TECHNICAL PAPER

The Employment Impact of Environmental Investment:

A Conceptual Framework

Eban Goodstein

February 1995

Technical Paper No. 202

Economic Policy Institute

THE EMPLOYMENT IMPACT OF ENVIRONMENTAL INVESTMENT: A CONCEPTUAL FRAMEWORK

Eban Goodstein"
Technical Paper No. 102
February 1995

Economic Policy Institute
1730 Rhode Island Ave., NW Suite 200
Washington, D.C. 20036
202-775-8810
. Department of Economics, Skidmore College, Saratoga Springs, SY 12866.

Abstract

Macroeconomic policy currently places a significant constraint on attempts to reduce unemployment in the United States. If the Federal Reserve can be persuaded to let unemployment rates fall below 6%, than environmentally sensitive production technologies and processes may contribute to net job growth. This paper evaluates six avenues of potential job growth: adoption of labor intensive technology; import substitution, job sharing, dynamic spillovers, export promotion and anti-recessionary investment spending. These six routes can be divided into two general categories: approaches which wring more jobs from existing resources, and approaches which rely on increased economic activity to spark job growth. The latter, of course, may aggravate environmental problems.

1 .O Introduction

Over the next fifty years. the world's population will at least double to around 11 billion. while the number of people in the U.S. is expected to increase by 50%- from 250 to 380 million.[1] These very solid numbers pose a difficult challenge-- how are we to provide productive employment and income for these extra hands, while still insuring a liveable planetary environment? Under a business as usual scenario, one has to imagine increasing the global scale of economic activity, and its attendant automobile, truck and airplane emissions, coal and nuclear power plant pollutants, hazardous and municipal waste. pesticide and fertilizer pollution. deforestation and soil erosion, all by at least two-fold. In the modern world. is there such a thing as a sustainable economy, and can it provide jobs for all?

Many, including Vice President Gore (1990), have argued that the spread of environmentally conscious production processes can help address the employment crisis in America today. Deindustrialization over the last two decades has led to high overall unemployment rates. and real wages have stagnated on average, while falling for those at the bottom of the skill ladder. In contrast to the Gore view, of course, some have argued that deindustrialization and high unemployment rates have been, in large measure. ***caused*** by environmental protection.

In fact. I have shown elsewhere that up to the present time, environmental protection has been essentially neutral with respect to jobs.[2] Jobs created in the environmental sector have roughly matched jobs lost in other sectors. If anything, most studies of the impact of environmental spending find that it has had a small positive impact on total employment in the U.S. economy. At the same time, layoffs from environmental regulation have been surprisingly small-- on the order of 1300 workers per year in recent years. Is investment in new environmental technology and production methods different than our historical experience with regulation? Can clean technology substantially reduce unemployment?

Part of the confusion surrounding this issue arises from the fact that economists and environmentalists (along with local economic development officials) tend to talk past one another when it comes to jobs. Most economists focus on cyclical unemployment, viewing job growth and decline as a macroeconomic phenomenon. At the level of policy, if not theory, unemployment is a necessary evil, some basic level of which must be maintained to ward off inflation.

By contrast, environmentalists and development officials focus on what they perceive to be a widespread shortage of decent paying jobs. In this view, unemployment has ceased to be predominantly cyclical, and instead has become structural in nature. This analysis calls for a supply-side response, in which available resources are used to generate maximum employment, matching people with jobs. As a consequence, environmentalists tend to ignore macroeconomic issues, and concentrate on micro-level "jobs per dollar of expenditure" questions about environmental technology.

At a national level, the macroeconomic view must dominate. If, as is true today, the central bank pursues monetary policies which choke off economic growth whenever unemployment approaches six percent, successful micro-level job growth strategies will ultimately be self-defeating. To see this, suppose (as discussed below) that adopting energy efficient technologies created one million extra jobs by the year 2010. In response, the Federal Reserve, fearing wage-push inflation, would raise interest rates and reduce job growth economy-wide, thus nullifying the job gains.

However, it is certainly possible that Federal Reserve beliefs and policy may change, and lower levels of unemployment will be targeted. High levels of disguised unemployment--temporary and discouraged workers-- and the fear-inducing climate of corporate downsizing today place a real constraint on worker militance. As a result, a level of unemployment well below six percent could probably be achieved without sparking significant inflation.[3]

It is also plausible that the cyclical component of employment may be rendered an

increasingly minor factor in a sea of structural unemployment. In an increasingly global economy. high levels of domestic demand simply act to boost imports. without significantly reducing unemployment. Under such conditions, secular unemployment rates in the western world will continue their upward drift, and even in a boom remain well above the level the central bank might consider inflationary.

Under either of these circumstances-- a change in Fed policy, or an upward trend in secular unemployment rates (or their combination)-- actions of the Central Bank will cease to become a binding constraint on employment growth. Then, micro-level issues of job creation from sustainable production methods would become important on a national scale.

The purpose of this paper is to explore ways in which investment in clean technologies or environmentally conscious production might reduce unemployment, given an accommodating Federal Reserve Board. Table I identifies six possible avenues to net job growth.

Net *Job Growth Based on Existing Resources*

(1) Shift to more labor intensive technology.
(2) Reduce imports, especially of oil.
(3) Shift to job sharing and a shorter work week.

Yet *Job Growth through Green Growth?*

(4) "Dynamic spillovers".
(5) Capture of export markets.
(6) Boost private sector investment spending during recessions.

TABLE 1-- POTENTIAL SOURCES OF NET JOB GROWTH

These changes in our production might increase net, economy-wide employment in one of two ways. The first is to redeploy existing resources in the economy, so that the same pool of national income now supports more workers. The first three measures iisted above fall into this category: labor intensive technology; import substitution, and a shorter work week. The second way that environmental spending might cut the unemployment rate would be by boosting economic growth. Export promotion, dynamic spillovers, and recession-fighting investment spending all have this effect. Such measures of course, have the potential to undercut their environmental advantage *if* the higher growth leads to accelerated environmental degradation.

In this paper, I look closely at these six paths to potentially "sustainable" full employment. First, I lay out the conditions under which net job growth is likely to arise. Second, I evaluate (in a crude fashion) both the extent and distribution of possible employment gains. Along the way, I consider potential environmental drawbacks from increased job growth.

2.0 New **Jobs From Current Resources**

This section will consider the opportunities for increasing employment without relying on economic growth. Any such strategy will require a shift to what can be called a Clean Technology (CT).[4] A CT has three main attributes: it provides a service of comparable quality to existing technology; it does so at a long run private cost that is comparable to that of existing technology; and it does so in a "cleaner", less environmentally damaging fashion than existing technology.

Many advocates of CT's have focussed on only the third characteristic-- environmental superiority. However, the first two are equally vital. If potential CT's do not provide a comparable service at a comparable market price (including taxes and imbedded regulatory expenses), consumers and businesses are unlikely to adopt them regardless of their environmental benefit. Moreover, if CT's raise costs significantly, they have the potential to

reduce the competitiveness of U.S. firms and thus promote capital flight.

Examples of potential or current CT's include: solar electric (photovoltaic and solar thermal) electricity, wind powered electricity, electric vehicles. high-speed rail for inter-city transport. waste reduction and re-use technologies in manufacturing and agriculture, certain types of recycling, mass transit in certain locations, and energy and water efficiency technologies.

In addition a simple shift in our approach to production qualifies as a clean technology: a 30-hour work week. with 30 hour pay. The flip side of over-consumption in the developed countries is overwork. A reduction in the workweek to increase employment would only be feasible if workers were interested in accepting greater leisure and time for family and community in exchange for less consumption, with its attendant environmental damage.

2.1 **Labor Intensive Production**

The first way to increase employment using current resources is to shift to clean technologies which are more labor intensive. More jobs are supported in this way for two reasons. First, labor intensive jobs typically pay lower wages; second, because they require less capital. rhe share of national income earned as profit falls, while the wage share rises. (Note this does not mean that the profit rate falls; a reduction in the profit share will not trigger capital flight.) Both of these factors mean that more workers can be supported for a given level of GDP. Recall also that clean technologies are cost-competitive. This means that the level of national income remains roughly constant with their adoption. Appendix A Illustrates these effects in a simple input-output model.

A raft of input-output studies have examined proposed shifts in investment spending to energy efficient technologies, solar energy, and solid waste recycling.' These studies have generally concluded that such technologies boost employment through increased labor intensity. One of the more comprehensive national studies [Geddes (1993)] looked at the

impact of shifting investment towards cost effective energy efficiency measures. The authors found that a large-scale, but still cost effective shift in investment out of capital intensive oil, gas, and electricity sectors, and into more labor intensive manufacturing and installation of energy efficient technologies would increase US employment on net by just over 1 million jobs in the year 2010.

Based on information provided in the Geddes et al report, it is possible to break down this increased employment into proximate "causes": a shift into lower wage sectors; a higher share of wages in GDP; and the substitution of domestic production of energy efficient technologies for imported oil.[6] (Import substitution is discussed further in the next section). Relative to the base case, Geddes et al find that investment in energy efficiency lowers average wage and salary income by $63 per job; multiplied by total employment, this yields a figure of $9.7 billion ($1990) to finance additional jobs.

Also relative to the base case, the wage share in GDP rises from 60.2% to 60.5% and as a result, personal income increases by $17.8 billion. Finally, oil imports fall by around $17.7 billion in total; this increases the wage pool by $10.7 billion (the wage share of the reduction in the import bill). Table 2 illustrates the employment increases associated with each of these effects.

Almost half of the increased employment comes from the increase in the wage share of GDP; another quarter comes from a shift to lower wage employment sectors, and the final 25% comes from an increase in national income arising from the replacement of oil imports with domestically produced energy efficient technologies. The point here is that a shift to labor intensive production boosts employment not simply, or even primarily by lowering wages; most of the increased employment in the Geddes et al. study is financed by a reduction in the profit share of GDP.

One way to promote more labor intensive production is to shift to more labor intensive, clean technologies-- energy efficiency, solar electricity, or solid waste recycling.

	Effective Increase in Wage pool	Increase in Employment	
		Jobs	Percent
Shift into Lower Wage Sectors	$ 9.7 billion	276,000	25
Increase in Wage Share of GDP	$17.8 billion	506,000	41
Reduction in Oil Imports	$10.7 billion	305,000	28
TOTAL	$38.2 billion	1,088,000	100

TABLE 2-- SOURCES OF JOB GAINS IN THE GEDDES ET AL. STUDY

SOURCE: Author's calculations, based on data in the study, as well as *Annual Energy Outlook,* 1992 (US DOE: Washington, DC).

Another possibility is a government employment program. For example, suppose the government were to support a large-scale reforestation program. This is a highly labor intensive (and relatively low-wage) process. To finance such a program, cuts might be made in weapons production, a highly capital intensive process. The result would be net job gains. Again these gains would arise not only because of lower wages in the forestry sector. but also because a smaller percentage of national income would be paid out as profit on capital investment-- in this case to investors in weapons companies.

Yet a third way to promote more labor intensive production, particularly in manufacturing, is to shift some of the production cost burden from labor to pollution, or indirectly, to energy. For example, quasi-fixed costs associated with employer provided health care reduce employment in manufacturing, as firms opt instead to pay overtime. [Ehrenberg and Smith (1994) 135-144] If health care costs were financed out of general (energy?) tax revenues under a single-payer system, this disincentive for hiring workers would

disappear. Moreover, by shifting tax costs from a good (labor) to a bad (pollution) overall economic efficiency in the economy would improve.[7]

To sum up: one way to increase net employment without relying on economic growth is to shift towards more labor intensive production. This has one drawback. Labor intensive jobs are generally lower wage jobs-- indeed the lower wages are one way in which increased employment is financed. However, another important effect of increased labor intensity is to increase the wage share of GDP. Thus, there is not a one-to-one trade-off between more jobs and lower wages.

Another potential drawback of a shift to labor intensive production is a possible loss of competitiveness and a shift in production out of the country. However, we have ruled out this problem by defining a clean-technology as one that is both environmentally superior and cost-effective. In essence, lower labor productivity is compensated for by an increase in the efficiency of other resource use. Thus the adoption of clean-technologies will not raise the costs of American products ***vis a vis*** our competitors.

2.2 **Import Substitution**

As suggested above, reducing reliance on imported goods in a cost-effective manner provides another route to increase domestic employment. Technically, such a move will increase domestic GDP and thus domestic growth, but will have an offsetting effect on the exporting country. Thus there will be no increase in overall global output, and possibly, little impact on global employment. In effect, reducing imports **is a** way to reshuffle jobs from the exporting to the importing country.

That being said, cost-effective reductions in imports remain a good idea from an environmental point of view. Long distance trade in goods and services generates important environmental costs. International trade accounts for around one-eighth of world oil consumption; fossil fuels are associated with a variety of environmental problems, ranging

from oil spills, urban air pollution, acid rain and global warming. In addition energy production is heavily subsidized, to the tune of $28 billion per year in the U.S, not including military expenditures to protect Persian Gulf oil fields and shipping lanes. Developing countries too. engage in massive energy subsidies, with electricity prices averaging half of the OECD. Trade based on subsidized, and highly polluting energy use is truly a waste of global resources."

Moreover, import substitution can be a critical local development tool. An important underutilized resource for many communities are material, energy or water waste. "Plugging the leaks" can free-up local resources for investment in other areas. Thus while initial job gins may come at the expense of exporters, over the longer term induced economic growth may provide net employment opportunities.

To illustrate the local impact of import substitution, a recent study done for the Department of Sanitation in New York City, found that boosting the percentage of waste that was recycled from 3% to 25%, while reducing the percentage incinerated from 76% to 57%: would result in a permanent net increase in local employment of around 400 jobs per year. This was true, even accounting for the higher taxes necessary to pay for the somewhat higher cost per ton for the recycling option. The increase in jobs arose first because recycling is labor rather than capital intensive, leading to a higher local payroll generating bigger indirect employment effects in the city. Second, New York City produces little of the equipment necessary to manufacture incinerators, so incineration had a low "domestic" content.'

Several studies have found similar effects for energy efficiency investments. In 1988, the New York State power authority had made an initial commitment to purchase 1800 MW of electricity from a massive hydroelectric project being planned by the Ontario Provincial Government in northern Canada. The James Bay project is expected to have a major environmental impact, flooding 2700 square miles of sub-arctic tundra that is used for subsistence hunting by Cree and Inuit native peoples. In a review of the project, motivated in part by environmental concerns, New York State in fact concluded that aggressive

government and utility promotion of energy efficiency measures would forestall the need for new capacity through the year 2006. The State Energy Office estimated that reductions in energy demand sufficient to offset the hydro project could be obtained at a cost of 2.5 cents per KWh, while James Bay power came in at 5.35 cents per KWh.[10] State and utility investment will thus save energy and consumers money, at the same time.

According to the NY State Energy office, importing energy from Canada generated very little in-state employment. By contrast, energy efficiency (demand-side management) investments were expected to generate 19,000 New York jobs alone per billion of expenditure. DSM measures also had the fewest proportion of workers in technical and professional jobs-- a plus for less skilled workers, but probably indicative of lower average earnings. Both environmentalists and labor unions worked together to kill the contract."

A study of a rural weatherization program in Alaska by Colt (1989), found that a $790,000 investment on the part of the state generated savings of $106,000 annually in fuel bills, for an attractive 12% rate of return." Colt also estimated that because weatherization relied on relatively few imported inputs, the program generated 17,900 Alaskan jobs per billion of expenditure, one-third again as many local jobs as hospital construction or highway maintenance (around 11,000), and twice as many local jobs as highway construction (7,800).

The point here is that cost-effective import substitution can provide an important foundation for local job growth. While some of this job growth comes at the expense of exporters, import substitution provides an important tool to help spark economic growth at the local level. It may thus lay the foundation for more positive sum job gains over the longer term. Moreover, import substitution has clear environmental benefits.

23 **Job Sharing**

The final way to increase employment without increasing production is to move towards policies which promote sharing existing work. Indeed, this option has been widely

discussed in Europe. and companies such as Volkswagen in Germany have instituted a four day work-week to avoid layoffs. Schor (1991) suggests that Americans are "overworked" in the sense that many of us would trade future increases in income for reduced work hours. If this were to happen. higher levels of future consumption. and its associated pollution. would be traded for more time spent with family or in the community. At the same time, the available work would be shared out in the form of more part time jobs.

Yet, paradoxically, Schor finds that the work week in the U.S., though not in Europe, has been rising over the last several decades. Her argument is that we get trapped in a "work and spend" cycle. Employers demand long hours, both to increase the output from salaried workers, and to avoid paving benefits to new workers.[13] Overwork then gets translated into overconsumption, as workers try and make the best of a bad bargain. High unemployment and the declining power of unions have meant there has been little resistance to this trend.

To illustrate the potential importance of job-sharing, we can look at the growth of "temporary employment" in recent years. From 1985 to 1990, employment in temporary help agencies rose from 734.000 to 1295,000. If temp employment had risen at the rate of overall job growth, there would have been only 811,000 temp jobs in 1990. The difference. 484,000, we mirht consider to be "extra" temp jobs. When evaluated at average working hours, these jobs are the equivalent of 345,000 full time jobs. As a crude estimate, then. 139.000 extra employment slots arose from the shift to temps and away from full-time workers over the period."

Temporary employment can and does meet the needs of some workers for a more flexible and shorter work week. But as Callaghan and Harrmann (1991) note. it can also be an avenue for discriminating against workers in terms of pay, promotion opportunities and fringe benefits. These issues must be dealt with before a more general move to a shorter work week will be feasible. Universal health coverage, or at least pro-rated provision of health benefits to part-time workers are a clear pre-requisite. Beyond this, Schor suggests other policies, including increased vacation and family leave time, legislating work hours for salaried

employees, and replacing overtime with comp time.

This section has considered job growth policies which rely on reallocating resources while maintaining a constant level of production. We now turn to the possibility of boosting net job growth via increases in output.

3.0 Net Job Growth from "Green Growth"?

Many authors have argued that the term "green growth" is an oxymoron. For example, Daly and Goodland (1993) maintain that the North should "stabilize its resource consumption" and assist the southern countries via transfers to promote global sustainable development. The logic behind this argument is straightfonvard: more consumption means more production which means more resource degradation. Daly and Cobb (1989) argue that in the U.S. (though not in developing countries) the negative effects on social well-being and quality of life of resource degradation currently outweigh the positive contributions from increased material consumption.

Even if this view were widely accepted, it is highly unlikely that Northern countries would halt their growth in the near term. Thus growing in as green a fashion as possible-- by investing increasing shares of national output into environmental clean-up and less resource intensive technology present the feasible road to a potentially sustainable future. This section considers three possible routes to net employment growth which also rely on economic growth as conventionally defined.

Of course, with a Federal Reserve committed to low inflation, net job growth from economic growth is destined to be limited. However, tight labor markets and income growth can also strengthen the political hand of labor. A stronger labor movement in turn could push for the policy reforms necessary to achieve some of the goals outlined in the first part of this paper, for example, national health insurance, family leave or extended vacation time.

3.1 Dynamic spillovers

The most ambitious claims for job growth from environmental investment are based on dynamic spillovers. Moore and Miller (1994), referring to environmental technologies ranging from scrubbers to fuel cells. gas turbines to photovoltaic electricity argue: "A United States that loses control over the true source of jobs-- this wealth created by genius-- will be a nation that has lost control over its own destiny."

Vice President Gore (1990) sees environmental concerns as laying the foundation for effective industrial policy within the context of a "Global Marshall Plan":

'One of the problems with the ongoing debate over industrial policy is that, unlike in the past, the policy has no clear focal point. Instead, we hear little more than broad assertions about the need to compete more effectively or improve our productivity. The debate seems sterile, an argument about means but not ends, so it is not surprising that many Americans conclude that. in principle. it is better to limit the government's role in directing or distorting the activities of private firms. But as soon as a worthy goal becomes the focus of a national effort that cries out for coordinated national leadership, the terms of the debate shift dramatically; the debate becomes a discussion of ends as well as means, and the natural American 'can do' instinct to reach the stated objective begins to take over.

The fundamental purpose of the Strategic Environment Initiative is to enable us to make dramatic progress in the effort to heal the global environment; in my opinion, that goal will eventually become so compelling that America will demand the kind of inspired leadership that made the Apollo program so productive and inspiring. The new program could reinvigorate our ability to excel at applied as well as basic research, spur gains in productivity, lead to innovations, breakthroughs and spinoffs in other fields of inquiry, and reestablish the United States as the world's leader in applied technology."

Fundamental technological breakthroughs have long been argued to form the backbone

of so called “long waves” of growth in capitalist economies [Kondratieff (1926), Schumpeter (1939)]. In a recent study, Kleinknecht (1987: 66) finds that the post-war boom was preceded, and he argues, driven by a remarkable burst of major product innovation. He lists 23 radical product innovations in the period 1930-1950, as against only 5 from 19.50 to 1970.

In the environmental area, photovoltaic solar energy in particular is viewed as the latest in a series of truly revolutionary innovations, such as the automobile or the microchip. Such technologies help provide the foundation for what Nell (1988) has called “transformational growth”:

“Transformational growth, in the industrial era, means just what the words imply: it is growth that transforms the economy, changes its structure-- meaning the relative sizes of its sectors (agriculture, manufacturing, services)-- and, as a result and then as an interacting cause, the distribution of income and the urban-rural relationship, together with the nature of work, of household life, and so on”.

Such overarching change unleashes a tremendous and expansionary demand for new products and services. In the case of automobiles, these first were the manufacturing, sale and repair of cars. But through the ensuing suburbanization of America, snowballing demand for new highways, shopping malls, spacious home construction, home furnishings, and lawn care, to name a few products, was spawned.

In Nells’ formulation, transformational growth requires more than a revolutionary technology. It also requires underexploited markets. Much of the growth in demand that followed in the wake of the automobile revolution can be tied to the existence of cheap land, and uncrowded, government built superhighways, within the now-expanded commuting shadow of large cities. More generally, the period of transformational growth which Nell calls industrial capitalism, was fueled by the corporate replacement of services previously produced by households. From giving birth to making clothes, from buying a home to heating it in the winter, services and goods once produced at home were replaced by store-bought.

Given this background, what might we realistically expect from the photovoltaic solar industry? First, let us grant that photovoltaics represent a major innovative technology, aimed at two markets: base load power. and stand-alone power production. The base load market is currently the larger of the two, and also. currently, is not underserved. For PV to achieve significant market penetration in the United States, its cost per Kwh would need to fall to a level at least comparable to that of coal. Yet simply replacing coal fired electricity with comparably priced PV electricity would not qualify as "transformative growth". To achieve the latter PV prices would have to fall well below those of coal. Under such a scenario. PV might form the basis for technological innovation based on very cheap electricity. One might envision, for example. the implications of large scale desalination plants in Southern California. However, near term predictions for long run PV costs are on par with coal, at around S.05 per Kwh.[15]

The greater transformative promise for PV arises in the market for stand alone power production. Solar powered vehicles, for example, would dramatically reshape fuel supply networks. Gas stations would again become service stations, but now servicing PV units. Remote site power has the potential to electrify "off-grid" locations. This would have an obvious transformative impact for underdeveloped countries, generating export opportunities in a variety of fields. In the U.S., stand alone power combined with improved telecommunications might promote yet another wave of decentralization of residential and business communities. Stand alone electrical appliances and other devices also represent new markets.

It is obviously difficult to predict the impact of a new technology, and in particular to assess the new patterns of production and demand it might spawn. But along with biotechnology, fiber optics, and microchips, photovoltaic energy may lie at the core of a cluster of radical innovations upon which a new long wave of economic growth might be based.

However, a caveat is in order. Past episodes of transformational growth have required

both fundamental innovation in technology, and underserved markets. But, as the globalization of production proceeds, it is not clear whether episodes of transformational growth can still generate high levels of domestic employment. The microchip, for example, has had very mixed impacts on U.S. employment. The niche into which computers have moved most aggressively is the labor market. Computers tend to replace workers directly, both in the office and on the factory line. Moreover, by revolutionizing communication technologies, the microchip has contributed to the offshoring of U.S. production facilities. This is perhaps most evident in the production of the microchips and computer components themselves. While deindustrialization in the US cannot be blamed primarily on the microchip, the increased demand spawned by information age transformations have not solved our structural unemployment problems.

Given this, the strongest employment argument from dynamic spillovers is a defensive one-- some share of the good jobs in the early 21st century will be tied to leadership in photovoltaics. A sensible industrial policy should seek to enlarge that share.

3.2 **Export promotion**

Export promotion is the flip side of import substitution, and as such we should be cautious of embracing it as a "green" policy. Increased exports often require displacing local production, and will surely generate transportation-related environmental costs, the reduction of which make import substitution attractive.

That being said, even opponents of growth in rich countries view technology transfer from the North to the South as being an essential component of sustainable global development.[16] One could envision, for example, a program of tied foreign aid, in which solar panels, manufactured in the United States, are "sold" to Brazil using aid dollars. In this way, exports can provide U.S. jobs without increasing U.S. consumption; Brazil, meanwhile, receives a low pollution energy source (with free fuel) to further its' own development agenda.

It is important to distinguish between export of environmental clean-up equipment and services (scrubbers or hazardous waste clean-up), and export of clean technology (electric cars or solar cells). Several studies have suggested that markets for clean-up technology and services are. relatively speaking, likely to remain rather small.

US EP.4 (1993) reports that the U.S. exported about $1.3 billion in pollution control equipment in 1990: exports in this sector were a bit larger than in sporting goods, a little smaller than machine tools. Elkington and Shopley (1989) argue that in spite of the increasing need for waste management technology in the developing world, commercial demand has been and will be slow to develop.

Given this. the export of leading edge, clean technologies clearly have more potential for boosting domestic employment. given an accommodating federal reserve. But this essentially returns us to the discussion of dynamic spillovers in the previous section. If environmental technology lays the foundation for transformative growth, one side effect would almost certainly be an improvement in the balance of payment via an increase in exports. Holding everything else constant, an increase in exports means a net addition to aggregate demand: in the short run, every $1 billion increase in demand generates around 20.00 jobs.

3.3 **Stimulus Effects.**

From 1972 to 199 1. total annual environmental expenditures spending by firms rose from $52 billion to S91.5 billion, measured in 1991 dollars. Along with this spending, of course. has come a couple of million jobs, disproportionately weighted to employment in traditional blue-collar sectors-- manufacturing, communications, transportation and utilities." But these jobs need not represent net employment gains; over the long term, if the money had not been spent on environmental protection, it would have been spent elsewhere in the economy. Another way to say this is that environmental spending will "crowd out" investment in other areas. This will happen directly, as environmental investment lays claim to scarce

inputs such as engineers or machine tools, driving up their price. It will also happen indirectly, by raising price and reducing demand for the service of polluting products.

As we have seen above, net job gains might be realized as the economy shifts into producing relatively more environmental goods and relatively less of everything else, provided Federal Reserve policy accommodated higher levels of employment. To date, however, most studies of the long term aggregate employment effect of environmental spending has been essentially neutral-- in terms of jobs, the "crowding out" has occurred roughly on a one-to-one basis.[18]

But over the short term, environmental spending may have significant anti-recessionary effects, by providing an automatic boost to aggregate demand. In a simple Keynesian view of the business cycle, recessions are driven by autonomous reductions in consumer or investment spending; once the animal spirits are in a bearish mood, the economy spirals downward. But because environmental investment is mandated by law, firms cannot reduce such spending as much as they cut back on general investment in plant and equipment. Thus, one might hypothesize that aggregate investment spending falls less in a recession than it would in the absence of environmental regulation, and therefore conclude that the recession would be less severe.

Such a conclusion requires, however, that environmental investment does not crowd out general investment on a one-to-one basis over the downturn. Why might this be true? In a recession excess capacity insures that increases in aggregate demand merely boost output, with no concomitant increase in input prices, and thus no direct crowding out. At the same time, the fact that polluting goods bear a relatively higher price tag should have no substantial effect on the length or depth of a Keynesian business cycle."

If this hypothesis was borne out, the short term employment effect of environmental regulation would be substantial. During the recession of 1990-l 991 for example, pollution abatement and control expenditures were around $92 billion per year, a $40 billion increase in

real terms since 1972. As a counterfactual take the case of no federal environmental regulation, and thus no addition to environmental spending after 1972. Assume an intermediate case of 50% crowding out during a recession. Then, using the average employment multiplier for manufacturing found in Geiler et al (1992) the 1991 expenditure of an extra $40 billion would have boosted U.S. employment over the downturn by around 305,000 jobs."

This is yet another crude estimate, but suggests that environmental spending may have an ongoing and important role in tempering job loss during recessions. Of the six routes to net job growth identified in this paper. this is the only one likely to have already had a sirniiicsnt impact on the empioyment picture in the U.S., precisely because it is not choked off bv Federal Reserve policy.

1.0 Conclusion

This paper began with the premise that macroeconomic policy currently places a significant constraint on the potential for attacking the problem of unemployment in the United States. If the Federal Reserve can be persuaded to let unemployment rates fall below 6%, than rnvironmentally sensitive production technologies and processes may contribute to net job growth at the microeconomic level through one of six routes. These six routes can in turn be divided into two general categories: approaches which wring more jobs from existing resources, and approaches which rely on increased economic activity to spark job growth.

Table 3 summarizes the main findings regarding the magnitude of job gains that might be realized. While these results are based on "back of the envelope" calculations, they are certainly suggestive of the potential for net employment gains through environmental investment. If the figures are in the ballpark, they imply that the impact of just three measures-- substituting away from capital intensive fossil fuels, reducing oil imports, and encouraging the growth of equitable job sharing-- might generate around 1-2 million extra jobs over a twenty year period. This would reduce unemployment by 1%-2%, again provided

that the central bank accommodated this kind of job growth. Moreover, and perhaps more relevant to policy, in specific areas with high levels of structural unemployment, a combination of these strategies might be pursued by local development planners.

Of the six, the stabilizing function that environmental spending provides during recessions is not subject to the constraints of macroeconomic policy. Further work would be useful to identify how large this effect has been in the past, and is likely to be in the future.

APPROACH	POTENTIAL JOB GAINS
LABOR INTENSIVE PRODUCTION	782,000 BY 2010
REDUCED IMPORTS (OIL)	17,200 PER $ BILLION
JOB "SHARING" (GROWTH OF TEMP EMPLOYMENT)	139,000 FROM 1985-l 990
DYNAMIC SPILLOVERS	????
INCREASED EXPORTS	
LIMITING DEPTH OF RECESSION	305,000 IN 1991

TABLE 3-- "CRUDE" ESTIMATES OF POTENTIAL JOB GAINS

SOURCE: See text above.

References

Breslow, Marc, John Stutz, Paul Lignon, Frank Ackerman, Nancy llgenfritz and Peter Murad (1992) *Socioeconomic Impacts of Solid Waste Scenarios for New York City: A Report to the New York City Deparrment of Sanirarion* (Boston: Tellus Institute).

Callaghan, Polly and Heidi Hartmann (1991) *Contingent Work: A Chart Book on Part-time and Temporary Employment* (Economic Policy Institute: Washington, DC)

Colt. Steve (1989) "Income and Employment Impacts of Alaska's Low Income Weatherization Program", *ISER Working Paper 89.2* (University of Alaska: Anchorage),

Daly, Herman and Robert Goodland (1994) "An Ecological-Economic Assessment of Deregulation of International Commerce under GATT", *Ecological Economics, 9,* 13-22.

Daly, Herman (1993) "The Perils of Free Trade", *Scientific American,* November.

Ehrenberg, Ronald and Robert Smith (1994) *Modern Labor Economics* (Harper Collins: NY)

Eisner. Robert (1994) *The Misunderstood Economy* (Harvard Business School Press: Cambridge, MA)

Elkington. John and Jonathan Shopley (1989) *Cleaning Up: US. Waste Management Technology and the Third World* (World Resources Institute: Washington. DC)

Geller. Howard, John DeCicco, and Skip Laitner (1992) *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies* (American Council for an Energy Efficient Economy: Washington, DC)

Goodstein, Eban (1995) *Economics and the Environment* (Prentice-Hall: Englewood Cliffs, NJ).

Goodstein, Eban (1994) *Jobs and the Environment: The Myth of A National Tradeoff* (Economic Policy Institute: Washington, DC)

Gore, Albert Jr. (1990) *Earth in the Balance* (Houghton Mifflin: NY)

Hirst, Eric (1987) "Energy and Economic Effects of Utility Financial Incentive Programs: The BPA Residential Weatherization Program", The *Energy Journal, (Y-2, 97-109.*

Khawaja, Muhannad, Thomas Potiowsky and H. Gil Peach (1990) "Cost-Effectiveness of Conservation Programs: The Hood River Experiment", *Contemporary Policy Issues, 8,174-184.*

Kleinknecht, Alfred (1987) *Innovation Patterns in Crisis and Prosperity* (St. Martins: NY).

Kneese, A. and C. L. Schulze (1975) *Pollution, Prices and Public Policy* (Brookings: Washington, DC)

Kondratieff, (1926) *Review of Economics and Statistics, 17, 105.*

Koplow, Douglas (1993) *Federal Energy Subsidies: Energy, Environmental and Fiscal Impacts,* (Alliance to Save Energy: Washington, D.C.).

Moore, Curtis A. and Alan S. Miller (1994) Green *Gold: Japan, Germany, The United States and the Race for Environmental Technology* (Beacon Press: NY).

Muller, Frank, Skip Laitner, and Lyuba Zarsky (1992) "Jobs Benefits of Expanding

Investment in Solar Energy" Solar *Industry Journal,* Fourth Quarter, 17-25.

Nell, Edward (1987) *Prosperity and Public Spending* (Unwin Hyman: Boston)

Nelson, Richard R. and Gavin Wright (1992) "The Rise and Fall of American Technological Leadership". *Journal of Economic Literature, 30-4, 1931* - 1964.

New York State Energy Office (1993) *Hydro-Quebec Economic Study, Draft Report,* and *Drati Appendices* (NYSEO: Albany, NY).

Paley, Thomas (1992) "Shifts in Sectoral Unemployment", *Economic Inquiry 30, 117-133.*

Rrpetto. Robert, Roger C. Dower, Robin Jenkins and Jacqueline Geoghehan (1992) *Green Fees: How a Tax Shift Can Work For the Environment and the Economy* (World Resources Institute: Washington, DC)

Schumpeter. Joseph (1939) *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process* (McGraw Hill: NY)

U.S. E PA (1993) *International Trode in Environmental Protection Equipmenr* (US EPA. Office of Policy, Planning and Evaluation: Washington, DC).

Zweibel, Ken(1990). *Harnessing Solar Power. The Photovoltaics Challenge* (Plenum Press: New York, NY).

APPENDIX A

This appendix illustrates in a very simple framework that a shift to more labor intensive production might increase the wage share of GDP, and reduce the profit share, while holding profit rates constant. The economy has two sectors, energy and manufactured goods. The latter is the labor intensive sector. The I-O model below is denominated in dollars: for example, $.70 of energy are required to produce $1 of energy. Note that the profit rate is $.10 on each dollar, Capitalists loan firms the income necessary to purchase inputs, and require a 10% return.

		OUTPUTS	
		Energy	Manufactured Goods
INPUTS ($ input/ $ output)	Energy	.7	.1
	Manuf. Goods	.1	.3
	Labor	.1	.5
	Loans	.1	.1

Final demand is initially Energy=$lO, Manufactured Goods=$10. GDP is thus $20. Under these circumstances, it is can be shown that total energy output is $40 and total manufacturing output is $20. Wage income is:

.1*$40+.5*$20=$14

Profit is:

1 *$40+.1*$20=$6.

Sow assume that $1 in final demand for energy efficient manufactured goods is substituted for $1 of final demand for energy. GDP thus remains constant at $20. (This simulates a cost-effective shift to energy efficiency.) Now total energy output falls to $37 and manufactured output rises to $21. Wage income is:

.1*$37+.5*$21=$14.20

Profit is:

.1*$37+.1*$21=$5.80.

The wage share has thus risen from 70% to 71%, with no decline in the profit rate.

Endnotes

1. Population projections are from the World Bank (1992) and the U.S. Census Bureau as reported in "Population Growth Outstrips Earlier U.S. Census Estimates", *The New York Times,* 12/4/92.

2. Goodstein (1995).

3. See for example, Eisner (1994) or Paley (1992).

4. This definition follows Goodstein (1995), who also provides a more extended discussion.

5. Input-output models are imperfect forecasting instruments. Their primary drawback is that they hold wage and relative price levels constant, and thus do not allowintersectoral adjustments as demand shifts. Geddes et al (1993) argue that the labor market shifts they envision are relatively modest and should have little impact on wages; they also examine the robustness of their results to possible induced changes in oil prices.

Geddes et al (1993) review several energy efficiency studies; see also Colt (1989). For solar studies, see the review in Muller et al (1992). For solid waste see Breslow et al (1992).

6. Income per job and the wage share in GDP can be calculated directly from Table 11-6. The reduction in the oil import bill can be estimated based on a reduction in oil usage of 7 quads (page 19), and the reference case data provided in Annual *Energy Outlook 1992* (US DOE: Washington, DC). The increase in income listed in Table II-6 ($28.5 billion) must then be partitioned into the portion due to the reduction in oil imports which in turn boosts GDP, and the residual, which results from the higher wage share. For more details, please contact the author.

7. Kneese and Schulze (1975) made the initial efficiency arguments. Repetto et al. (1992) review evidence for the efficiency argument, and also make the case for employment. On the latter point, also see Goodstein (1994).

8. For a discussion of the environmental problems with unregulated trade, see Daly and Goodland (1994). The us subsidy figure is from Koplow (1993). The OECD subsidy figure is from Daly (1993).

9. Breslow, et al. (1992) Because recycling also requires capital spending on "imported" equipment, the two options did not differ greatly in either their labor intensity, or "domestic" content. However, the differences were large enough to translate into an employment advantage for recycling.

10. New York State Energy Office (1992). In a study of the Bonneville Power Authority's conservation program, Hirst (1987) found that efficiency programs were highly cost-effective investments, when undertaken to forestall construction of new generating capacity. Khawaja et al (1990), in a study of the Hood River Conservation Program, concluded that retrofits could deliver power from between 3 and 7 cents per KWH.

11. New York State Energy Office (1992.)

12. This is an internal rate of return, based on a twenty year savings.

13. Schor's (1991: 59-72) explanation for employer's preference for long hours also reflects an associated increase in the "employment rent".

14. Data on total and temporary employment and hours is found in Callaghan and Hartmann (1991). Average temp hours in 1990 were 31 per week; full time hours were 43.5.

15. Zweibel (1990).

16. See Daly and Goodland (1993) for example.

17. Goodstein (1994).

16. Goodstein (1994)

19. If anything, it might smooth out the cycle, if firms raise prices to cover environmental investments during booms.

20. The average manufacturing multiplier is 15,250 jobs per billion dollars of expenditure.