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INTRODUCTION

For several years now the United States has been struggling with environment and energy problems and there seems to be no end in sight. This is not to say that we are unable to solve our problems; but rather to say that we are facing problems which are neither short term nor static in nature. Fundamentally our difficulties are due to the overloading of the environment with pollution and to the great rate at which we are consuming natural resources. Increasing population and economic growth both tend to place a greater load on the environment while improved technology tends to decrease that load. In addition the changing elements in society, such as population migration, consumer habits, and resource development and exhaustion, all cause the nature and location of the environmental load to change with time.

This would indicate that we will never be wholly free of problems for even as this country develops and solves problems, new ones will arise. It is also important to recognize that we are not faced with a small number of large problems but rather with millions of problems of every size and description which occur at all levels and in all sectors of society. To act effectively against this vast array of difficulties it is necessary to enlist the aid of as much of society as possible. This can be accomplished by encouraging risk taking throughout the society by providing incentives which reward activity beneficial to society and punish activity which is harmful.

When dealing with the problems of the environment there are a few basic facts concerning the nature of the problems which must be kept in mind. Foremost among these facts is that environmental problems can be considered as the need to reduce the rate of irreversible change in an environment due to the activity of man. In environments which are currently regarded as unacceptably polluted, such as Lake Erie and the Los Angeles Air Basin, the intent of the environmental controls applied has been to reduce the input of pollution and by doing so to reduce the effect of man on the environment in question.

At first glance it may not be obvious that the changes in the environment due to pollution are irreversible. But consider the case of Los Angeles for a moment. Even if a magic solution were found so that Los Angeles never again had to suffer through a smoggy day we would still be faced with the damage accumulated during our years of smog. This damage takes on many forms, such as the impaired health of the residents, the reduced biological diversity of the area as shown by the death of large numbers of palm trees, and the unnaturally rapid aging of physical objects like rubber goods and painted buildings. These forms of environmental damage will not be undone by simply "solving" the smog problem so it must be realized that we are paying the price of an irreversibly damaged environment.

In areas which are regarded as "clean" the hope of the environmentalist is to keep them "clean." To some this implies that we should strive toward a no growth economy. If it could be assumed that growth meant simply increasing the number of people, automobiles, and powerplants then it would be true that to avoid pollution we would need to avoid growth. But it is clearly possible to grow and to reduce our impact on the environment at the same time. It is therefore not a question of growth per se but rather a question of the way in which we grow. Indeed, it may be better for

the society as whole to spread the pollution load over a greater area rather than attempt to maintain some areas in their natural pristine condition at the expense of the already congested cities.

It must also be realized that the problems of the environment will be with us for all time to come. Individual problems may be solved but new problems will take their place. New problems would continue to arise even if we were to achieve zero growth in both population and the economy for zero growth does not imply a static society. For example, even if our total population remained constant, some areas, such as Oregon and Washington, can be expected to rise in population and thereby create new environmental problems for those areas. Changes in consumer habits can also create new problems. In California action has been taken recently to protect large desert areas from ever-growing use by dune buggies and dirt motorcycles. Ten years ago this problem did not exist because ten years ago dune buggies and dirt bikes existed only in insignificant numbers. Similarly, an even newer invention, the snowmobile, is in the process of creating new problems in our winter recreation areas. We can expect that consumer habits will never cease changing and therefore we can also expect to face environmental problems in the future which we do not face today.

Even more important than changes in consumer habits and movements of population in creating new environmental problems are our ever more limited resources. We find ourselves being driven to such activities as offshore drilling and coal strip mining as both our demand for resources increases and our more easily obtained supplies diminish. That these activities raise new environmental problems need not be emphasized here. Again it is important to realize that the scarcity of energy and mineral resources will continue for the foreseeable future. Our continuing consumption of natural resources

(which is inevitable even in a zero growth world) will eventually exhaust our current sources and drive us to adapt to the use of new materials and new sources. These new sources will undoubtedly bring with them new environmental problems and solutions.

Obviously the rate at which we exhaust our current natural resource supplies and are forced to find either new supplies or substitutes is dependent on our rate of consumption. Efforts toward the conservation of our national resources are therefore valuable in slowing the rate of change required of society. In addition to this obvious benefit from conservation there is an additional benefit in protecting our productivity. For example, we currently face an energy crunch. This is simply another way of saying that we are demanding more energy than can be supplied by our traditional sources. With such a disparity between supply and demand there is an obvious tendency for the price of energy to increase, thereby causing an increase in the cost of producing any energy intensive good. Many conservation measures, such as using smaller automobiles, improving building insulation, recycling of aluminum cans and many others, reduce energy use with little or no penalty and by reducing the demand they help to protect the productivity of industry.

An important point raised by the above discussion is that no segment of society stands alone. The risk of increased energy costs and decreased productivity felt by industry is in fact a risk to the society as a whole since decreased productivity will enlarge our inflation problems. In addition, industry is relatively unable to reduce its consumption (since industrial energy use is already relatively efficient) while commercial and private energy users can make substantial reductions in consumption for small cost by changing their habits. It can be seen therefore that the solution to our energy crunch consists of several parts which must be used in a balanced way. There

must be changes in consumer habits, improvements in energy technology, and increases in the energy supply from both old and new types of sources. Saying that change should occur in a balanced way is really equivalent to saying that a wide variety of solutions to a problem should be pursued simultaneously. This provides two benefits; first, there will always be a fall back position if some "solution" is found to create more problems than it solves; second, any one solution will eventually either become inapplicable, because the problem is constantly changing, or it will run into diminishing returns. In fact any solution which is expected to deal with a long term problem must consist of many parts for these same reasons.

The need for a balanced approach can also be seen quite clearly in the problems of the cities. It would be agreed by all the parties concerned that attacking the problems of the cities requires a great deal of change and risk taking. But there is no agreement at all on who should do the risk taking. The federal government seems to want the local governments to solve their own problems and the local governments seem to want technical solutions which will allow them to solve their problems without changing their habits. A more realistic approach to city problems would consist of both technological and non-technological change brought about by risk taking at all levels of government and industry.

The current approach to city problems is to attempt to couple directly a specific problem to a specific risk taker. For example, the problem of air pollution has been declared a technical problem to be solved by the automobile industry. There are a number of disadvantage with this approach. For one thing it tells the cities that they can continue to build freeways and increase their automobile populations while someone else solves the problem by building clean automobiles. This ignores the fact that any one approach to a problem as complex as

that of air pollution will eventually run into diminishing returns, which means that in the long run no single approach will be adequate. The large scale agitation in Los Angeles for a rapid transit system is a belated recognition of the fact that a greater diversity of approaches to the problem is necessary. Another disadvantage to specifying the problem and the risk taker too precisely is that it encourages a solution to the problem as stated rather than to the more complex problem that actually exists in the world. Furthermore, a precisely stated goal tends to encourage a single solution rather than a diverse menu of solutions. For an example of this consider the fact that all the United States automobile companies intend to meet the 1976 auto emission standards using virtually identical catalyst systems. This consonance of behavior is astounding when we consider that the catalysts have not been proven in service and that the introduction of low pollution vehicles could have been a major form of technical competition stimulating the slow moving United States automobile firms.

The lack of risk taking apparent in United States industry has led to a call for government sponsored research and development to fill the gap. One of the arguments used to support proposals for government risk taking is that the cost of developing new technology is too high for industry to pay alone. There are undoubtedly some cases, such as supersonic aircraft and fusion reactors, where the cost of research and development is too high to be paid by industry without government support. However, it should be remembered that we are facing a myriad of problems of all sizes and types, not a limited number of large technical problems. In addition we must be careful not to assume that all cases showing a lack of risk taking are the result of industrial poverty. For example, the automobile industry has shown a noticeable lack of risk taking in providing an

alternative to the internal combustion engine, and it now seems likely that a government sponsored research program will be created to develop a new type of engine. Clearly the United States automobile industry cannot make any convincing claim of poverty.

Two additional problems with government sponsored research and development also become apparent when we consider the above example of government sponsored engine development. Ideally the problems faced by society would be recognized while they are still small and solved using the best method as determined by the competition between a wide variety of possible solutions. The first point is that governmental action on a problem is not likely to begin until that problem has already become large and well defined, which means that the solution will not be ready for implementation until long after it is needed. In addition, the fact that a problem is considered to be well defined will limit the range of solutions developed.

The second problem referred to above is that risk taking is required both for the development of new technology and for its implementation by industry. It is a denial of reality to assume that industries always use the most advanced technology available. The point to be emphasized here is that even when technology exists there must be some incentive to insure its adoption. Furthermore, it should be realized that research applicable to real world problems cannot be conducted in a vacuum. There must be interaction between the researcher and the man who will be using the ideas developed. An excellent example of the failure to interact can be found in the relation of the construction industry and the solar energy researchers. There is little incentive for builders to fool with solar energy and so they provide little input to the researchers. The result is low-keyed research of little practical value.

We have seen that the United States can expect to continue facing environmental and energy problems for all time to come and

that the problems themselves are constantly changing due to the dynamic character of the society as a whole. We have also seen that any effective approach to our problems must encourage risk taking at all levels of society. In addition, a wide diversity of approaches to a problem are necessary if the problem is to be dealt with in anything beyond the very short run.

RISK INTERNALIZATION

As has been pointed out earlier, the entire society is faced with risks associated with the environment and the energy crises. One of the most important facts to realize is that risk refers to unpredictable events. For example, it is safe to say that the entire society will suffer if energy costs continue to rise, therefore we can regard the possibility of increased energy costs as a risk. It is also safe to say that we have no way of telling how much the price of energy will rise. That the future is not predictable should come as no surprise to any observer of world and national events such as the recent Arab-Israeli war, the discovery of oil in the North Sea, and the delaying and near banning of the Alaska pipe line.

It is tempting, however, to predict the future as well as possible given the current state of knowledge, and then to act on the basis of the prediction. This kind of attempt to eliminate uncertainty is dangerous because it can lull society into thinking that a specific set of plans based on the future, as it is predicted, can solve our problems. Some years ago it was believed that nuclear power generation would be well on its way toward replacing coal power generation by 1975. The entire nuclear program has been beset by unpredictable delays and environmental constraints, causing the original timetable to be relaxed again and again until now we hear about the emergence of coal as the forgotten fuel of the 1970s. The

mistake made here was not one of making overly optimistic plans, for undoubtedly the plans were based on the best information available at the time, rather it was a mistake of assuming the world to be predictable.

Instead of attempting to eliminate risk and uncertainty by predicting the future in detail we would advocate accepting their existence and promoting the use of mechanisms which would encourage the internalization of risks by members of the society. Risk internalization means that a risk felt by society (such as rising energy costs) is translated into a risk felt by a member of society (such as trying to sell seven-mile/gallon Chryslers after the price of fuel goes up to a dollar a gallon), so that the member of society will take the chance of changing his behavior (building 20-mile/gallon Chryslers). In this example it should be noticed that Chrysler faces two risks: that of changing its behavior and that of attempting to remain the same in the face of changing circumstances. The use of incentives is to guide the change in behavior in a direction beneficial to society as a whole and to encourage more rapid change by increasing the risk involved in avoiding change.

One mechanism which can be used is taxation, both positive and negative. The question then becomes: what do we want to encourage and how high does the tax need to be to create activity? Those economists who believe that it is possible to eliminate uncertainty would attempt to set the level of the tax by cost benefit analysis. The difficulty here is that uncertainty cannot be eliminated. For example, is it reasonable to estimate the damage done to the environment by DDT in dollars; and who would be taxed since the chemical has been in use for years and its harmful effects are only now being discovered? It would seem more rational to use the tax to encourage good behavior in the future rather than as a form of punishment. Because a tax

would be used to influence behavior it is obvious that only by studying the effect of taxation on behavior can the level and form of the tax be determined.

One of the greatest benefits to the use of risk internalization is that it will produce a wide diversity of solutions to a problem and these solutions will be in competition with one another. It can never be determined in advance which solutions will be adopted during the competitive process and which will be abandoned. But it is safe to assume that only the most effective measures will survive. Another benefit to a risk internalization approach is that it will encourage activity at all levels in the economy. For example, an energy tax would speed the trend to smaller automobiles, encourage the use of better home insulation, and discourage the unnecessary use of lights. These changes and a thousand others in behavior and technology would be promoted. The problem of energy waste occurs at all levels of activity and should be discouraged at all levels.

SUGGESTED RESEARCH

I. Measurement of Environmental Efficiency

No matter how incentives are applied it is necessary to have some way of measuring the changes that result. What this amounts to is finding ways to measure the environmental efficiency of new technology relative to old technology. For example, one could measure the heating requirements of buildings of various types of construction, and by doing so identify which approaches, using current technology, provide the greatest benefit. In addition, this type of measurement would provide a yardstick by which to judge the value of new technologies.

II. Tax Incentives

Obviously, taxation represents one of the most easily applied forms of incentive; however it is often not clear what the form and magnitude of a tax should be to achieve a given effect. The aim of research, therefore, should be to attempt to understand the relation between the magnitude of the tax and the discontinuous changes in behavior brought about by the tax. As an example of how such research might be conducted consider the case of automobile taxation. The industrial countries of the world have widely varying automobile taxes both in magnitude and in form. Comparing the automobile purchase and use patterns in the different countries and relating these patterns to the taxes applied by each country should yield considerable information on the effect of the taxes on the consumer. Also it would be valuable to determine how the manufacturers have tailored their products to the taxes faced in their markets.

The disadvantage in attempting to tie a specific risk taker to a specific risk has been discussed earlier, but it bears repeating here. Tax incentives should be aimed at having the broadest possible effect so that risk taking activity will be encouraged throughout society rather than in a single isolated area. Forcing risk taking in an isolated segment of society can provide nothing better than a very expensive, short term solution to the problem in question. The greater the portion of society involved in the solution to a problem the greater is the chance of a successful, long term solution.

III. Risk Taking in the Power, Oil, and Automobile Industries

Of the problems currently facing the United States energy, transportation, and pollution are among the most important; and the industries involved in them are the largest in the world. Yet in spite of their great wealth, the power, automobile and oil industries seem

unwilling or unable to internalize the risks facing society in their spheres of activity. Rather than engaging in risk taking and competitive behavior they are all characterized by a remarkable consonance of behavior. The goal of research should be to answer the following questions. What are the constraints on risk taking felt by the industries? What incentives and disincentives currently affect the behavior of the firms? How might these incentives be altered to encourage more competitive behavior? What is their attitude toward the regulations which they face and how might the method of regulation be changed to produce more dissonant behavior?

All of the above questions can be boiled down to the one question: how can incentives and disincentives be applied to reduce the consonance of behavior found in our major industries? As in the above mentioned study of automobile taxation there is a great deal to be learned by comparing the effect of working environment and industry attitude on the behavior of firms in the industrial countries of the world. This is especially important since consonance of behavior in these major industries is not typical of all industrial nations.

IV. Anti-trust Policy

It is not at all clear that positive incentives alone will be sufficient to discourage consonance of behavior in large industries. The possibility of altering anti-trust legislation so that it will provide a significant deterrent to consonant behavior should be examined.