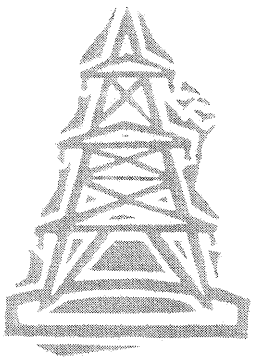
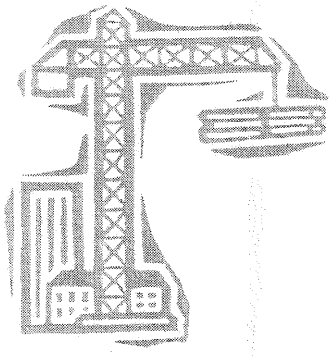




The Economics of Climate Change

Myths and Reality

WWF

The Economics of Climate Change: The Myths and the Reality

Introduction

The United Nations Intergovernmental Panel on Climate Change has reported that in order to prevent global climate disruption, and subsequent demographic, physical, economic and political disruption, it is necessary to stabilise the atmospheric concentrations of greenhouse gases rather than allow them to continue to accumulate at current – rising – levels.

The principal greenhouse gas, carbon dioxide, is at the heart of all industrial economies. therefore, reducing this gas to sustainable levels, while developing their industrial sector at a rate that does impinge upon economic performance, is a challenge that faces the governments of all industrialised and industrialising countries.

Since scientific consensus on the reality of climate change was reached in the IPCC a vociferous fossil fuel dependent industry lobby has attempted to stall progress in the negotiations by arguing that any action would be too rash, cost jobs and ruin competitiveness.

This despite two polls, one undertaken on behalf of the Australian Institute of Company Directors and another from the Confederation of British Industry, supporting global greenhouse gas reduction targets.

To do nothing in the face of such overwhelming scientific and industry consensus is false economics. Cost wise, those industries choosing to act now to reduce their dependency on fossil fuel makes sense – and to act now could prove to be no only a wiser decision, but a cheaper one.

The following four economics analyses argue that to take early, mitigating action against climate change would, in fact, prove more cost effective than a "wait and see" approach.

Paper 1 Beyond No-Regrets: The Real Economics of Precaution

Climate change is uncertain. Industry argues it is better to "wait and see" than to act now. In the first of these economics reports, WWF argues that while the risk from not acting now is high, irreversible damage, the costs, of ambitious controls are minimal if phased in gradually.

Paper 2 **The Costs of Delay: How Early Action Lessens Climate Change Costs**

Industry argues that actions should be delayed until new technologies are available and existing capital retired. WWF's analysis shows that delay means more investment in polluting infrastructure and that new technologies will only emerge if driven by tough targets now.

Paper 3 **Competitiveness and Kyoto: Lobbying Myth or Economic Reality?**

Special pledging by some industries says that acting before there are global targets will damage competitiveness. WWF's report shows this to be untrue, with the effects of competitiveness being minimal or positive, especially for countries which act quickly.

Paper 4 **The Costs of Delay to Developing Countries**

Finally, OPEC and the fossil fuel lobby have argued that any Kyoto commitments will destroy world trade and harm the least developed countries. WWF shows this to be economic fiction and that developing countries have much to gain, both environmentally and economically, from ambitious targets at Kyoto.

WWF Climate Economics Briefings: 1

Beyond No-Regrets: The Real Economics of Precaution

Summary

The fact of human-induced climatic change is undisputed, but the rate, scale and distribution of its impacts are highly uncertain. More research is unlikely to quickly resolve this uncertainty because critical processes cannot be accurately modelled, and new discoveries continually introduce extra complexities. Economic analysis shows that the correct response to such uncertainty is to undertake significant early action to mitigate the causes of climate change, rather than concentrating investment in attempting to adapt to potential impacts.

Strong, early mitigation action is needed to respond to uncertain climate change impacts because:

- Greenhouse Gas (GHG) emissions and climate change damages are irreversible.
- Early action beyond no-regrets levels reduces the cost of responding to uncertain future climate damages.
- Adaptation is a riskier, and thus more expensive, response strategy than mitigation.

Introduction

The large uncertainty surrounding climate change impacts is one of the critical influences on policy formation. Initially, it was hoped that increased research would significantly reduce uncertainty and allow a firm scientific basis for future actions. However, though our knowledge has greatly increased over the last ten years, and discernible climatic change has been clearly observed, the true complexity of climatic interactions has also become increasingly apparent.

Despite mounting evidence of the potential for severe and irreversible damage from climate change, most discussion has assumed that the only risk is in acting too quickly, and spending too much on reducing greenhouse gas emissions (for example, Montgomery, 1997). It has been argued that mitigation actions should be minimal and confined to "no-regrets" policies (those with minimal or zero net-costs).

However, existing techniques on how to make good decisions under uncertainty, which are extensively applied in business, monetary policy and environmental risk assessment, show that such arguments are simplistic, partial and wrong.

Good policy must weigh up the risks associated with both action and inaction, assessing which one is likely to give the best outcome over all possible futures.

Economic logic argues that the urgency and scale of precautionary action can be assessed by weighing the relative severity, irreversibility and risks associated with action and inaction. Immediate precautionary action should be taken if it increases future flexibility in responding to uncertain events. In climate change policy, flexibility is achieved by reducing the potential for irreversible climate damage, and by immediate investment in new, clean technologies.

WWF believes that current knowledge shows the risks of damage associated with rising GHG concentrations to be far higher and harder to reverse than the economic risks associated with immediate, significant GHG mitigation.

Given current knowledge, truly precautionary mitigation actions should go far beyond "no-regrets" policies.

In addition to building in flexibility when the future is very uncertain, economic analysis recommends taking action to reduce the likely *range* of future outcomes, which can only be achieved by reducing GHG emissions.

Responses to uncertain climate damage should emphasise emissions reductions, because the alternative of investing in adaptation does not reduce the likelihood of extreme damage.

Buying an Option on the Future: How Irreversible Impacts imply Early Action

GHG emissions and many of the potential impacts from climate change are either completely irreversible, (for example, human morbidity and species extinction), or practically irreversible in the short to medium term (for example, sea level rise). In contrast to the permanent costs of uncontrolled climate change most mitigating actions can be reversed at no extra cost after 10-30 years, when they come to the end of their natural life.

Given the uncertainty surrounding the severity of climate impacts, it makes economic sense to invest in the reversible option of mitigation now. Abatement measures can be removed cheaply, but if GHG emissions continue unabated and damages prove to be high there will be no practical way to reverse these effects.

The formal basis for the above conclusions comes from option theory, which is routinely used by businesses to evaluate investment decisions in a climate of uncertainty. Option theory replaces standard cost-benefit analysis when problems contain three characteristics: the future must be uncertain; actions must be at least partially irreversible - and there must be potential for learning.

To give an example: the future price of oil is uncertain, but oil companies have to make large irreversible investments in order to supply future demand. Because delay allows them to see if future prices will fall so low as to make the new investment unprofitable, they value that option and are prepared to pay to secure it. The "option value" of being able to delay is the difference in likely profits. In high risk situations this can be a large proportion of total investment value.

In most real world situations there are costs associated both with both acting now and with waiting. For example, waiting to make the investment could allow a competitor to gain a permanently higher market share, whatever your future investment. Therefore, the relative irreversibility and yield of different potential outcomes will determine which option - to wait to reduce uncertainty, or to invest now - is in fact valuable.

WWF argues that GHG emissions and climate change impacts are harder to reverse than mitigation actions taken to slow climate change, and so the valuable option is to avoid increasing GHG concentrations.

This implies that even with high uncertainty it is worthwhile to invest significantly in greenhouse gas abatement - at levels well beyond no-regrets measures - as the alternative is an irreversible commitment to future climate change.

This conclusion rests on the relative reversibility of climate damage and mitigation measures, which is explored below in detail, and not on any aversion to risk by policy makers. The issue of risk aversion and how this affects climate policy is explored later in the paper.

The Relative Reversibility of Climate Change Impacts and Mitigation Options

Once emitted, carbon dioxide remains in the atmosphere for over 100 years. Even the most aggressive actions to increase carbon sinks - reforestation for example - will take many decades to

significantly affect GHG concentrations. In any event, a massive planting programme would hit land availability constraints and so would be just a one-off measure for a fixed time span.

The impacts of climate change will be even more persistent than rises in GHG concentrations, because of the long time lags between changes in radiative forcing and changes in natural systems. Even if GHG concentrations are lowered this will not reverse species extinctions, and cannot restore unique ecosystems which have irreversibly changed. Such arguments also hold for managed and productive ecosystems (for example, agriculture and fisheries), as well as impacts on man-made infrastructure, such as water collection systems and sea defences, which become inadequate or obsolete due to climatic changes.

In contrast, most mitigation investments in areas such as energy efficiency, power systems and transport have a working lifetime of under 30 years. Only changes to infrastructure, such as transport networks and urban plans, are irreversible on comparable timescales to GHG emissions.

It has also been argued that mitigation efforts should be postponed because the true severity of climate change impacts will only be found by letting GHG concentrations increase. If this was true, immediate stabilisation of GHG concentrations would lock us permanently into an uncertain future, but allowing climate change to continue would eventually remove any uncertainty over the scale of impacts.

This argument is flawed because the lag between increased GHG concentrations and climatic changes means that uncertainty will remain as long as GHG concentrations continue to rise. The truth is that the impact of a particular GHG concentration level will only be apparent once all ecological and climatic systems have reached equilibrium, which will take centuries. Therefore, delaying action will give us little additional information about the impact of climate change, while exposing the world to increased risks of irreversible damage.

On balance the facts suggest that immediate mitigation is a valuable option, because it will prevent future irreversible damage. The "option value" associated with early action has not been adequately considered in many existing economic models of the problem, including models which recommend delay as the economically efficient action.

The value of avoiding irreversible damage through early abatement action is a strong argument for rejecting the flawed results of existing economic models.

Investing in Flexibility: Why Delay reduces our Ability to Respond to Uncertainty

Flexibility of response is extremely valuable if climate change damages turn out to be much higher than expected, and a very rapid stabilisation of GHG concentrations is needed. In this case, highly polluting infrastructure will have to be quickly phased out and rapidly replaced by new low GHG emitting technologies. Flexibility will also require immediate investment in adaptation to a changed climate while emissions and concentrations are slowly reduced.

Delaying significant mitigation efforts to reduce GHG emissions will reduce such flexibility because there will have been continuing investment in long-lived capital which promotes high GHG emissions, and new low emission technologies will be immature and unready for practical implementation.

The development of new, clean technologies will mainly occur in the private sector in response to a perceived market demand. If governments do not announce credible policies to reduce GHG emissions in the short term, companies will not believe their long-run policy statements. Therefore, they will not invest as much in R&D and technologies will not be readily available if rapid emission reductions are needed. The value of such technological flexibility is understated by conventional economic models because they assume the rate of innovation in the economy is unaffected by government policies and economic signals.

Therefore, in standard economic models when a rapid response is needed to decrease emissions, clean technologies are assumed to be available "off-the-shelf", with no lead time for innovation, development or commercialisation. Some models have included the time needed to phase out old, polluting capital. But have only to considered relatively short-lived infrastructure (such as power stations), rather than more pervasive investments, such as transport infrastructure and urban plans. As a result these models *overestimate* the flexibility of economies to react to changed government policies and price signals.

This prediction of flexibility inspires complacency on the part of governments. In reality we need to plan for flexibility now. Otherwise, when emissions reductions are finally attempted it will be more expensive than predicted to reach a particular target level of emissions reductions. In the face of such increased mitigation costs GHG concentrations may be allowed to stabilise at a higher level, leading to greater irreversible damage to humans, economies and eco-systems.

The lead time associated with developing clean technologies and phasing out polluting capital means that immediate mitigation of climate change preserves valuable flexibility in the face of continuing uncertainty. By preserving flexibility, investing in early mitigation actions gives us more options to react, whether climate change impacts are high or low.

Early mitigation action is an effective insurance policy against the uncertainty surrounding climate change impacts. Like any insurance policy, the premium - that is, the amount of early mitigation - should rise if uncertainty around the possible range of climate impacts increases. Therefore, higher levels of uncertainty over climate impacts implies more investment in precautionary action, not less.

Insuring Against Ignorance: Correct Responses to what We Cannot Know

Economic arguments for early mitigation action assume policy makers have a relatively high degree of knowledge about the future. While the precise severity of climate change is not known, the relative probabilities of different impacts are assumed to be well understood. This implies a detailed

knowledge of the links between rising GHG concentrations, changing climatic conditions and impacts on natural and made-made systems far into the future.

Such knowledge of the future is termed "soft" uncertainty. Betting on a fair dice is an example of soft uncertainty, because the probability of each potential result occurring is accurately known. If the future can be described by "soft" uncertainty, then current policies can be made which accurately balance the likelihood of all possible futures and include the right amount of flexibility needed to respond to extreme outcomes. These techniques are used every day by companies and financial institutions to balance future risks in currency, equity and capital markets.

But we do not know the full range of possible outcomes - let alone their probability of occurring. This type of ignorance about the future is termed "hard" uncertainty. Betting on the throw of a dice without knowing the number of sides it has is a good example of hard uncertainty.

Though the distinction between hard and soft uncertainty may seem abstract, it has profound indications for how climate policy should be made. Economic models which calculate climate change policies can only deal with soft uncertainty. However, a full assessment of climate change policy must take into account our ignorance of natural systems.

The simplest way to do this is to take a risk averse attitude. Risk averse policies aim to decrease the range of likely future outcomes, thus lowering the possibility of extreme consequences which will require radical policy responses. To repeat the dice analogy; a risk averse policy aims to reduce the maximum possible number of faces on the dice, and thus the range of likely outcomes. In the case of climate change the only reliable way to reduce the range of outcomes is to lower GHG emissions, because investment in adaptation cannot lower uncertainty over future impacts.

Though the causal connection between GHG emissions and climatic change is well identified, the size and type of different impacts at the local level are virtually unknown. Without accurate knowledge of local impacts, investment in pre-emptive adaptation - for example, introducing new building standards, higher sea defences or expanded water supply systems - will always be of uncertain benefit. Adaptation is also unable to prevent damage to natural systems which underpin much of human activity. Therefore, relying on adaptation is risky because if and when the unforeseen happens - societies will be both vulnerable to the irreversible impacts, and unable to quickly lower GHG emissions because of existing polluting infrastructure and lack of clean energy alternatives.

In contrast, by investing in early mitigation we can be certain that the risk of severe and extreme climate damage has been lowered, because the causal link between rising GHG concentrations and climate change is clear. Slowing the immediate rate of climate change is equally important because this will make natural systems more likely to successfully adapt.

While investment in adaptation often seems attractive next to achieving significant cuts in greenhouse gases, its results are less reliable. There is more hard uncertainty surrounding the benefits of adaptation, and this must be reflected in any analysis of the balance between preventing and responding to climatic change.

Early mitigation will reliably reduce the range of future climate damage - investment in adaptation cannot be trusted to do this. Early action should concentrate on mitigation methods, because adaptation is a poor insurance policy for the planet.

Conclusions

Making good policy in the face of uncertainty should follow two basic rules. Firstly, that precaution should prevail when uncertain future outcomes are likely to be extreme and irreversible. Secondly, that flexibility must be maintained to respond to uncertain future events.

The first point is a restatement of the Precautionary Principle. Given our ignorance of the climate system, current policy decisions should aim to reduce and eventually eliminate the causes of climate change, rather than trying to anticipate and adapt to its symptoms.

The second principle acknowledges that we are already committed to a certain level of climate change. Inertia in both human and natural systems means that this is practically irreversible. Therefore, good policy should ensure that human societies maintain the flexibility to respond to future uncertain impacts. The irreversibility of damage from climate change and the long timescales needed to develop clean technologies, makes immediate investment in mitigation the most economically efficient option.

If we wait to see the outcome of climate change we will be forced to remain spectators, unable to reverse what we have done. The only real insurance policy, which preserves our ability to control the future, is begin strong, immediate action to mitigate the causes of climate change.

Mitigation action must begin immediately and go beyond so called no-regrets measures, otherwise we will be under-insuring the planet and storing up costs for the future.

Selected Bibliography

Dixit, Avinash and Robert Pindyck (1993), *Investment Under Uncertainty*, Princeton University Press, Princeton, New Jersey.

Hall, Stephen and M. Stephenson (1990), "Optimal Control of Stochastic Non-Linear Models", in Henry, S. G. B. and K. D. Patterson (eds), *Economic Modelling at the Bank of England*, Chapman and Hall, London.

Kolstad, C. (1993), "Mitigating Climate Change Impacts: The Conflicting Effects of Irreversibility in CO2 Accumulation and Emission Control Investment", Paper presented to the *International Workshop on the Integrative Assessment of Mitigation, Impacts and Adaption to Climate Change,* IIASA, Laxenburg, October 1993.

Mabey, Nick, Stephen Hall, Clare Smith and Sujata Gupta (1997), *Argument in the Greenhouse: The International Economics of Controlling Global Warming*, Routledge, London.

Manne, A.S. and R.G. Richels (1992), *Buying Greenhouse Insurance*, MIT Press, Cambridge, MA, USA.

Montgomery, W. David (1997), "Framework for Short- and Long-term Decisions", in *APACE Symposium on Critical Issues in the Economics of Climate Change*, International Petroleum Industry Environmental Conservation Association, London.

Ulph, Alistair and David Ulph (1994), "Global Warming: Why Irreversibility may not Require Lower Current Emissions of Greenhouse Gases", *Discussion Paper in Economics and Econometrics,* 9402, University of Southampton, UK.

Ulph, Alistair and David Ulph (1994), "Who Gains from Learning about Global Warming", *Department of Economics Discussion Paper* 94-11, University of Birmingham, UK.

Vercelli, Alessandro (1994), "Hard Uncertainty and the Environment", *Nota di Lavoro* 46-94, Fondazione Eni Enrico Mattei, Milan, Italy.

WWF Climate Economics Briefing: 2

The Costs of Delay: How Early Action Lessens Climate Change Costs

Summary

Failure to control emissions now increases the risk of irreversible, catastrophic damage, and increases the costs of responding to such damage by delaying investment in clean technology. Though climate change is a long term problem, immediate action to significantly slow its causes makes economic sense. Waiting decades before acting will result in higher damages to people and ecosystems, and will also greatly increase the cost of eventually halting the rise in GHG concentrations.

The economic logic of early action rests on three arguments:

- Delay causes higher environmental and economic damage from climate change.
- Delay increases mitigation costs due to continued investment in polluting infrastructure.
- Delay raises response costs by slowing the development of new, clean technologies.

Introduction

Atmospheric concentrations of greenhouse gases (GHGs) have been rising since the industrial revolution and the rate of accumulation continues to increase. As the impact of this pollution on the global climate becomes clearly visible, the need for action would seem to be obvious. However, some economic studies have argued that delaying action to reduce GHG emissions for two to three decades is, in fact, the economically efficient policy course (see Weyant, 1997).

The models underlying these results are superficially complex, but actually highly simplistic when compared to the systems they claim to study. In particular, these models have made simplifying assumptions about climate damage, the efficiency of investment and mechanisms of technological development, which drastically *lower* the apparent costs of delay.

Good economics involves carefully weighing the costs and benefits of different actions, and in WWF's view the costs of delaying mitigating actions clearly outweigh any minor benefits gained by waiting.

Waiting at the Cliff Edge: How Delay raises Climate Change Damage

Delaying action to slow climate change by several decades will undoubtedly increase the amount of damage caused. The path to stabilisation is crucial. Rapid rises in emissions, followed by drastic falls, will cause significant changes to society and adverse impacts on rates of temperature increase. Damage will increase even if the final stabilised concentration of GHGs in the atmosphere, and the date this target is reached, is the same.

The non-linear nature of the climate system and growth in global GHG gas emissions makes it more than likely that current rates of temperature change will accelerate if nothing is done. Therefore, delaying GHG abatement will greatly raise the probability of dramatic ecosystem changes and consequent environmental and economic damage.

Ecological systems are generally able to adapt to changing external conditions without dramatic loss of diversity or function, but successful adaptation depends on changes happening slowly enough for keystone species to migrate. Immediate abatement would slow the rate of climatic change, thus giving slow-moving species such as trees more time to adapt.

Agriculture, fisheries and forests will be particularly vulnerable to increased rates of climatic change. For example, climatic shifts often disrupt the usual balance of pest and predator species affecting important commercial crops. Such disruption increases both the frequency and severity of infestation cycles, requiring greater interventions of agri-chemicals to ensure

crop survival. If artificial supplements or controls are not available then the variability of yields will be dramatically increased, with obvious impacts on subsistence populations.

In fisheries, rapid climatic changes will increase population variability by affecting both breeding success and food availability. With greater yearly variability in stock numbers there is greater risk of overfishing or disease reducing the stock to ecologically unsustainable or non-commercial levels. Management responses to this will be to reduce allowable yearly catches, with obvious effects on fish prices and employment.

Likewise, man-made systems also need time to adapt. Failure to slow climate change will result in accelerated redundancy for some long-lived infrastructure, or expensive retrofitting if replacement is uneconomic. This is particularly true for sea defences, water supply and distribution systems, and commercial and residential building stock. Slowing the rate of climatic change will allow the capital stock to be replaced at the end of its natural life, preventing the high costs of premature scrapping and obsolescence.

Delaying mitigation actions will increase the costs of climate change through higher damage to natural and managed ecosystems and premature obsolescence of man-made capital. These costs have not been considered by economic studies which recommend delaying actions, making their results incomplete and biased.

Investing in Pollution: How Delaying Action increases Inefficient Investment

Delaying action to reduce emissions of GHGs is likely to greatly increase, rather than decrease, the future cost of achieving a long run GHG stabilisation target. A delayed response to climate change will eventually require very rapid conversion to a low fossil fuel using economy if similar concentration targets are to be met. At least 70 per cent of fossil fuel emissions are dependent on infrastructure with a lifetime of over 30 years. Therefore, attempting to change quickly to a low carbon economy will involve either widespread scrapping of existing capital or the use of more expensive retro-fitted options.

If governments signal to the private sector that no action to slow climate change is proposed for several decades, a new generation of high-energy using capital will be installed. For example, continued investment in high-energy using, extensive and dispersed transportation systems encourages additional low efficiency investment as industrial, commercial and residential premises are attracted by cheaper land rents and better access. Reversing this pattern of development will be highly costly because the profitability of each investment is conditional on the others.

Similar problems exist for other long lasting investments. Private investors in infrastructure (for example, power stations, office buildings) typically look for full financial returns in around 15 years, though the capital itself has a lifetime of 30-40 years. Expectations of future regulations on fossil energy usage will have little influence on the design of new facilities unless the majority of their financial returns will have to be recovered under GHG restrictions. Therefore, a new generation of polluting capital will be installed if action is delayed. If, as some suggest, older polluting capital is excluded from GHG controls this will raise total mitigation costs. Because the required reductions will have to be made in parts of the economy which are already low GHG emitters.

Delaying action raises the cost of converting to a low GHG emission economy by allowing a further generation of polluting machinery and infrastructure to be installed. In contrast, immediate changes to both public and private sector incentives through regulations, taxes or permit systems would encourage incremental changes in planning and design.

Early mitigation action allows incentives to reduce GHG emissions to be gradually increased, encouraging evolutionary changes to economic structures and minimising the disruption and cost of moving to a low GHG emitting economy.

Waiting for a Miracle: How Delay Hampers Innovation and New Technology

All economic studies arguing against immediate action to tackle climate change have ignored the extra costs of faster climatic change and continued investment in polluting technology. Not surprisingly failure to account for these costs biases the studies towards recommending delaying mitigation action. This result is further reinforced by errors in their modelling of innovation processes and technological evolution.

In these economic models innovation is a purely time dependent process: as time goes on technology appears from outside the economic system and improves the efficiency of production. By definition the working of the economy does not affect the evolution of new techniques in this type of model. If society needs to reduce dependence on one input - such as fossil fuels - the necessary technologies are assumed to exist.

It is obvious that given such a view of technology, delaying action to deal with climate change would appear to be a logical strategy. While nothing is being done innovation in abatement technology will carry on at the same rate as if a high abatement strategy was being followed. These new, efficient techniques are, therefore, assumed to be available for use as soon as politicians decide the time is ripe for action.

This strategy of waiting for the appearance of miracle technology is obviously alluring to policy makers because it defers all decisions by two or three decades. But the assumptions on which it is based bear no resemblance to the workings of the real world. In reality, technology is produced by forces working inside the economic system and becomes refined through a constant process of evolution in service (learning-by-doing). The dependence of innovation on the marketplace is apparent from the fact that the vast majority of non-military research and development money is spent by private companies. This dwarfs public funding through universities or research institutes. These companies expect a commercial return on their investment in the short to medium term, and are not carrying out work in the expectation that it will reach commercial viability in 20 to 30 years.

Expecting these technological advances to happen without an active and immediate market for the product is analogous to expecting Pentium processors to have developed without customers having to buy earlier generations of computers. The logic of these economic models would have told us all to delay buying computers until the technology was improved and prices had fallen.

The technology to deal with climate change will only appear if there is a market for it. Companies need immediate incentives to start research, and must have faith that governments will adhere to targets so creating a demand for new equipment. Delaying any mitigation action sends the wrong message, because governments cannot make credible policy commitments twenty years in advance. Knowing this, companies will not invest in technology development until they see compelling signs that governments are serious about tackling the problem of climate change.

The influence of market expectations on innovation rates is not only common sense, but has been observed in the past. The oil shocks of the 1970s created expectations of continually rising oil prices, and massive investment in energy efficiency and alternative power sources. Though prices did not eventually rise, the effect of these expectations on the long run efficiency of energy use can clearly be observed. Studies indicate that genuine innovation was stimulated by these price rises, and not just increased use of existing technologies.

Delaying action will retard technological development in two ways. Firstly, fewer new innovations will appear due to lower R&D investment by companies. Secondly, existing technologies will be less efficient because learning-by-doing requires a healthy competitive market to spur improvements. Existing economic models ignore these effects and so overestimate any direct abatement cost savings from delaying action.

Conclusions

Climate change has huge economic implications, and it is important that actions to combat it are carried out in a cost-effective and equitable manner. However, the use of economic models which produce perverse results due to overly simplistic assumptions does nothing to improve the quality of the decisions that must be taken in the short-term.

A more complete assessment of the costs and benefits of delay tend to suggest that significant immediate action will both reduce damage from climate change and lower the future costs of reaching long-run GHG emission targets.

Given the weight of economic evidence against them, and the gross flaws in their studies, it rests with the proponents of delay to prove their case based on more a credible analysis. In the meantime positive mitigation action should begin as soon as possible to reduce the causes of climate change.

Selected Bibliography

Freese, Curt (1996), *The Commercial , Consumptive Use of Wild Species*, Report for the World Wildlife Fund-US, Washington, USA.

Smith, Clare, Stephen Hall and Nick Mabey (1995), "Econometric Modelling of International Carbon Tax Regimes", *Energy Economics,* **17**, No.2, pp.133-146.

Mabey, Nick, Stephen Hall, Clare Smith and Sujata Gupta (1997), *Argument in the Greenhouse: The International Economics of Controlling Global Warming*, Routledge, London.

Weyant, John P. (1997), "Insights from Integrated Assessment", in in *IPIECA Symposium on Critical Issues in the Economics of Climate Change*, International Petroleum Industry Environmental Conservation Association, London.

WWF (1997), *Ecological Impacts of Climate Change on National Parks and Protected Areas of the World*, World Wildlife Fund-US, Washington D.C., USA.

WWF Climate Economics Briefing: 3

Competitiveness and Kyoto: Lobbying Myth or Economic Reality?

Summary

The split of responsibility in the United Nations Framework Convention on Climate Change (UNFCCC) between developed and developing countries, has caused considerable political concern within Annex I countries because of fears that their industries will lose competitiveness and relocate to non-Annex I countries. However, WWF believes that these fears have been greatly exaggerated, and are based on special interest lobbying not careful economic research.

WWF's position is based on three strands of argument:

- Achieving the GHG mitigation targets proposed at Kyoto will have minimal or positive impacts on overall trade volumes and employment.

- Relocation of energy intense industries is determined by larger economic forces than climate change policy.

- Early mitigation will promote the development of cleaner technologies which will give competitive advantage in the export markets of the future.

Introduction

The Berlin Mandate proposes binding greenhouse gas (GHG) emission reductions in Annex I countries (OECD, CIS and Eastern Europe), while placing no restrictions on emissions in developing countries. This is in recognition that the industrialised Annex I countries are responsible for over 75 per cent of increased GHG concentrations over the past two centuries.

This split of responsibility has caused considerable political concern within Annex I countries, as they fear a loss in competitiveness[1] and the potential for industries to relocate to non-Annex I countries. Some industry groups have inflamed such fears by saying any binding GHG reductions would cause them to relocate outside Annex I, weakening the agreement and increasing unemployment.

A further fear is that if Kyoto fails to impose significant targets on GHGs across Annex I, countries which have strong unilateral mitigation targets - notably in the European Union - will face a decrease in competitiveness compared to other industrialised countries. These fears have made the proposed EU emission targets, which it considers feasible and achievable at very low cost, conditional on acceptance by the whole of Annex I.

WWF believes that these fears have been greatly exaggerated, and are based on special interest lobbying not careful economic research. These predictions are inconsistent with all independent economic studies on competitiveness impacts - and those carried out by the US and EU governments - which show minor and mixed impacts on trade and employment outside fossil fuel production sectors.

WWF's position is based on three strands of argument:

- Achieving the GHG mitigation targets proposed at Kyoto will have minimal or positive impacts on overall trade volumes and employment.
- Relocation of energy intense industries is determined by larger economic forces than climate change policy.
- Early mitigation will promote the development of cleaner technologies which will give competitive advantage in the export markets of the future.

Concerns over competitiveness impacts of mitigation actions are understandable, but have been exaggerated. In the aggregate any impacts will be small, and swamped by other - more conventional - economic factors. However, there is an advantage in countries being "first movers" in developing cleaner technologies, as these will dominate future export markets as global emission targets are progressively tightened.

Competitive Impacts of GHG Mitigation: Major Problem or Minor Distraction?

Industrial groups in Annex I countries fear a loss of international competiveness - the total value of goods traded by an economy - as a result of increased energy costs following implementation of the proposed restrictions on GHG emissions. However an examination of trends in trade, investment and energy costs and prices shows that such a view is unfounded.

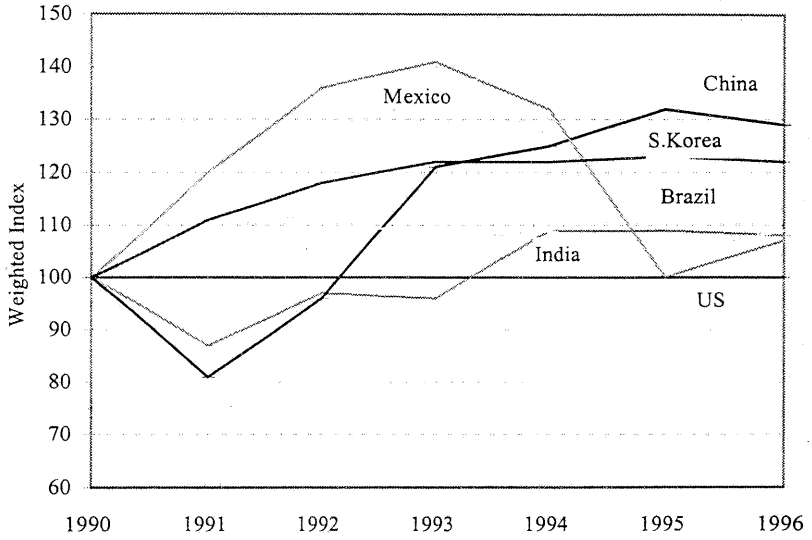
Empirical evidence reveals that energy prices have little bearing on overall trade and investment decisions. In 1996 the largest increases in US investment went to Annex I countries - which accounted for approximately 70 per cent of US foreign investments - which tend to have significantly higher energy prices (UNCTAD 1997). For example, in 1996 the price of heavy fuel oil was 18 per cent higher in Japan and 34 per cent higher in the UK than in the US (IEA 1996).

The reason why this is the case is because energy costs only make up a small percentage of total input costs (generally between 3-6 per cent) compared to labour costs and capital costs for the vast majority of industries in the tradable sector. In 1993 industries where energy costs accounted for less than 3 per cent of their output value employed around 90 per cent of the workforce and were responsible for over 90 per cent of output (OIT 1997). Only heavily energy intensive industries - petroleum refining, iron and steel, chemicals and other metals - where energy costs range from 10 to 20 per cent are likely to suffer significantly from changes to energy prices. These industries, however represent only a small share of employment and output. Furthermore, as discussed below, factors other than input prices will have a greater effect on their trade and investment decisions.

Recent trends in energy prices show that they have increased in most of the developing world, relative to the US. Figure 1 shows relative prices changes between 1990-1996 for key developing countries - where 1990 is taken as the base year.

These increases have been a result of energy sector reforms to streamline economies and improve international competiveness. In this respect such reforms are likely to continue and spread to other developing countries. This would imply that Annex I industries are unlikely to suffer a loss in competiveness as a result of energy price increases since their main non-Annex I competitors face similar price rises (WRI 1997).

Figure 1: Energy prices for key developing countries relative to the US



Source: WRI (1997)

Though the majority of the tradable sector will experience few changes as a result of GHG mitigation policies, those sectors providing abatement technologies and services will see a marked growth in both internal and external markets. Non-fossil fuel industries will benefit in particular as new markets for renewable energy sources and energy efficient equipment opens up. These effects are expanded on in the final section on cleaner technology.

The significance of possible changes to the tradable sector arising from the proposed restrictions on GHG should be put into context. Most studies expect changes in sector exports, outside fossil fuel production, to be in the order of plus or minus 2-5 per cent, with aggregate changes being much smaller (0.5-2 per cent). These minor shifts should be compared with projected growth of 40 per cent in OECD economic output by 2010, with a corresponding growth in aggregate trade of anywhere from 50 to 130 per cent.

It must be remembered that the introduction of environmental policies to curb GHG emissions may only be part of a broader package of economic reform. For example, implementing a carbon tax to increase energy prices will raise substantial revenue, which could be used to recycle labour or capital taxes. This will correspondingly decrease the cost of other inputs and increase the competitive edge of many industries - particularly in the service sector. Economic models show significant employment gains from labour tax recycling and the possibility of lowering equilibrium levels of unemplyment in Annex I economies, without stimulating price inflation.

The GHG mitigation policies will have little impact on the overall competitiveness of Annex I countries. Only the most heavily energy intensive industries and fossil fuel producers are likely to suffer negative effects.

If carbon or energy taxes are used to reduce GHG emissions then recycling tax revenues through labour taxes would yield the additional benefit of reducing unemployment as well as encouraging a more efficient use of energy.

The Relocation of Energy Intensive Industry: Cause or Coincidence?

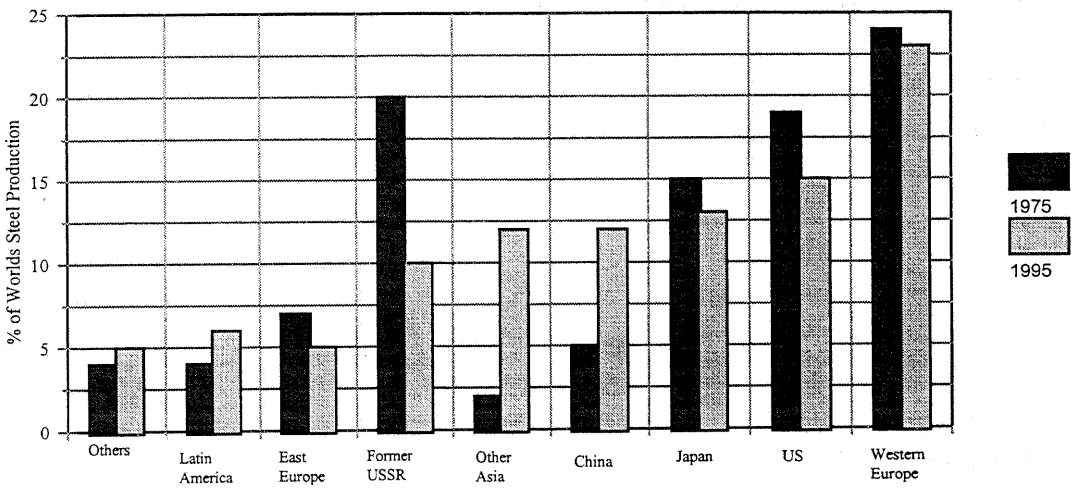
There is much economic research and political apprehension within Annex I countries that energy intense industries will relocate to areas outside the agreement once restrictions on GHGs are imposed. However, statements by these industries of massive job losses and industrial meltdown are not backed up by independent analysis of past or projected future economic trends.

Energy intensive industries have stronger motivations other than energy prices influencing their location decisions. Most notably: market access; product quality; existing trade links; and trading restrictions such as import quotas and tariffs. Others motivations include economic and political stability, secure legal rights, efficient financial markets, an educated workforce and reliable infrastructure services (WRI 1997).

In the US the most energy intensive industries - chemicals and primary metals - continue to invest in other OECD countries where energy costs are high. In 1996, over 60 per cent of US foreign investment in chemicals and over 50 per cent of its overseas investment in primary metals went to Western Europe. Clearly any increases in energy prices, which as discussed above may also affect developing countries, will have little bearing on the decision by energy intensive industries to relocate.

The consensus of research in this area is that investment decisions are primarily based on long run factors such as market growth. For example, as Figure 2 shows, world steel production has proportionately shifted towards the newly industrialised countries, particularly in South-East Asia over the past twenty years. The chemical industry has seen similar global shifts in production. It must therefore be expected that even with GHG mitigation measures energy intensive industries would relocate from stagnant Annex I markets to capture these new growing markets.

Figure 2: World steel production



High sensitivity to factor prices - notably labour - is only really observed in light assembly and textile sectors, which have repeatedly shifted location around the world chasing lower costs. This "footloose" behaviour is characteristic of low capital cost industries reliant on low skill labour. It is not typical of energy using industries, which are capital intense and dependent on high levels of technical skill.

The movement of bulk production in these energy intensive sectors to areas of growing demand is being accompanied by productivity improvements and product differentiation into high quality and specialised products within mature economies. Therefore, for those firms which will continue to be located inside Annex I countries, technical improvements in productivity and product range will be more important factors for industrial survival than energy prices.

Unfortunately, policy makers have been swift to respond to the inflated possibility of additional industrial relocation by suggesting that energy intensive industries could be exempt from statutory measures. Although this reduces the already small risk that more of these politically sensitive industries may migrate, the protection comes at a high cost. Much of the energy saving in industrialised countries has been accomplished by reducing material use in products. For example the use of steel in the automobile industry. Exempting the producers of inputs to manufacturing industry from GHG controls will remove price signals for increased efficiency further down the product chain.

The overall result will be higher costs of compliance to reach the same emissions targets, because cheap abatement opportunities through input reduction will be unexploited. Policy makers must carefully weigh the impact of exemptions on the efficiency of meeting national targets before giving in to special interest pleading.

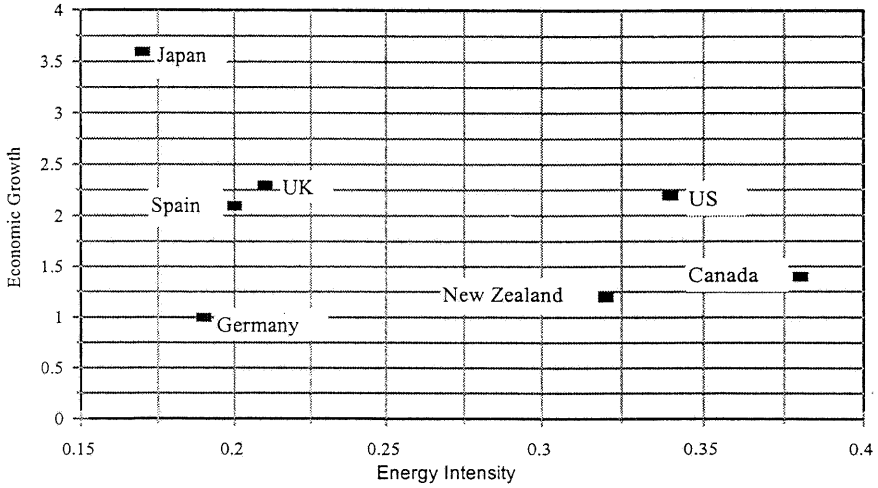
There currently exists a natural trend for energy intense industries to relocate to industrialising economies to take advantage of new growing markets. Companies remaining in industrialised countries will either be protected by trade barriers, or compete through high technology products. The introduction of GHG controls in Annex I countries is unlikely to have a major impact on these firms' location.

Getting the Signals Right: Stimulating Development of Cleaner Technologies

Current energy prices do not incorporate the full external costs of pollution, whether local or global, masking the price signals to reduce consumption of energy intensive products. This retards innovation and new technological advances in energy use, which have been shown to respond to price signals. Therefore, failing to correct these incorrect signals through a misplaced fear of reduced competitiveness, will allow a further generation of polluting machinery and infrastructure to be developed, produced and installed. This will cause considerable environmental damage and greatly increase the cost of eventually reducing emissions (see WWF Economics Briefing on "The Costs of Delay").

The impact of correcting the price signals will be a gradual shift in the development and commercial application of cleaner technologies as the demand for energy intense products declines. Such cleaner technologies will often lead to win-win situations where economic as well as environmental benefits can be procured. These economic benefits may be as a consequence of immediate cost saving, or new competitive advantages as these innovative solutions, products, processes allow firms to export into new markets.

Figure 3: Energy intensity and economic growth



There are already a number of important examples which highlight the possible positive relationship between economics, high environmental standards, and low energy use. As shown in Figure 3, countries such as Japan and Germany have tended to be more competitive than nations with lower energy prices. Especially in energy intense - and so supposedly vulnerable - manufacturing sectors. In these cases high energy prices have not hindered economic growth, but could be said to have encouraged innovation and competitive improvements. While this correlation is not conclusive and does not imply simple causation, it does suggest that there is no necessary connection between low energy prices and economic success.

Apart from considerable environmental benefits, the promotion of cleaner technologies through early GHG mitigation is likely to improve competitiveness in two ways: by reducing the possibility of expensive retrofitting of equipment in the future to reduce emissions; and by giving a "first mover" advantage to companies in future global markets for GHG mitigation process and technologies.

Conclusion

Concern among Annex I countries that GHG mitigation will cause a loss of competitiveness and relocation of their manufacturing industries has been one of the largest impediments to putting in place meaningful emission reductions.

The conclusion of this paper is that such concern is unwarranted. Early action to control GHGs will have a fairly small impact on overall industrial competitiveness in Annex I countries. The maximum predicted impact is a few percentage points increase or decrease in trade volumes, while over the same period Annex I trade will grow by up to 150 per cent.

For those countries willing to take the lead there are potentially huge gains in being the first to develop new clean technologies which will supply the growing future demand as GHG emission limits are tightened.

At the same time, the loudest voices against binding reductions - the energy intense industries - are unlikely to suffer major competitive pressures or alter their existing trend of relocating to fast growing industrialising economies.

The competitiveness impacts of GHG mitigation are small compared to existing economic trends. With imagination, policies can be introduced which boost exports, increase employment and reduce other forms of pollution.

It is clear that issues of competitiveness should not inhibit countries and regions from agreeing significant reductions in GHGs emissions at Kyoto, or from going beyond their Kyoto targets on a unilateral basis.

Notes

1.*Among economists the concept of a country's "competitiveness" is controversial, and often derided as meaningless. The ability to compete can only really be compared when examining individual companies trading in like products. Countries trade across a range of sectors depending on their particular specialisation and natural advantages,and there is no simple pattern for what determines their ability to trade successfully. However, the concept of overall competitiveness does have weight in climate policy discussions were it is generally interpreted as the total value of goods traded by an economy.*

Bibliography

IEA (1997), *Energy Taxes and Prices*, OECD, Paris

Mabey, N, Hall, S, Smith, C and Gupta, S (1997), *Argument in the Greenhouse: The International Economics of Controlling Global Warming*, Routledge, London

OIT (1997), US Department of Energy, Washington, D.C

Tindale, S and Holtham, G (1996), *Green Taxes: Pollution Payments and Labour Tax cuts,* IPPR Briefing Paper

UNCTAD (1996), *World Trade and Development Report*, Geneva

UNCTAD (1997), *World Investment Report*, Geneva

World Resources Institute (1997), 'US Competiveness is not at Risk in the Climate Negotiations', Climate Notes, October.

WWF Climate Economics Briefings: 4

The Costs of Delay to Developing Countries

Summary

Early action to prevent climate change will be carried out in industrialised countries which have produced the majority of past GHG emissions. The FCCC states that countries outside this group should not be disadvantaged by such actions, but some recent economic studies have suggested that this may happen. However, a more complete analysis shows that most non-Annex I countries will benefit from early action both economically and environmentally.

Early action in benefits non-Annex I countries through three routes:

- Immediate abatement reduces the economic damages from climate change.
- Immediate abatement will have minimal or positive impacts on world trade.
- Immediate abatement will encourage technology transfer to developing countries.

Introduction

Some recent economic modelling claims to show that the actions of developed (Annex-I) countries to reduce climate change will have large negative impacts on trade with developing (non-Annex I) countries, even those that are not major exporters of fossil fuels. That is why preliminary compensation mechanisms for non-Annex I countries have been tabled for negotiation at Kyoto.

However, these studies do not give a balanced assessment of how Annex I commitments will affect the global economy, because they ignore the impacts of uncontrolled climate change and use outdated models of global trade.

If climate change continues uncontrolled, disposable incomes in Annex-I countries will fall as money is diverted from consumption into adaptation and damage restoration. Current modelling exercises ignore the impact of this reduction in consumption on world trade.

Failing to act now to control climate change will also have direct negative impacts on incomes, unemployment and health in non-Annex I countries. Every scientific and economic study has concluded that most climate change impacts will be felt in those countries, and will be particularly severe in tropical countries that rely on subsistence and export agriculture.

As well as ignoring the negative costs of inaction, these studies also overestimate the negative impacts of Annex I action on world trade. The models are highly simplistic and based on outdated measurements of trade relations. They do not account for current shifts in trade and foreign investment, and they ignore the influence of recent trade liberalisation through GATT.

WWF analysis concludes that implementing Annex-I measures to combat climate change can have a neutral or positive effect on trade between Parties. That is why we believe that the move towards substantial, binding restrictions on Annex I countries should not be delayed, or even halted, by concerns based on incomplete and misleading research.

The Price of Delay: the impact of climate change on non-Annex I countries

The negative impacts of continuing rapid climate change will fall heaviest on those countries which are climatically extreme and highly dependent on agriculture for their export and subsistence economy. Decline in crop production will be one of the main impacts, along with projections of increased disease and impacts from extreme weather events, sea level rise and flooding.

Industrialised countries will respond to increased climatic variation through expensive domestic investment in advanced technology and infrastructure, whereas developing countries will have no such technological buffers to soften the blow.

Agriculture serves as a good illustration of broader climate change impacts. In Africa, production of staple foods such as maize and millet are predicted to fall in most countries; for example, a 10-40 per cent of drop in maize productivity in Zimbabwe, and 63-70 per cent decrease in millet productivity in Senegal. Climate change in Africa is expected to increase the prevalence of droughts, raising the risk of famine. And repeated crop failure will stimulate a vicious cycle of soil erosion and desertification in some of the most agriculturally stressed countries in the world.

Rice yields in Asia are harder to predict and will depend on regional changes in rainfall. In China, rice productivity is expected to decline across most of the country by less than 10 per cent, and is expected to increase in northern areas. In the rice growing regions of South and South-east Asia, studies suggest that there will be large regional variations. Rice production will also be affected by sea level rise: for example, over 1 per cent of Malaysia's rice producing land could suffer the effects of coastal inundation.

The impacts of climate change in Latin America will be most heavily felt in Brazil, where wheat yields are expected to decline from 15 per cent to 50 per cent. Losses in wheat productivity in Latin America as a whole may range between 5 and 50 per cent.

However, these estimates ignore changes in the prevalence and distribution of pest and weed species; incidence of storm damage; and catastrophic changes in current climatic patterns. The magnitude of all these effects is likely to depend on the rate of climate change, and the time available for human and natural systems to adapt. The slower the changes, the smaller the negative consequences are likely to be.

Agriculturally-dependent developing countries are most at risk from continued rapid climate change, and have most to gain from early action to slow its causes. The risks are far higher than any threats to non-Annex I exports likely to be caused by Annex I country mitigation action.

Looking back to predict the future: how models exaggerate trade impacts

Models predicting drastic impacts on world trade from the implementation of Annex I commitments are based on an outdated and simplistic analysis of world trade.Trade flows are assumed to be only marginally affected by changes in product prices and tariffs, and to be independent of new innovations, foreign investment or the expansion of developing country markets and industries. The results are therefore unreliable at each stage of their calculations.

Any decline in Annex I purchasing power due to FCCC commitments will be lower than in these economic models. Because they fail to include "no-regrets"[1] options, the gains from removing existing vast subsidies from polluting sectors, and the direct economic benefits of reducing both local pollution and climate change impacts. Increasing climate impacts will inevitably cause more funds to be spent on domestic precautions - for example, larger sea defences, changes in agriculture and infrastructure - and this will potentially reduce the demand for imports from other countries in the same way that mitigation measures are assumed to do.

Though income losses are overstated in these analyses, the largest errors stem from the assumption that developing country exports are highly dependent on income growth in industrialised countries. For example, a 1 per cent drop in Annex I GDP reduces imports by 2-4 per cent. This is an exaggeration which stems from a simplistic analysis of past economic behaviour, particularly the oil crises of the 1970s which depressed trade in a unique way.

By basing their models on past trading patterns, the connections between the economies of OECD, transition and developing countries have been exaggerated. Increasingly, agricultural and raw material (excluding oil) exports to the North are becoming less important relative to manufacture, and trade among Southern countries is increasing. The Southern manufacturing exports to the North are worth over three times the value of non-oil exports, and this is where future growth will lie.

Figure 1 shows that growth in world trade is continually outpacing Northern incomes, so increasing trade stems mostly from shifts in production between countries.

The strongest forces driving growth in global trade are changes in the composition and origin of products, and the growth of consumer demand in developing countries. Future growth will be determined by the potential for further global liberalisation and tariff reduction, and the growth of overseas investment.

Figure 2 graphically illustrates this structural change in the global economy, by plotting the estimated worst case effects of Annex I mitigation efforts on developing country exports to industrialised economies against high and low projections of future trade flows (*all assumptions from UNCTAD, 1996*). High export growth assumes fast liberalisation and diversification of the global economy, coupled with 2.7 per cent annual growth in industrialised economies. The other scenarios assume relatively slower penetration of developing country products into developed markets and growth rates of 2.2 per cent and 1.8 per cent respectively. Figure 2 shows that this conservative range of assumptions results in a wide range of future trade growth outcomes.

Figure 1: Growth in World Trade and Industrialised Country GDP

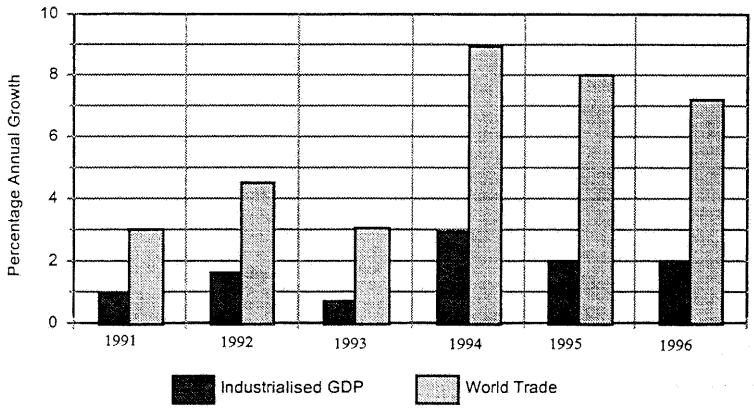


Figure 2: Developing Country Non-Oil Trade Growth under Different Scenarios to 2010

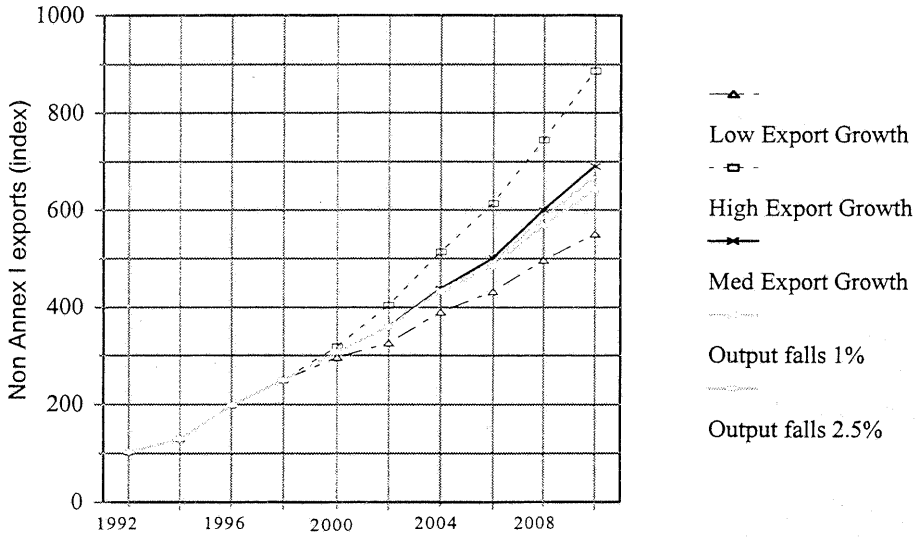


Figure 2 illustrates the impact of Annex I mitigation measures by plotting the result of a 1 per cent and 2.5 per cent drop in industrialised country GDP onto the medium export scenario. These figures represent, respectively, extreme cost estimates for achieving stabilisation of Annex I emissions at 1990 levels until 2010; and achieving a reduction in Annex I emissions of 20 per cent below 1990 levels by 2010.

To put these examples in context, conventional economic models have calculated the cost of reaching these emission reduction targets to be two or three times less than the illustrative figures used here. Furthermore such models fail to include the no-regrets options - the gains from removing subsidies to polluting sectors - and the economic benefits of reducing local pollution and climate change.

The idea that immediate substantive action to mitigate climate change will destroy - or even seriously damage - the world trading system is unfounded. Even when every worst case assumption is included, the impact of climate policies is seen to be minimal when compared to other global economic forces.

The projected effects of any drop in Annex I incomes on trade flows are so small that they will not be observable, and proportionate compensation will be incalculable.

The Positive Story: Increased Trade, Technology Transfer and Lower Costs

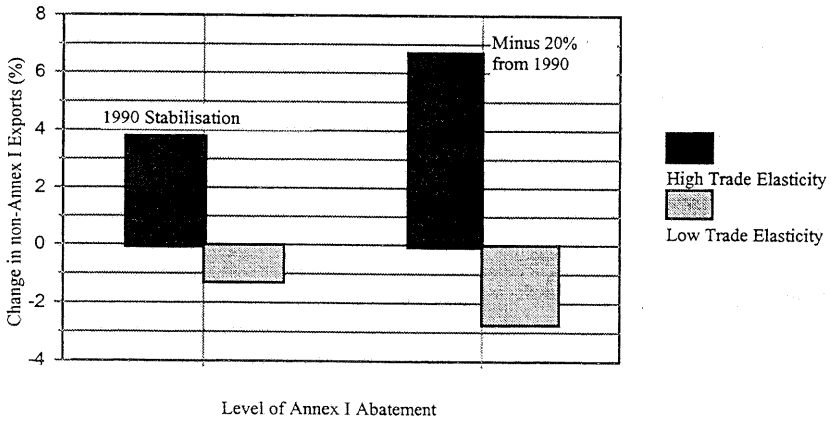
The selective use of particular economic models has not only exaggerated any potential negative effects on global trade from Annex I commitments, but it has also failed to include positive impacts which are likely to be more significant.

Annex I controls will raise the real price of energy in countries that supply new low emissions technology, providing a further - if small - source of competition between complying and non-complying countries. If energy or carbon taxes are a major method of lowering CO_2 emissions, recycling tax revenues through labour or capital taxes will increase the competitiveness of domestic non-energy intense industries. These changes in the relative prices of goods, and the shift in Annex I country imports from fossil fuels to carbon-efficient equipment, will *increase* the volume of trade between Parties.

Non-fossil fuel exporters will see particularly large gains.The switch in trade from fossil fuels to advanced manufactures by Southern countries, (energy efficient technologies, for example) especially when aided by new foreign investment, will lead to the transfer of technology in new sustainable industries that do not depend on finite natural resources or volatile commodity markets.

Figure 3 illustrates the sensitivity of trade flows to price changes (trade elasticities) by plotting the impact of developed country commitments on non-Annex I exports (totals 1997-2010 based on Mabey *et al*, 1997). The "low elasticity" case - were trade is unresponsive to price changes - is based on measurements of past behaviour (1960s-1990s). The "high elasticity" case - were trade flows are more affected by price changes - involves doubling the measured elasticities, and includes a small amount of relocation in highly energy intense sectors.

Figure 3: Change in Non-Annex I Exports (1997-2010) for Different Trade Elasticities



Although these figures are illustrative and surrounded by uncertainties (especially around exchange rate reactions and foreign investment), they do show that negative impacts on global trade are not a foregone conclusion of Annex I actions.

Any increase in trade will lower the cost of Annex-I compliance, and is good for all Parties to the FCCC. The only potentially negative consequence is that greenhouse gas emissions may rise in non-Annex I countries exporting goods that consume more fossil energy in production than the equivalent Annex I country goods they replace. But any effect will be quite small.

Industrial relocation: a real cost or special pleading?

Much economic research and political concern in Annex I countries has been about whether companies will relocate to unrestricted areas and export back into Annex I countries. Of course, any relocation will benefit non-Annex I countries, but it is unclear how large this effect will be.

High energy-using sectors such as the chemicals, cement and steel industries have protested about their vulnerability to energy price rises, and have threatened to relocate from Annex I countries unless they receive preferential treatment. Although these sectors do use more than the average proportion of energy in production (≈15-20 per cent of input costs), their case is less persuasive than it first appears.

Most energy-intense industries in Annex I countries have managed to remain competitive even though energy prices differ markedly between, for example, Europe and the USA. Most industries are either protected behind tariff barriers or compete on technological advantage or specialist niche - not merely on price. As trade barriers are lowered, and the market for bulk steel and chemicals moves to developing economies, it is to be expected that these firms will relocate anyway in order to take advantage of the new markets. Those remaining will be speciality producers less vulnerable to differences in labour and energy costs between countries.

Annex I mitigation measures will stimulate diversification and growth in world trade. This is likely to outweigh the impact of any fall in incomes - and existing trends in industrial relocation to non-Annex I countries are unlikely to be changed. Non-Annex I countries will see new opportunities for exporting low emissions technology, thus reducing their reliance on volatile commodity markets.

Conclusions

Rather than a being a threat to non-energy exporters, greenhouse gas emission limits on developed countries represents an opportunity for non-developed countries to expand into new and lucrative markets which will continue to grow. Increased trade will also benefit developed countries by lowering compliance costs, and is unlikely to lead to more industrial relocation than is already under way.

The trade impacts of developed countries' actions are a distraction from the real issues surrounding decisions to be made at Kyoto. The actual risks to non-developed economies come from continued unchecked climate change which threatens to impose significant costs on their economies, especially in areas such as commercial and subsistence agriculture.

Rather than lobbying for compensation mechanisms, the vast majority of non-developed countries have more to gain from receiving enhanced technology transfer. This would allow them to take advantage of new trading opportunities and lay the foundations for true sustainable development in the future.

Notes

1. No regrets refers to little or zero net costs.

Bibliography

IPCC 1996, *Climate Change 1995. Impacts, Adaptation and Mitigation of Climate Change: Scientific-technical Analyses.* Contribution of Working Group II to the Second Assessment Report of the IPCC. Eds., Watson, R.T., M.C. Zinyowera and R.H. Moss. Cambridge University Press.

Fankhauser, Samuel, *Valuing Climate Change*, Earthscan, London, 1995.

Mabey, Nick, Stephen Hall, Clare Smith and Sujata Gupta, *Argument in the Greenhouse: The International Economics of Climate Change*, Routledge, London 1997.

UNCTAD, *World Trade and Development Report*, Geneva, Switzerland, 1996.

WRI, *World Resources Report 1994-95*, World Resources Institute, Washington.

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