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Can Irreversibility Explain the Slow Diffusion of Energy Saving Technologies? (with Kevin Hassett)

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Forum

Can irreversibility explain the slow diffusion of energy saving technologies?

In a recent paper in this journal, we developed a model of home improvement behaviour in the presence of irreversibility and explored whether this added feature might be useful in understanding the very slow diffusion of new energy technologies – the so-called 'energy paradox' – that has been the subject of much inquiry in the energy literature for decades. Employing a model that is standard in the investment literature, we showed that the classical or 'Marshallian' rule no longer holds, and that the actual decision rule depends on the moments of the relevant price process. For a stylized example, we showed that the hurdle rate applied by consumers increased by approximately a factor of five because of the introduction of irreversibility and uncertainty. We then provided an example of how the model might be used to explain the diffusion of new investments, and demonstrated that diffusion was much slower if the good being purchased is irreversible.

In a recent response to this paper, Sanstad *et al* (1995) concede that all of the above is true. They point out, however, that – using the data we used in our stylized example – while the hurdle rate used by consumers is roughly four to five times larger than it would be if the investment were reversible, it is still much lower than hurdle rates that have been estimated in the literature. They conclude that our work is, therefore, of little value for understanding the high apparent discount rates that consumers apply to home-improvement purchases. In response we would like to make the following points.

As with all theories, the model's empirical relevance cannot be assessed without careful econometrics. Our paper developed the theory, and then presented a brief example of how the theory might be applied. The example was highly stylized: our measure of the price of the home improvement capital good was simply a price index for durable commodities. In order to assess the empirical relevance of our theory, one must obtain deflators for energy prices and home improvement capital goods that closely fit individual decisions being observed, then estimate a hurdle rate controlling for the effects of these prices, and finally test the null hypothesis that the hurdle rate is that which would be predicted by our model. Until this step is taken, no one should either believe that our model solves the energy paradox or that the model has fallen short.

The most perilous step in the empirical testing of our model will be the acquisition of price data for home improvements. This is both because it is difficult to find long time series of price data at the appropriately disaggregated level, and also because it is extremely important that the price index used adequately captures technical change in home improvement. In particular, it is easy to show that hurdle rates can be enormously high in the present climate of rapid technical change, as anyone considering the purchase of a new personal computer can attest. While we have better data on energy prices, we must be extremely cautious concluding that features present in the historical series adequately reflect current consumer expectations of future price movements, and the sensitivity of results to assumptions about these expectations should be investigated carefully. Small changes in the measure of the trend in energy prices can have a large effect on the predicted hurdle rate.

It seems that Sanstad *et al* have taken our stylized example too seriously, concluding that the ultimate validity of our theory hinges crucially on this single example, so much so that one need not even consult standard errors. It is not correct to conclude that an example based on a durable commodities price index is directly relevant to, for example, Cole and Fuller's (1980) study of thermal shell measures. The predicted hurdle rate of our model is very sensitive to the parameters of the relevant price processes, and model evaluation can only proceed on a case-by-case basis. Our model can easily be used to justify arbitrarily high mark-ups, depending on the constellation of parameters in the particular example chosen. The model could therefore generate, depending again on the relevant price parameters, predicted hurdle rates as high as the highest estimates in the literature. For example, using actual price data Metcalf and Rosenthal (1995) find that the model predicts hurdle rates on the order of 20% for refrigerators. This fact is obscured by the discussion in Sanstad *et al*, because they allow for extremely limited parameter variation, which minimizes the ability of the theory to explain high hurdle rates.

Sanstad *et al* also misrepresent the arguments made in our paper, and then argue against points we never made. The authors seem to imply that we presented our theory, then presented a single example of how the theory might be applied, and then concluded that this example somehow proved that our model can explain every high hurdle rate ever estimated.[1] Our position has always been much more cautious than that. For example, we state on p 711: 'While there may in fact be market barriers to investment in energy efficient capital, we note that the reasoning that led to the (Marshallian) benefit cost rule in Equation (3) is incorrect, and that policy inferences drawn from this reasoning may be misguided' (Hassett and Metcalf, 1993). Since our model can – as Sanstad *et al* concede – explain hurdle rates five times (and more) larger than those in the standard model, then there is

[1]For example, their abstract states, 'Hassett and Metcalf argue that the uncertainty and irreversibility attendant to such investments, and the resulting option value, account for this anomalously high implicit discounting.'

promise that the model can resolve the energy paradox. Whether it ultimately does is the subject of ongoing empirical work, but it seems odd to argue that a contribution that increases the predicted hurdle rate dramatically is 'of little value'.

The prima facie case for the importance of irreversibility is strong. Are we to conclude from Sanstad *et al* that irreversibility should simply be ignored by future researchers? It seems to us that irreversibility is a key feature that characterizes energy home improvements. Individuals who spray insulation in their walls do not – we believe, at least – expect that if energy prices turn down next year they will be able to extract the insulation and sell it to get their money back. Because of this, the hurdle rates applied to the decision are likely to be many times higher than conventional hurdle rates, and researchers are ill advised to ignore this. Will irreversibility ultimately explain the very high hurdle rates estimated in the literature? It may be that several additional factors, eg liquidity or time constraints, will be needed to close the book on the energy paradox. We state, as we did in our original work, that this is still an open question.

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This work does not necessarily reflect the views or opinions of the Board of Governors of the Federal Reserve System.

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