



**An outline of the case for a 'green' stimulus**  
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Economics and Policy





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## Executive summary

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- *There is a growing consensus among policy-makers around the world that the great risks arising from climate change brought about by human activities require strong cuts in emissions and that strong action is urgently needed. Nevertheless, the global slowdown in economic growth has raised the question, might it be better to delay such action until the world economy recovers?*
- *We argue, no. If the appropriate mix of policies is adopted, action to tackle climate change could form a central part of a fiscal package designed to moderate the economic slowdown. A 'green' fiscal stimulus can provide an effective boost to the economy, increasing labour demand in a timely fashion, while at the same time building the foundations for sound, sustainable and strong growth in the future. Our argument proceeds as follows:*
- There has been a sharp deterioration in the near-term economic outlook for both industrial and developing countries. A fiscal stimulus is part of the appropriate response because the downturn has been driven by decelerating demand.
- Fiscal policy is not always the right tool to use for countercyclical purposes. But the comparative advantage of monetary policy is less evident in current circumstances. Past experience gives some guidance as to when active fiscal policy is likely to be more effective, giving support to the case for a stimulus in industrial countries now.
- Fixing the global financial system is also a top priority at present, to restore effective financial intermediation and boost the flow of credit (including to 'green' projects).
- Given the uncertainties at this point, it makes sense to implement a diverse set of measures, but with the emphasis on spending increases rather than across-the-board tax cuts. A good fiscal stimulus should be targeted, timely and temporary. It is important that measures do not bring the long-term credibility of fiscal frameworks into question. That is more of a challenge in some countries than others, so the scale of the stimulus should vary according to local circumstances.
- Action on climate change remains urgent. If policy-makers were to put action off until the impacts of climate change forced the issue to the top of the political agenda, the stock of greenhouse gases that would have built up in the atmosphere as the flows of emissions accumulated would entail severe and increasing risks for many decades.
- From the perspective of the economic management of these risks, it makes sense for world emissions to be reduced by at least 50% from 1990 levels by 2050 and for the developed world to aim to bring its emissions down by at least 80%, given past history and its access to resources and technologies. That will require the developed world as a whole to implement deep cuts by 2020 to reach the path to this long-term objective.
- The objectives of economic recovery and urgent action on climate change complement each other. 'Green' measures can be targeted and timely. We offer in Table 1 a qualitative assessment of the merits of various specific measures. Some can be brought forward from medium-term plans to the short term or are one-off adjustments. Others will need to continue into the long term and hence will require funding arrangements when fiscal deficits are reined in, as they will have to be.

- It is important that fiscal measures that are not explicitly 'green' do not make achieving climate change goals more difficult by subsidising greenhouse gas emissions or 'locking in' high-carbon infrastructure for decades to come.
- An effective set of policies to combat climate change requires several components. One component is the promotion of energy efficiency and low-carbon technologies. That gives a lot of scope for targeted and timely public spending measures. Many energy efficiency measures would be particularly effective as part of a fiscal stimulus, as they could be implemented quickly and would be relatively labour-intensive.
- Another component is carbon pricing. This element of policy has weakened, judging by the fall in the price at which carbon quotas are traded – a fall reflecting the impact of the economic slowdown and efforts by quota holders to raise funds.
- Together with the reductions in oil and other hydrocarbon prices, this weakness risks sending the wrong signals to firms and households about the merits of low-carbon investment options and low-carbon goods and services. That makes the third element of climate change policies – building confidence in the long-term framework for greenhouse gas reductions – all the more important.
- It is difficult to be precise about the appropriate size of the 'green' element of the necessary global fiscal stimulus. But a case can be made for a 'ball-park' figure of some US\$400 billion of extra public spending worldwide on 'green' measures over the next year or so. Unblocking the financial system will allow the private sector in due course to finance a greater share of the continuing investment in 'greening' the economy that will be necessary.
- It is vital that the rationale for a comprehensive framework to reduce emissions is explained and the case for it made vigorously, given the need to reconcile continuing measures against climate change with eventual fiscal consolidation. If people become convinced that the framework will hold in the long term, that could unleash a wave of creativity and innovation in 'greening' the economy – a more durable foundation for economic growth than dot.com booms and housing bubbles.
- But the long-term credibility of the framework requires that the shape of the post-Kyoto policy regime is made clear as soon as possible. If industrial countries take the opportunity to delay action on climate change, that could impair their credibility and undermine agreement at the UNFCCC conference in Copenhagen in December 2009, damaging the signals that are crucial for fostering low-carbon investment.
- Decisions about the scale and composition of fiscal expansions are needed as soon as possible if they are to play their role in preventing a slide into a global depression. Governments need to commit to a strong 'green' element in a fiscal recovery plan in the first half of 2009 or indeed the first quarter.

## 1. Introduction

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There is a growing consensus among policy-makers around the world that the climate change brought about by human activities needs to be halted. Many countries have adopted long-term objectives to reduce greenhouse gas emissions sharply to achieve this end. The United Kingdom, for example, enshrined in law last November the objective of reducing greenhouse gas emissions by 80% by 2050.<sup>(1)</sup> President Obama is also pursuing a 80% reduction in United States emissions by 2050, although the details and timeframe of legislative proposals are yet to be finalised. The European Union is seeking to reduce emissions by 30% by 2020 if an international agreement on cuts is achieved, and by 20% even if it is not. The UN climate summit in Poznań last December concluded with a general recognition that emissions need to peak and start to decline within the next 10 to 15 years.

But these aspirations do not by themselves pin down what policy-makers need to do in the next couple of years to meet them. The global slowdown in economic growth has raised the question, might it be better to delay strong actions against climate change until the world economy recovers? Before the European Union summit in October 2008, eight EU members suggested that carbon dioxide emissions targets ought to be revised in the light of current “serious economic and financial uncertainties.”<sup>(2)</sup> The Prime Minister of Italy told a press conference “our businesses are in absolutely no position at the moment to absorb the costs of the regulations that have been proposed.” The recent underperformance of ‘clean energy’ companies compared with the stock market in general suggests that investors now expect the pace of transformation of the energy sector will be slower than previously thought.<sup>(3)</sup>

So does the worldwide economic slowdown warrant letting up on measures to arrest climate change? We argue the contrary. Tackling climate change globally remains urgent and delay would still be costly. If the appropriate mix of policies is adopted, action to tackle climate change could form a central part of a fiscal package designed to moderate the economic slowdown. The development of a low-carbon economy can provide new jobs and new opportunities for innovative businesses. A ‘green’ fiscal stimulus can be a more effective fiscal stimulus, building the foundations for sustainable, strong growth in the future, rather than unsustainable bubbles.

This paper first rehearses the argument that a fiscal stimulus, particularly a discretionary increase in public spending, is an appropriate part of the response in industrial countries in current circumstances (alongside an accommodative monetary policy and measures to mend the global financial system). Then it considers the major elements of a desirable policy framework to stop human-induced climate change, assessing how current macroeconomic circumstances affect the merits of speeding up or slowing their implementation. It then considers how some specific proposals for ‘green’ spending perform against criteria for an effective ‘green’ stimulus and what magnitude that stimulus might be on a global scale.

(1) The reductions are to be measured against a baseline of 1990 levels or, in some cases, 1995 levels.

(2) In the event, these members’ reservations were overcome.

(3) The Wilderhill Clean Energy Index, a global stock index composed mainly of companies that stand to benefit substantially from a transition to clean energy technologies, has fallen about 60% over the past year, compared with a fall in the S&P500 of around 35% in the same period.

## 2. The need for a fiscal stimulus

### Why is a fiscal stimulus appropriate?

The case for a fiscal stimulus rests on the diagnosis of the cause of the current economic downturn. The evidence suggests that it reflects unusually strong adverse shocks to aggregate demand. There has been a sharp deterioration in the outlook for both industrial and developing countries, notably in the United States, driven by decelerating demand.

For example, staff at the International Monetary Fund (IMF) have concluded that "the current crisis, which started in the housing and financial sectors, has now led to a strong fall in aggregate demand. There are indications that this fall could be larger than in any period since the Great Depression."<sup>(4)</sup> In the UK, HM Treasury has noted that "between the summer of 2007 and summer 2008, the world economy progressively suffered from the unprecedented confluence of two major economic shocks (credit crisis and commodity price surge)." The argument is that discretionary increases in government spending are able to offset, at least in part, the decline in private-sector demand.

Already, policy-makers around the world have started to prepare such increases, as in the UK Pre-Budget Report presented to Parliament on 24 November 2008. The Managing Director of the IMF suggested in December that, for the G20 countries, a stimulus amounting to around 2% of GDP would be appropriate. The IMF has emphasized the need for a collective approach to avoid 'beggar thy neighbour' measures such as competitive devaluations.

At the same time, governments have been seeking ways of repairing the global financial system. Without financial intermediation working properly, the prospects for private demand growth taking over the baton from public spending increases speedily are poor. This paper focuses on the case for a fiscal stimulus, rather than the case for measures to mend the financial system, because the synergies with policies to tackle climate change are more evident for the former. But we acknowledge the urgent need for the latter. Indeed, they are vital if, among other objectives, project finance for large-scale low-carbon energy infrastructure is to become available again at a sufficient scale.

### Some counter-arguments

The stirring of fiscal activism marks a break from recent economic orthodoxy, which has generally held that monetary policy is the appropriate tool to use for countercyclical purposes. Taylor (2000), for example, identified several advantages for monetary policy compared with fiscal policy. He pointed out that the lag between observing shocks to the economy and changing the policy instrument is usually much shorter for monetary policy; reversing policy changes in response to new information is much easier and political inertia is less of a problem.

(4) See Spilimbergo *et al* (2008).

(5) This is the proposition of 'Ricardian equivalence' – that changes in taxes and debt have the same effect on private consumption. See Barro (1974).

(6) See Lucas (1987).

(7) See the discussion in Krugman (2005).

(8) Barlevy (2005).

And he observed that, in the United States, discretionary fiscal policy had not been countercyclical in practice.

There are also other potential problems with an activist fiscal policy. In particular, it can crowd out private spending – directly, or by pushing up the cost of labour and other inputs to production, or by leading to higher interest rates and thus an appreciation of the exchange rate. Tax cuts will be ineffective if taxpayers anticipate fully the increased taxes that will have to be paid in the future if the government's intertemporal budget constraint is to be satisfied.<sup>(5)</sup> And if lenders to government begin to suspect that the government may not have the capacity to repay the real value of public-sector debt in full, default risk premia and/or inflation premia on government bonds may rise sharply, exacerbating the tightening of credit conditions. Another critique of activist fiscal policy is the proposition that business cycles are not very costly and hence macroeconomic policy activism is unnecessary.<sup>(6)</sup> Some have gone further, arguing that downturns weed out inefficient firms and bring about innovative change.

### The riposte of fiscal activists

However, many sceptics accept that there are circumstances when active fiscal policy is appropriate. Taylor, for example, discusses the case where the nominal interest rate is approaching its lower bound of zero, so that monetary policy is less easy to implement, particularly if the general level of prices is expected to fall. That scenario became relevant in Japan a decade ago and in recent months more widely.<sup>(7)</sup> Moreover, because credit market problems have made the monetary transmission mechanism from the central banks' actions to activity less effective and less predictable, the comparative advantage of monetary policy has been reduced. It can, however, support active fiscal policy by preventing nominal interest rates rising in response to a fiscal expansion, turning off the mechanism that leads to crowding out.

Second, some of the theoretical assumptions made in the case against fiscal activism do not hold in practice. For example, Ricciuti (2003) surveys studies of whether so-called Ricardian equivalence holds and concludes that it does not, so that tax cuts are likely to affect activity, particularly when many agents in the economy are credit constrained and are therefore unable to smooth their consumption over time – a problem that has become particularly acute in the UK because of the stresses on the banking system. Temporary public spending increases should not crowd out private consumption fully even if Ricardian equivalence does hold, because consumers will seek to smooth their spending over time. As far as the costs of business cycle fluctuations are concerned, these have been considerably higher than originally suggested by Lucas and others.<sup>(8)</sup>

As Andersen (2005) points out, modern macroeconomic research in fact provides a rationale for an active fiscal stabilization policy: various market failures cause the economy to adjust inappropriately to shocks and, to the extent that policy-makers can respond to those shocks in a way that private markets cannot, there is scope for fiscal policy as long as activity is affected by aggregate demand in the short run.<sup>(9)</sup> As many households and firms are credit constrained,<sup>(10)</sup> particularly in current circumstances, changes in their incomes are more likely to be transmitted to changes in their spending. Andersen generally prefers automatic stabilizers<sup>(11)</sup> to discretionary fiscal policy, because the latter requires knowing a lot about the source of shocks to, and the structure of, the economy. But he argues that it is appropriate “in the case of ‘large’ shocks or situations where the economy is caught in an expectations trap keeping output at a permanently low level.” The world economy has been subjected to large shocks recently, reflected in deteriorating credit conditions, large asset price falls and slowing world trade.

#### Empirical evidence

Not only is there a theoretical case to be made for activist fiscal policy, there is also empirical evidence in its support. Research at the IMF has investigated how effective fiscal policy has been in responding to downturns in economic activity, particularly recessions.<sup>(12)</sup> They conclude that the impact of fiscal expansions has varied widely across countries and time. They tend to be more effective<sup>(13)</sup> when (i) there is excess capacity, (ii) the economy is relatively closed, (iii) public spending is a relatively large share of the economy, and (iv) fiscal expansion is accompanied by monetary expansion. Conditions (i), (iii) and (iv) are satisfied for many industrial countries at the moment, while (ii) is satisfied if one considers the industrial countries collectively. The authors find little evidence of ‘crowding out,’ directly or via interest rates or the exchange rate.<sup>(14)</sup> The current slowdown is unusual in several respects, such as its global reach and the role of credit conditions and the stresses on the banking system. That makes past experience a less useful guide to how firms and households will react to monetary and fiscal policies in current circumstances. For example, are tax cuts more likely to be spent, because more people are credit constrained? Or are they more likely to be saved, because of heightened concerns about debt-laden balance sheets and sharp falls in house prices in many countries? Nevertheless, the evidence suggests that fiscal expansions can moderate economic slowdowns.

#### What form should a fiscal stimulus take?

Theory and empirics, then, both support the need for a fiscal stimulus in the current circumstances, given the size of the adverse demand shock experienced and the impairment of credit markets. But what form should the fiscal stimulus take?

In general, spending increases are likely to be more effective than tax cuts, because some fraction of tax cuts is very likely to be saved. An IMF review of OECD experience found that, for spending increases, short-run fiscal multipliers tend to be in the range 0.6 to 1.4, while for tax cuts, they tend to be significantly lower, lying in the range 0.3 to 0.8.<sup>(15)</sup>

Tax cuts are likely to have a larger multiplier effect if they are focused on people who are credit constrained (such as people with poor income prospects and few assets to offer as collateral). The current funding difficulties of the developed world’s banking systems suggest that the supply of credit has fallen, increasing constraints on spending. But if firms and households wish to build up their stocks of financial assets or run down their debt, the impact of tax cuts will be more muted. To the extent that recipients of tax cuts deposit more money in banks, alleviating their funding difficulties, tax cuts might help to relax credit constraints. But that might simply allow banks to increase their stock of liquid assets rather than loans to firms and households.

Another consideration is that tax cuts and increases in transfers are generally easier to implement swiftly than increased public spending on goods and services, particularly if the latter is to be properly evaluated and monitored. But tax changes alter important relative prices and, for this reason, volatility in tax rates is generally inefficient.<sup>(16)</sup> However, some changes in relative prices may be warranted, because of current circumstances (e.g. to encourage consumers to bring forward spending from the future by lowering prices today relative to prices in the recovery) or because they are of merit in their own right, correcting market failures (see later section on carbon pricing). And changes in aggregate spending by the public sector can also affect relative prices. Given the uncertainties at the current point, it makes sense to implement a diverse set of measures, but with the emphasis on spending increases.

(9) Andersen also observes that “recent literature devotes very scant attention to fiscal stabilization policy.”

(10) Sarantis and Stewart (2003) estimate that, on average over 20 OECD countries, 70% of households were credit constrained.

(11) The automatic stabilizers are taxes and spending items, such as VAT receipts and unemployment benefit payments, that adjust automatically as the level of activity in the economy varies.

(12) Hemming, Mahfouz and Schimmelpfennig (2002).

(13) Effectiveness is assessed in terms of the size of the fiscal multiplier (the change in total demand for a given change in tax receipts or public spending).

(14) They note that in some very limited circumstances – for example, when fiscal sustainability is in question – a fiscal *tightening* may stimulate the economy by increasing the government’s credibility and releasing resources that are then used by the private sector. But the current levels of real long-term interest rates and unemployment in the major industrial economies do not suggest that this is relevant at the moment.

(15) Hemming, Kell and Mahfouz (2002).

(16) This follows from the convexity of the indirect utility function.

As the Institute for Fiscal Studies (IFS) has argued, a good fiscal stimulus would be “targeted, timely and temporary”.<sup>(17)</sup> The second two criteria are straightforward. Timeliness is important, because the stimulus will be more effective, the sooner it is implemented after the initial shocks to demand, moderating the downward multiplier effect on domestic investment. The stimulus need only be temporary, continuing until asset prices, goods prices, firms and households are able to adjust fully to the shocks that have triggered the slowdown. Given the size and unusual nature of the shocks in this case, that may take several quarters. But if the stimulus were to last too long, it would risk pushing up default and inflation premia on government bonds, as investors became more worried about whether the government would be able to service its rising debt. As the IFS points out, though, a temporary stimulus need not entail temporary policy measures; but it does require an exit strategy to finance any long-term policy measures when recovery comes.

Demonstrating the sustainability of fiscal plans over time is particularly important for countries in which the structural full-employment deficit is high or the government’s contingent liabilities are large, in order to stop default and inflation premia rising abruptly. Such countries may therefore have less scope for discretionary fiscal stimuli, a point made forcefully by Buitter (2008). But fiscal sustainability does not necessarily require rapid stabilization of government debt/GDP ratios as long as the long-term fiscal framework is credible.<sup>(18)</sup> And default and inflation premia do not suggest that lack of long-term credibility has yet become a serious problem for industrial countries.<sup>(19)</sup>

Targeting is a more difficult issue. One criterion is to focus spending increases and tax cuts where they would have most effect on aggregate demand – where the fiscal multiplier is greatest. That is a key consideration at the moment, given the urgency of tackling the economic downturn. Spending increases do better on this criterion than across-the-board tax cuts. Spending increases need to target sectors where there are less likely to be bottlenecks from capacity constraints or scarcity of specialised skills, and tax cuts need to be focused on credit-constrained households and firms.

But a second criterion is the impact of the stimulus on well-being over the longer term. Public spending, for example, needs to be considered in the light of cost-benefit analysis, not the size of the associated fiscal multiplier alone. Digging holes in the road and filling them in again – the caricature of pure Keynesian demand management – may be effective in stimulating demand as a last resort, but creating private or public capital that also generates returns over longer horizons is preferable. Measures should help to provide the conditions to sustain economic growth when it returns, by, for example, correcting market failures that inhibit innovation. And there are other social objectives (e.g. poverty reduction) that need to be included in the assessment.

(17) IFS (2008). The IMF discusses a longer list of desiderata relevant to the *overall* fiscal stimulus: that it should be timely, large, lasting, diversified, contingent on subsequent economic developments, collective and fiscally sustainable. See Spillimbergo *et al* (2008).

(18) Leith and Wren-Lewis (2005).

(19) It is appropriate for policy-makers facing large contingent liabilities to exercise caution, however, given that once bond prices have fallen and credit default swap premia have risen markedly, it may be too late to restore credibility.

### 3. The need for policies to tackle climate change

#### The urgency of action against climate change

The global economic downturn is concentrating policy-makers' minds on the issue of how to boost economic growth and utilise spare resources and unemployed workers. The current crisis, by forcing policy-makers to reconsider their economic policies in the round, may provide an opportunity to introduce reforms that foster enhanced efficiency and more sustainable long-term growth. But there is a danger that the challenge of climate change may be put aside if meeting it appears to conflict with short-run political and economic objectives.

However, action on climate change remains urgent. If policy-makers were to put action off until the impacts of climate change forced the issue to the top of the political agenda, the stock of greenhouse gases that would have built up in the atmosphere would entail severe and increasing risks for many decades. If greenhouse gas concentrations are to be stabilised at around 500 parts per million CO<sub>2</sub>-equivalent, global greenhouse gas emissions need to start to decline within the next 15 years and to be reduced by at least 50% from 1990 levels by 2050. That is a demanding target but it makes sense if the risks of dangerous climate change are to be avoided, given the current state of scientific knowledge (Stern (2008)). It would reduce the chance of the global mean temperature rising by more than 4°C from pre-industrial levels to around one-in-ten, and the chance of a rise of more than 3°C to less than 50-50, according to simulations with the Hadley Centre's climate model. Earlier action by industrial countries is warranted because developing countries need to be convinced of the technical and political feasibility of a transition to a low-carbon economy before they accept limits on their own emissions. And a more demanding target for emissions reductions by the developed world is appropriate, given history and its access to resources and technologies; it should aim to bring its emissions down by at least 80%. That will require the developed world as a whole to implement deep cuts by 2020, of the order of 20-40% relative to 1990 levels, to reach the path to this long-term objective and to encourage developing countries to commit to substantial emissions reductions themselves.<sup>(20)</sup> The long-term objective would still leave rich countries with above-average per capita emissions by 2050.

Yet even with increasing efforts to encourage energy efficiency and develop low-carbon technologies, goods and services, in this decade greenhouse gas emissions have been increasing at an average rate of over 2.5% per year.<sup>(21)</sup> So the transformation of energy and transport systems has to be accelerated. And, given the long lives of many of their components, like electric power plants, it is important to ensure that near-term investment in their infrastructure does not 'lock in' high-carbon technologies for decades to come.

<sup>(20)</sup> That does not mean that all industrial countries should take on identical targets for emissions reductions relative to 1990. Countries where emissions have risen a lot over the past 20 years will have to achieve the cuts necessary in the long term over four decades rather than six. Other factors such as prospective economic growth, population growth, industrial mix and energy endowments will also play a part in determining the pace of individual countries.

<sup>(21)</sup> An average rate of 2.6% per year for greenhouse gases, measured in terms of CO<sub>2</sub>-equivalent, from 2000 to 2005, excluding emissions due to land use and forestry, according to the World Resources Institute (2009).

<sup>(22)</sup> See Stern *et al* (2007).

The prospect of temporary reductions in emissions over the next two or three years as a result of the economic slowdown does not change that imperative. Insofar as the slowdown leads to delays in private sector infrastructure investment (not least due to project financing problems), it may lead to higher emissions when the economies begin to recover than there would have been otherwise, because of the delay to the necessary technological transformation. And the impact of a single business cycle downturn on the growth of the stock of greenhouse gases in the atmosphere is unlikely to be large. Deutsche Bank (2008a) has revised down its estimate for 2008 to 2020 of business-as-usual emissions covered by the EU Emissions Trading Scheme by just 2.5%. If the global impact of the downturn is similar, that amounts to only about one year's growth in emissions.

An additional impetus to policy-makers comes from the deadline provided by the UNFCCC meeting in Copenhagen in December 2009, which has to formulate a successor to the Kyoto Protocol. International collective action on the basis of broadly shared long-term objectives is crucial if climate change is to be halted. Delays could undermine agreement, damaging the signals crucial for fostering and sustaining low-carbon investment, now and in the longer term.

#### The fiscal impact of policies for tackling climate change

So how can the urgency of action on climate change be reconciled with the imperative of combating the current economic slowdown? The answer is straightforward if action on climate change can also help to stimulate the global economy in the short run. Hence the question is, how do climate change policies score against criteria for a successful fiscal stimulus, particularly effectiveness in stimulating aggregate demand?

To answer that question, it is helpful first to distinguish between different aspects of climate change policy. There are four main elements to a well-designed long-term policy framework for tackling climate change: (i) stimulating the development of low-carbon technologies, (ii) putting a price on greenhouse gas emissions to reflect the costs that they impose, (iii) encouraging people to regard emissions as a 'bad', and (iv) promoting adaptation. The first three are needed in order to bring about – in a cost-effective way – the sharp reductions in emissions that are necessary, while the last is needed because of the climate change to which the world is already committed. All require collective action to some degree and therefore warrant the involvement of political institutions.<sup>(22)</sup>

First, technologies. The production of goods and services has to be undertaken in ways that generate much lower greenhouse gas emissions. The appropriate methods and technologies to do that have to be identified, developed and deployed.

That requires overcoming a number of market failures. For example, it is well-known that, because knowledge is generally a public good, innovations will be under-supplied in a competitive market economy, so that in the absence of countervailing policy, decarbonisation would be much more difficult.<sup>(23)</sup> This problem is particularly acute for the power sector, given its technological and market characteristics.<sup>(24)</sup>

Another market failure can arise when people in a market have differing amounts of information about the costs and benefits of potential investments involving different technologies. For example, in the case of landlords and tenants, tenants may be unwilling to pay an appropriate share of the costs of home insulation because they cannot fully check the costs and long-term benefits of the investment. More generally, imperfect information entails capital market imperfections that can inhibit any investment that needs external finance, as is usually the case with big energy and infrastructure projects. Lenders have to monitor what borrowers are up to, and this is difficult and costly when the borrowers' activities are complex. This problem is acute at the moment, because uncertainty about the liquidity and solvency of lenders and borrowers is particularly high.

Second, pricing the climate change externality. The costs imposed by greenhouse gas emissions need to be internalised by those responsible for them. This is the rationale for carbon pricing. It provides a decentralised and pervasive signal to consumers and firms that encourages them to reduce purchases of carbon-intensive goods and services and substitute lower-carbon goods and services for them, while providing an incentive to develop and deploy low-carbon technologies and processes.

Third, persuasion. The ethical case for action against climate change has to be made and the rationale for particular measures has to be explained clearly if climate change policies are to establish and then sustain political legitimacy. That is vital, both in its own right and in order to provide stability in households' and firms' expectations about future policy, given the extraordinarily long time horizon over which they will have to operate and the worldwide scope they will need to develop.

Fourth, adaptation. The capacity of households and firms to adapt to the impacts of climate change needs to be enhanced, given the increases in the concentration of greenhouse gases in the atmosphere that have already taken place. The climate system adjusts slowly to such increases, so that climatic conditions would continue to change even if greenhouse gas emissions were to be halted today. Much adaptation will not require, or benefit from, government intervention, but public authorities do have to ensure that public goods like coastal defences and highway systems are designed and built with climate change in mind. And governments have a role in producing and disseminating information about changes at local level to which firms and households will have to adapt.

<sup>(23)</sup> See Jaffe, Newell and Stavins (2004).

<sup>(24)</sup> Discussed in Foxon (2003) and Stern *et al* (2007).

<sup>(25)</sup> See, for example, Popp (2002) on induced productivity growth in low-carbon technologies in response to energy price changes.

### Technologies for reducing greenhouse gas emissions

Tackling the market failures that set up barriers to innovation and energy efficiency should increase the incentives for businesses to invest in research, development and deployment of low-carbon technologies and for households and firms to undertake cost-effective measures to improve the energy efficiency of their activities. By unleashing private investment, that can contribute to a fiscal stimulus. Initially, there is likely to be a backlog of worthwhile projects once market failures have been overcome. So there should be a burst of activity followed by a lower, but steady, level of spending subsequently. That is a helpful time profile given the need for an increase in spending in the immediate future.

One way of tackling the market failures is to alter the incentives faced by and information available to firms and households. Thus putting a price on greenhouse gas emissions provides a pervasive incentive to undertake research into ways of reducing them.<sup>(25)</sup> Offering prizes for innovations that meet specific low-carbon objectives is another way of dealing with the under-provision of research and development (R&D) by providing a market incentive. There is also scope for public investments in basic R&D and for the linking of basic, intermediate and applied R&D. Providing information about how to improve home insulation can help to correct an information supply problem, as can the introduction of information technology for 'smart' monitoring of domestic energy use.

Such measures score well against the criterion of being targeted; small increases in public spending can unleash disproportionate increases in private sector investment. This is illustrated, for example, by Wade *et al* (2000) in their review of 44 energy efficiency programmes in nine EU countries. They find that information and education campaigns and innovative institutional programmes had succeeded in combining high employment gains, low government expenditure and cost-effective investments. Others have suggested that information technology can be used more imaginatively to help people monitor the impact of their actions on energy and carbon usage.

The provision of information or use of standards-setting to co-ordinate private-sector actions can be inexpensive, while both stimulating investment in the short run and improving the efficiency of the economy in the longer term. Designing and implementing appropriate policies of this type may be cheap but the policies themselves are likely to be quite complex. Their success depends on the government having the requisite information in the first place, which points to the advantages of bringing forward plans that have already been well formulated. In current circumstances, however, there could be a problem with timeliness, if firms and households choose – for example, because of credit constraints – to delay making investments even when they appear likely to be profitable in the long run.

This problem is likely to be exacerbated at the moment by the impact of reduced credit availability and lower aggregate demand on the viability of firms that have already built up relevant specialist knowledge – one reason why a ‘green’ stimulus needs to be complemented by measures to repair financial intermediation.

A second way of tackling market failure is to by-pass the problem by subsidising private investment, funding public-private partnerships or substituting public investment for private in low-carbon initiatives. That also has the advantage of demonstrating in hard cash the government’s commitment to climate change objectives, building the credibility of the policy framework. It makes sense to encourage ‘lumpy’ investments that have already passed project appraisal tests to be brought forward to take advantage of the lower real raw material costs, greater availability of labour and – as long as finance is available – lower interest costs associated with a demand-driven slowdown. That could score better on the timeliness front, as the impact on spending is less dependent on designing and implementing new regulatory schemes and tax incentives and familiarizing the private sector with them. Public spending also relieves or by-passes credit constraints on consumers and companies, which are unusually acute in the current slowdown. Subsidising the development of renewable energy industries with tax breaks for R&D or financing home energy efficiency programmes directly are good examples.

Introducing a long-term framework to tackle climate change entails changes in the composition of the capital stock. This stock adjustment has a cost, but this cost is lower when there is widespread spare capacity, so now is a good time to undertake it. The need for a stock adjustment will wane as the existing capital stock, reflecting pre-framework relative prices and technologies, is replaced.

Spending on the transition to a low-carbon economy also has the advantage at a time of rising involuntary unemployment that it is likely to increase the demand for labour. The opportunity cost of public spending is lower for that reason, so it makes sense to bring forward existing public spending programmes where possible. Kammen *et al* (2006) point out that renewable energy industries appear to be more labour intensive than the existing energy sector, particularly at the initial construction, manufacture and installation stage that is most relevant for a short-term fiscal stimulus.<sup>(26)</sup> Fankhauser *et al* (2008) argue that a shift from high-carbon to low-carbon activities is likely to lead to net creation of jobs at present, given the estimates of labour intensity in the literature, although there is much uncertainty about how labour productivity will evolve and about the impact of induced changes elsewhere in the economy.<sup>(27)</sup> Roland-Holst (2008) provides evidence from the lengthy experience

of Californian policies that the promotion of energy efficiency creates jobs (net) – of the order of 1.5 million full-time equivalent (FTE) jobs over the period 1972-2006 in California’s case, taking into account the jobs created by the diversion of spending from energy to other goods and services.<sup>(28)</sup> Deutsche Bank (2008b) draws together a range of estimates of job creation that tell the same story: measures to reduce dependence on fossil fuels, stimulate alternative technologies and save energy can create a substantial number of jobs over the time horizon relevant for tackling the current economic downturn, so they can be timely and targeted. The potential increase in the demand for labour reflects not only the labour intensity of many of the tasks that need to be undertaken in the short run, but also the backlog of tasks to be done when a new policy framework is brought in (e.g. retrofitting the existing housing stock with insulation).<sup>(29)</sup>

In the short run, spending on energy efficiency measures is likely to be directed towards domestic construction sector activity and hence have a low rate of leakage into imports, increasing the domestic fiscal multiplier – a potentially important consideration for any government that is uncertain about the likely fiscal policies of its trading partners. It is less relevant if industrial countries coordinate their fiscal measures, which would be particularly valuable in the case of measures to encourage low-carbon technologies, in order to avoid displacement of carbon-intensive activities to competing developed economies.

Spending to combat climate change is also likely to generate ancillary benefits such as an increase in fuel security and a reduction in local pollution. And such measures need not crowd out other socially valuable investment, given the relatively small size of the energy sector in relation to the economy as a whole (around 5% of GDP in the UK) and even more so the relatively small scale of R&D activity (around 2.5% of all business R&D spending in the UK). They could be part of a broader fiscal package. The key consideration from the point of view of climate change policies is that other measures are not inconsistent with encouraging the transition to a low-carbon economy. For example, new schools and hospitals should be energy-efficient and the design of new homes, roads and bridges should anticipate local climate change. Carbon- and energy-saving measures are more cost-effective when they are incorporated in new infrastructure rather than in retro-fits and repairs. It is also important that other spending initiatives do not slow down the transition. Hence increased subsidies to conventional energy use, for example by price subsidies, would be unhelpful.<sup>(30)</sup>

One caveat, however, is that more innovative and more capital-intensive projects are likely to be less timely, because of regulatory delays and the need to develop project plans first (for example,

<sup>(26)</sup> Such activities need not necessarily be more labour intensive in the longer term. That depends on the scope for economies of scale and ‘learning by doing’ as technologies mature.

<sup>(27)</sup> Decarbonising the global economy might therefore change the long-run shares of capital and labour in total income. But whether it will act as a countervailing force to globalisation and the impact of overall technological change depends on a range of factors, not least its impact on the demand for skilled, as opposed to unskilled, workers.

<sup>(28)</sup> At state level, employment creation in the United States is facilitated by the ease with which workers can migrate across state borders. In a more closed economy, measures similar to the Californian ones might be expected to create fewer jobs because aggregate supply would be less responsive.

<sup>(29)</sup> Public spending on the transition to a low-carbon economy provides an opportunity to address social needs as well as economic and environmental ones e.g. reducing the high energy costs (relative to income) of low-income families in poor-quality, energy-inefficient housing.

it may take 30 to 60 months to complete the pre-construction phases of preparing a new wind farm). That draws attention to the desirability of making regulation more efficient and better designed. Energy efficiency improvements have an advantage partly because of their dependence on known technologies and skills. The same applies to some measures to encourage switching to lower-carbon fuels (e.g. fuel-switching for public transport vehicles).

### Setting a carbon price

Carbon prices are already being set in the European Union, directly through the Emissions Trading Scheme (ETS) and various taxes, and indirectly through other environmental policies such as the UK Renewables Obligation. Other countries and regions have been adopting similar schemes. Yet the progress on institutional developments contrasts with recent price movements. The carbon price under the EU ETS has fallen by around 60% since its peak in July 2008. The price of carbon in Clean Development Mechanism transactions is also low. That represents a weakening of the incentive to reduce carbon-intensive activities. It may reflect in part the sale of quotas by otherwise credit-constrained firms that need to raise funds.<sup>(31)</sup> Is now the time to seek to push up the price?

Economic modelling of efforts to slow climate change suggests that the carbon price should rise steadily. There are four lines of argument:

- (i) The social cost of carbon rises steadily as the marginal costs of emissions rise with the size of the stock of greenhouse gases already in the atmosphere.<sup>(32)</sup> Year-to-year volatility in emissions (as opposed to a change in trend growth) is unlikely to have a significant effect because it has little effect on the overall stock of greenhouse gases or ultimate damage costs.
- (ii) Adopting an ultimate target for stabilising global greenhouse gas concentrations (the way in which policy is often characterised in the economic models) creates, in effect, an exhaustible natural resource (the ability to emit carbon). Hotelling's principle means that the price of this resource should increase at the real rate of interest.<sup>(33)</sup>
- (iii) In a world of uncertainty, fixing the trajectory of the price of carbon in the short to medium term is preferable to sticking to a trajectory for emissions in the face of shocks.<sup>(34)</sup>
- (iv) Expectations of a long-run rise in the carbon price are necessary if near-term investment in long-lived infrastructure and in R&D is to avoid 'locking in' high-carbon technologies.

Carbon pricing is also necessary to combat the 'rebound' effect from successful energy efficiency promotion. If there are low costs, or indeed negative costs, associated with many energy efficiency measures, as argued by McKinsey & Company (2009), they are likely to lower the cost of energy-intensive activities and increase disposable incomes. Both factors will tend to boost consumption of those activities in the absence of a countervailing increase in carbon prices.

Economic theory therefore gives cause for concern about the sharp fall in the carbon price. It is failing to give the appropriate steady, long-run signal to investors about the economic costs of high-carbon technologies and to customers about the true costs of their purchases. The falls since last summer in the prices of oil and other hydrocarbons, brought about by the economic downturn, have also diminished the short-term attractiveness of low-carbon investment, goods and services.

However, previous analysis has largely abstracted from business cycle considerations and the relationship of the carbon price to other asset prices. An increase in the carbon price, by imparting an adverse supply shock to the industrial sectors covered, would impede economic stimulus measures. Firms are unable to adjust their inputs, outputs and capital stocks immediately in response to relative price changes. Nor does it appear to be necessary in order to keep emissions within the limits set by the EU ETS, given that the quota price is determined in the market place with a fixed supply of quotas. And the continuing increase in the volumes traded on carbon markets suggests that deep and liquid markets are being established, which should help build confidence in their use and their efficiency in reflecting expectations about the future.<sup>(35)</sup> Measures to raise the carbon price are of less urgency at a time of economic downturn, as long as the long-term trajectory is not brought into question by its current low level.

(30) This is not acknowledged by all governments. The Mexican authorities, for example, are reported to be planning to cut the domestic gas price by 10%, cap petrol prices for the rest of the year, and reduce electricity tariffs.

(31) That illustrates how the carbon price reacts differently to macroeconomic shocks under a quota system than under a carbon tax regime. It seems unlikely that a fiscal authority with a carbon tax would, as part of a fiscal stimulus, cut one particular tax rate to such an extent – broader, more neutral tax reductions would almost certainly be preferred.

(32) The marginal impact of a given quantity of emissions on expected global mean temperature declines with the stock of greenhouse gases, but the marginal impact of temperature changes on expected climate change costs rises with temperature. Whether the social cost of carbon goes up or down with the stock of greenhouse gases in the atmosphere depends on which factor dominates. The risks of catastrophic changes at high temperatures suggest to us that the latter factor dominates.

(33) The 'natural resource' in question, the permission to pollute, is costless to exploit in the sense that its use does not require other resource use, unlike, say, coal, which has to be dug out of the ground. See Dasgupta and Heal (1979).

(34) Pizer (2002). That is not inconsistent with targeting the quantity of emissions in the longer term, as explained in Stern *et al* (2007), pages 354-358.

(35) Deals under the Clean Development Mechanism, however, have slowed.

### Building support for the climate change policy framework

Building the ethical and economic case for the climate change policy framework becomes more urgent at a time of a downturn like the present one. First, the choice of 'green' fiscal measures needs to be explained and justified. Second, the burdens on firms imposed by even a reduced carbon price could otherwise erode support for the framework as a whole. Third, the ground needs to be prepared for climate change policies during the eventual economic recovery.

Stopping climate change requires persistence over the long term in technology and carbon pricing policies. It is argued in previous sections that now is a good time to introduce stronger support for energy efficiency and renewable technologies in particular, but, given the nature of the relevant market failures, the need for this support will not evaporate when economic growth recovers. Without public support for the framework, putting in place financing measures for 'green' public spending and establishing the long-term credibility of incentives for investment in low-carbon infrastructure will be difficult. The danger is that the argument for a 'green' fiscal stimulus will be turned on its head when an overall stimulus is no longer necessary. Just as the government needs to outline a convincing strategy for consolidating the public finances once economic recovery is under way, it needs to continue to make the case for a long-term strategy against climate change.

### Adaptation to climate change

The final element of a strong climate change policy framework is the promotion of society's ability to adapt to the impacts of climate change. One way of doing that is to ensure that when the public sector provides long-lived public goods, or gives incentives to the private sector to provide them, these public goods are appropriate to the changing climate. A fiscal stimulus is likely to entail increased investment in infrastructure, given the lower opportunity costs of public investment at a time of demand-induced unemployment; it is important that this infrastructure is 'climate-proofed'. That is likely to entail higher spending (e.g. on more substantial flood protection and better insulated schools), as adaptation is not costless. But much adaptation will have to await greater clarity about the local impacts of climate change and their timing; many will not be felt for a generation or more. Given the lags between emissions and climate change damages, and the uncertainty surrounding the precise nature and incidence of the damages, action is more urgent on the emission-reduction front.

## 4. Proposals for 'green' spending in the current crisis

Many specific proposals for 'green' spending are under discussion as governments' plans for fiscal stimuli are further developed around the world. This paper has suggested some criteria that could be used to assess their potential benefits, both in aiding economic recovery in the near term and in tackling climate change over the long haul. In Table 1, we offer our own qualitative assessment of various recommendations for action, drawing on a range of sources including the Committee on Climate Change (2008) for the UK, and Pollin *et al* (2008) and the proposals in the current American Recovery and Reinvestment Bill for the United States.

The first criterion is *timeliness* – the extent to which a significant proportion of the associated spending would be likely to be carried out over the next year or so. The next four relate to how well such measures are *targeted*:

- (i) potential long-term social returns (with respect to climate change objectives),
- (ii) positive 'lock-in' effects from investment in long-lived low-carbon capital stock,
- (iii) likely extent of job creation and size of the domestic fiscal multiplier,
- (iv) use of under-utilised resources.

The first two of these focus on the measures' likely effectiveness as policies to tackle climate change, while the second two focus on their likely effectiveness as part of a fiscal stimulus. The sixth criterion relates to *time-limitedness*: the extent to which spending is likely to be shifted forward in time, reducing necessary spending later on. Measures that are additional and/or likely to be permanent place a greater onus on policy-makers to engage with the issue of fiscal sustainability.

This informal assessment draws attention to the potential of energy efficiency measures to deliver a fiscal stimulus and to help deliver climate change objectives. They are also useful from the point of view of enhancing energy security and reducing fuel poverty. Several initiatives in the transport sector look especially attractive as well. Large-scale new infrastructure investments are less obviously an effective tool for short-term economic recovery.

Our emphasis has been on criteria for assessing individual measures – a 'bottom-up' approach. It is difficult to judge precisely how large a contribution to the global fiscal stimulus is implied. HSBC (2009) notes that plans announced so far vary widely in the extent that they explicitly promote 'green' investment, ranging (in HSBC's assessment) from 0% in Poland to 69% in South Korea. Given the uncertainties about the fiscal multipliers for different tax and spending changes in current circumstances, any fiscal stimulus package needs to be diversified. There are limits to the extent to which 'green' investments can be scaled up, given the size of the sectors in which they would be made.

(36) The authors use input-output tables to derive direct and indirect employment effects of the first round of spending increases, and apply a fiscal multiplier towards the low end of the estimates for the United States reported in Hemming, Kell and Mahfouz (2002). They also point out that investments in such areas would provide jobs across a broad range of familiar occupations, and so would be unlikely to be inhibited by bottlenecks in the supply of highly specialised workers.

(37) That follows a downward revision of 0.75 percentage point in November 2008.

(38) The World Bank estimate for world GDP at market prices for 2007 was US\$54.3 trillion.

(39) 20% of 3.6% of annual world GDP. That would take more than a year to disburse.

(40) 54% reduction in greenhouse gases (CO<sub>2</sub>-equivalent) relative to the business-as-usual scenario by 2030 (30% reduction relative to the 2005 level of emissions).

(41) It is also broadly in line with the extra investment flows needed annually by 2030 in the UNFCCC's mitigation scenario relative to its reference scenario, if one does not deduct the investment spending saved by 2030 by reducing fossil fuel generation and supply, and having a smaller transmission and distribution capital stock (UNFCCC (2007)).

However, some guidance can be obtained from estimates of the costs and likely impacts of coherent sets of measures built up from a 'bottom-up' approach. For example, for the United States, Pollin *et al* (2008) propose a set of public infrastructure investments in public building retrofits, low-carbon public transportation, building 'smart' electricity grid systems and developing wind power, solar power and next-generation biofuels; that would entail a US\$100 billion programme over two years – equivalent to around 0.75% of one year's GDP. They estimate that it would create some two million jobs.<sup>(36)</sup> Since its publication, the economic outlook has deteriorated further and the scale of the likely United States stimulus has increased, so a more ambitious United States programme now appears reasonable. HSBC estimates that about US\$130 billion (16%) of the current United States Economic Stimulus Package comprises 'green' investment of one sort or another.

At a global level, a fiscal stimulus greater than the 2% of GDP suggested by the IMF's Managing Director in December 2008 is now warranted, given that the Fund in January 2009 revised down its world growth forecast for 2009 by 1.75 percentage points, despite the fiscal packages already announced.<sup>(37)</sup> A case can be made for an effort of the order of 4% of GDP, given the likely size of the fiscal multipliers. With annual world GDP of around US\$55 trillion,<sup>(38)</sup> that suggests a figure of upwards of US\$2 trillion. Overall, we suggest that a 'green' stimulus of the order of 20% of the total would be appropriate (higher in countries with a lot of unexploited opportunities for low-cost decarbonisation, lower in countries that have already made a significant start in this direction). That gives a 'ball-park' figure of some US\$400 billion of extra public spending worldwide on 'green' measures over the next year or so.<sup>(39)</sup>

To put that number in context, McKinsey & Company (2009) estimates that the annual incremental investment costs required to get the global economy on to an appropriate low-carbon trajectory<sup>(40)</sup> would be EUR 320 billion by 2015, a very similar order of magnitude. McKinsey & Company does not envisage that that would need to be funded wholly by the public sector. But in 2009, the near-term outlook for private-sector investment spending is poor and the public sector will have to bear a larger share of the burden. And it was argued in previous sections that some incremental investment should be brought forward from future years and that there is a backlog of projects to work through. So the 'ball-park' figure is broadly consistent with the McKinsey & Company estimate of the scale of the 'green' effort needed to achieve the long-term policy goal. It is also in line with the incremental costs of power generation that the International Energy Agency suggests will be required for greenhouse gas abatement (IEA (2008)).<sup>(41)</sup> Much further work is required on the details of what it should comprise. But an initiative of that magnitude would go a long way towards setting the world on a long-term trajectory of more sustainable, low-carbon growth.

**Table 1: Assessing selected proposals to combat climate change**  
**Scores (1 = worst; 3 = best)**

Mitigation target	Investment approach	Timeliness ('shovel-ready')	Long-term social return	Positive 'lock-in' effects	Domestic multiplier/ job creation	Targeting areas with slack	Time-limited/reversibility
<b>Buildings and industry</b>							
Residential energy efficiency (lofts etc), either utility-driven or local-authority-driven	Mixed public / private	3	3	2	3	3	3
Energy efficiency measures for public buildings	Mixed public / private	3	3	2	3	3	3
Boiler replacement programme	Private with incentives	3	3	2	3	3	3
Lights and appliances, e.g. utility-driven	Private with incentives	3	3	2	3	3	3
Renewable heat / fuel switch (e.g. solar, biomass)	Private with incentives	3	3	2	2	3	2
Micro-generation (wind, biomass), e.g. through feed-in system	Private or mixed public / private	2	3	2	2	2	1
'Smart' production (increase energy efficiency, monitor, meter and regulate delivery and consumption of energy and inputs)	Private with incentives	2	2	3	1	1	1
'Smart' infrastructure and buildings – increase energy efficiency, monitor, meter and regulate delivery and consumption of energy and water	Mixed public / private	2	3	3	2	2	1
Encouraging energy R&D (doubling percentage of GDP)	Mixed public / private	2	3	3	2	1	1
Industrial energy efficiency / mitigation, e.g. combined heat and power	Private or mixed public / private	2	3	3	2	1	3

Mitigation target	Investment approach	Timeliness ('shovel-ready')	Long-term social return	Positive 'lock-in' effects	Domestic multiplier/ job creation	Targeting areas with slack	Time-limited/ reversibility
<b>Power generation</b>							
Renewable energy promotion, e.g. through accelerated planning process	Private	2	3	3	3	1	3
Nuclear power, e.g. through accelerated planning process	Private	1	3	3	3	1	3
Carbon capture and storage demonstration projects	Mixed public / private	1	2	2	3	1	1
Upgrade to 'smart' electricity grid	Public with some clawback via tariffs	1	3	3	3	1	3
Advanced battery development	Private with incentives	1	3	3	2	1	1
<b>Transport</b>							
Supply-side efficiency in new cars, vans and HGVs (g/km)	Private with incentives	1	3	3	3	3	3
Switch to cleaner cars / fleet renewal e.g. through stronger differentiation of vehicle excise duty	Private with incentives	3	3	2	2	3	1
Connected urban transportation including road traffic management systems and work patterns	Mixed public / private	1	3	3	2	2	1
Supply-side efficiency in rail (engines, rolling stock)	Private with incentives	1	3	3	2	2	3
Mass transit and rail freight	Mixed public / private	2	2	3	3	3	1
Car efficiency standards	Private with incentives	1	3	3	2	2	3
Tyre check	Private with incentives	3	2	2	3	2	3
<b>Reducing emissions from deforestation and forest degradation</b>							
Afforestation, expanding and developing parkland, wetlands and rural ecosystems	Private with incentives	3	2	3	3	2	2

## 5. Conclusions

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There is a strong theoretical and empirical case for a fiscal stimulus in the industrial countries at present. The question is, what form should it take? We argue that this is the right time to be spending on measures to promote energy efficiency and low-carbon technologies, given the urgency of the case for reducing greenhouse gas emissions. Such spending would be effective in creating jobs within the appropriate timeframe – well-targeted and timely. It is also important to ensure that investments in public infrastructure undertaken as part of the fiscal stimulus enhance the economy's capacity to adapt to climate change. Installing infrastructure that 'locks in' high greenhouse gas emissions for many years to come will increase the difficulties of reducing emissions in the future and blunt the incentives for technological improvement and innovation. Decisions about the scale and composition of fiscal expansions are needed as soon as possible if they are to play their role in preventing a slide into a global depression. Governments need to commit to a strong 'green' element in a fiscal recovery plan in the first half of 2009 or indeed the first quarter.

It is less urgent for there to be a rise in the carbon price, as that does not appear to be necessary to meet quantity targets for emissions in the near term and might erode support for the overall climate policy framework. But it is vital that the rationale for a comprehensive framework to reduce emissions is explained and the case for it made vigorously, given the eventual need to reconcile continuing measures against climate change with fiscal consolidation. If people become convinced that the framework will hold in the long term, that could unleash a wave of creativity and innovation in 'greening' the economy – a more durable foundation for economic growth than dot.com booms and housing bubbles.

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