, 2011; Hasanov and Telatar, 2011), once hysteresis is tested in the linear model, the new test for hysteresis based on a nonlinear unobserved components model, proposed by Perez-Alonso and Di Sanzo (2011), which introduces threshold type nonlinearities is applied. This is the second contribution of this paper.

This article has the following structure. The next section offers a selective review of key research to date on the topic of persistence in energy economics. It examines the existing evidence with respect to the ways in which the long-run properties of energy consumption/production time series have been analyzed until now. The next section describes the estimation methodology and the data. The fourth section presents and discusses the results. The final section concludes with a discussion of policy implications and some promising avenues for future research.

2. Selective survey of previous research

The study of long memory properties of energy consumption and production variables is an important and active research field in energy economics. Since the seminal article of Narayan and Smyth (2007), the empirical analysis on the persistence in energy consumption and production variables has generated a sizable literature that examines its long-run properties by using a wide range of recent econometric approaches, which are summarized in Table 1.

At this point, it should be noted that there is also a vast literature on the relationship between energy consumption and growth in which the presence of unit root is tested in order to study the Granger causality. Strictly speaking this literature is not oriented to the study of the persistence, and we have excluded, intentionally, this body of literature in this selective review. In any case this literature has been recently surveyed by Ozturk (2010) and Payne (2010a, 2010b).

In summary, this section selectively reviews this literature on persistence in energy consumption and production, in terms of the lack of robustness in the findings, which seem to be highly sensitive to the assumption about the data generating process and whether structural breaks are or not taken into account.

All in all, the evidence is mixed. The most part of earlier studies on the stationarity properties of energy consumption/production have been carried out by using different kinds of univariate unit root tests by using time series or panel data (Narayan and Smyth, 2007; Hsu et al., 2008; Narayan et al., 2008).

Another group of studies reports evidence of structural breaks in energy variables. Allowing for such breaks reduces the persistence of deviations from the regime specific means, so breaks reduce local persistence. The structural breaks themselves, however, still produce substantial global persistence in energy series if not a unit root (see, Narayan et al., 2010; Aslan and Kum, 2011; Apergis and Payne, 2010b; or by using panel data unit root tests with structural breaks Chen and Lee, 2007; Mishra et al., 2009; Apergis et al., 2010a, 2010b).

A number of studies, including Gil-Alana et al. (2010), Barros et al. (2011, 2012) and Apergis and Tsoumas (2011a, 2011b), test for fractional integration[7] following the alternative way to test the property of long memory by means of the analysis of the spectral density function allowing the existence of a single structural break, proposed by Gil-Alana (2008).

All these previous studies have a common point: they suppose that energy variables follow a linear path. However, if energy variables follow a nonlinear path, linear unit root tests tend to overaccept the null hypothesis (Aslan, 2011, p. 4466). Only four works looking for nonlinear behavior in energy consumption and production variables identify regimes in which the energy variables behave like a unit root process (Maslyuk and Smyth, 2009; Aslan, 2011; Aslan and Kum, 2011; Hasanov and Telatar, 2011).

In conclusion, to date literature offers contradictory findings whether shocks to energy variables are transitory or permanent. This question is important for the design and effectiveness of energy

[6] Applications of this approach can be found in Assarson and Janson (1998); Salemi (1999); Congregado et al. (2011) or Perez-Alonso and Di Sanzo (2011).

[7] Lean and Smyth (2009) also use a LM test of fractional integration without structural change.