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## **Ecological tax reform and the double dividend of ecological sustainability and low unemployment: an empirical assessment**

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**Abstract:** Ecological Tax Reform (ETR) is a policy designed to tax such 'bads' as resource depletion and pollution and to reduce tax impositions on such 'goods' as labour and income. The aim of ETR is relatively straightforward: (1) taxing depletion and pollution should decrease the rate of resource throughput per unit of economic activity and relieve any growing pressure on the natural environment; (2) reducing tax rates on labour and income should encourage the employment of labour and reward value-adding in production. For these reasons, many observers believe that ETR has the capacity to deliver the double dividend of ecological sustainability and low unemployment.

Some ecological economists are quite comfortable with the positive employment effect of ETR but are not altogether confident that conventional ETR measures will result in ecological sustainability. They argue that sustainability is essentially a throughput problem, yet market prices – and this includes tax-adjusted resource prices – are an allocative instrument with the limited capacity to induce greater resource use efficiency. Despite the logical benefits of a more efficient allocation of natural resources, ecological economists believe that, left unchecked, efficiency gains are likely to be overwhelmed by the scale impact of increased economic activity (the 'Jevons' effect'). As such, tax-adjusted prices cannot prevent the intensity of environmental stress from eventually exceeding sustainable limits. To achieve ecological sustainability, many ecological economists believe it is necessary for an ETR package to include a separate policy instrument in the form of quantitative throughput controls that must be based on ecological rather than economic criteria.

With the ecological economic position in mind, this paper reveals the ETR performances of four nations – Sweden, Denmark, The Netherlands, and Finland. Using CO<sub>2</sub> emissions as an indicator of environmental stress, it appears in all four cases that significant efficiency increases have eventuated (as represented by the ratio of real GDP to CO<sub>2</sub> emissions). The employment impact of reduced income and labour taxes is much harder to discern but, importantly, total CO<sub>2</sub> emissions have either changed very little (Sweden and Denmark) or have markedly increased (The Netherlands and Finland). This evidence cautiously supports the ecological economic position and raises doubts as to whether conventional ETR measures can achieve ecological sustainability and, furthermore, the promised double dividend.

**Keywords:** ecological tax reform; CO<sub>2</sub> emissions; efficiency; Jevons' effect; ecological sustainability.

**Reference** to this paper should be made as follows: Lawn, P. (2006) 'Ecological tax reform and the double dividend of ecological sustainability and low unemployment: an empirical assessment', *Int. J. Environment, Workplace and Employment*, Vol. 2, No. 4, pp.332–358.

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## 1 Introduction

The principal aim of this paper is to provide some empirical evidence to support the ecological economic position on conventional Ecological Tax Reform (ETR) measures – namely, that while they are likely to improve resource use efficiency and increase the attractiveness of employing labour, they are unable to guarantee ecological sustainability. More to the point, they are unlikely to deliver the double dividend of ecological sustainability and low unemployment.

To support the ecological economic position, empirical evidence is provided of the efficiency, employment, and CO<sub>2</sub> emissions performances of Sweden, Denmark, The Netherlands, and Finland. These four countries have been chosen because they, more than any other countries, have come closest to explicitly implementing ETR (Hoerner and Bosquet, 2001). All four countries introduced CO<sub>2</sub> taxes in the early 1990s – the rates of which have since been modified – which were either immediately or later accompanied by decreased tax rates on income and/or labour.

For the purposes of this paper, the efficiency performance of the above four nations is reflected by the ratio of real GDP to CO<sub>2</sub> emissions. Both the total number of people employed and the unemployment rate are used to indicate the employment impact of ETR measures, while total CO<sub>2</sub> emissions are used as an indicator of environmental stress.

CO<sub>2</sub> emissions were the preferred environmental indicator for three reasons. Firstly, the environmental element of the ETR packages of all four countries focused primarily on subduing CO<sub>2</sub> emissions in order to meet Kyoto obligations. Secondly, since CO<sub>2</sub> emissions are highly correlated to energy consumption and energy is necessary to fuel the economic process, total CO<sub>2</sub> emissions constitute a good macro indicator of a nation's environmental impact. Finally, climate change – of which CO<sub>2</sub> emissions are the principal cause – is regarded as one of human kind's most pressing environmental dilemmas.

## 2 What is the conventional approach to ETR?

In conventional terms, ETR involves a policy mix of tax impositions on such ‘bads’ as resource depletion and pollution and reduced tax rates on such ‘goods’ as labour and income (*e.g.*, see O’Riordan, 1997; Roodman, 1998; Hoerner and Bosquet, 2001). In most cases, ETR is promoted as a revenue-neutral means of achieving the double dividend of ecological sustainability and low unemployment (Daly, 1996; Hoerner and Bosquet, 2001).

How does ETR supposedly deliver the double dividend? Firstly, by taxing resource depletion and pollution, ETR proponents believe there is an immediate incentive for producers to reduce resource wastage and a long-term incentive to develop and install resource-saving technologies. Thus, by reducing the rate of resource throughput per unit of economic activity, depletion and pollution taxes are able to alleviate the growing pressure that economic activity currently imposes on the natural environment.

From an employment perspective, conventional ETR proponents believe that reduced tax rates on labour and income will encourage the employment of labour and reward value-adding in production (Lawn, forthcoming). Moreover, by rewarding better rather than more production, ETR advocates believe that reduced tax rates on income can boost real wages and thus enable workers to reduce the number of hours spent at work. In turn, this can promote job sharing with the unemployed. In all, conventional ETR proponents argue that ETR can overcome the common fear that depletion and pollution taxes will result in rising unemployment (Bosquet, 2000; Forstater, 2004; Lawn, 2004a; Cowling *et al.*, 2006, Victor, forthcoming).

It is important to recognise, at this point, that conventional ETR measures rely entirely on the role that tax-adjusted market prices play in altering the incentives and disincentives of producers, consumers, and workers alike to achieve the desired goals of ecological sustainability and low unemployment. Clearly, an important assumption underlying the success of conventional ETR packages is that ecological sustainability can be achieved by internalising the spillover costs of resource depletion and pollution. In other words, by ensuring the prices of material goods reflect the marginal social cost of production (resource inputs) and consumption (waste outputs), all ensuing Pareto-efficient outcomes will be ecologically sustainable. As we shall soon see, it is here where some ecological economists depart, not from the concept of ETR itself, but from the conventional ETR approach.

## 3 What do some ecological economists have to say about conventional ETR measures and why?

### 3.1 *Conventional ETR measures and the Jevons’ effect*

Many ecological economists are quite comfortable with the idea that conventional ETR measures can have positive employment implications. As such, they believe that tax reductions on income and labour should remain an essential feature of any ETR package. However, they are much less confident that conventional ETR measures – namely, the depletion and pollution tax element – can bring about ecological sustainability. These misgivings stem from the ecological economic argument that

sustainability is essentially a throughput problem, yet market prices – and this includes tax-adjusted resource prices – are an allocative instrument with the limited capacity to induce greater resource use efficiency.

There is no doubt that a more efficient allocation of natural resources is socially desirable with obvious environmental benefits per unit of economic activity. The problem, according to ecological economists, is that, in a system devoid of any explicit limitation on the rate of resource throughput, efficiency gains are likely to be overwhelmed by the scale impact of increased economic activity (the so-called ‘Jevons’ effect’). If so, the aggregate rate of resource throughput and any subsequent environmental stress will increase rather than diminish. Since the conventional ETR approach of tax-adjusted prices does not involve an explicit limitation on the rate of resource throughput, conventional ETR measures cannot prevent the intensity of environmental stress from eventually exceeding sustainable limits.

To achieve ecological sustainability, many ecological economists believe it is necessary for an ETR package to include a separate policy instrument in the form of quantitative throughput controls based on ecological rather than economic criteria (Daly, 1991; Lawn, 2000; forthcoming). For this reason, ecological economists are very much in favour of tradeable resource use and pollution permits – essentially ‘cap and trade’ systems – rather than direct depletion and pollution taxes.<sup>1</sup>

How do permit systems successfully deal with the sustainability issue? Unlike conventional ETR packages, a restriction on the number of permits auctioned by a government authority limits the throughput of matter-energy to a rate consistent with the regenerative and waste assimilative capacities of the natural environment. This immediately resolves the sustainability goal. The revenue raised from the sale of the permits can be redistributed to the poor and those directly harmed by depletion/pollution activities. This assists in the resolution of society’s equity goals. Finally, the premium paid by resource buyers for the limited number of permits – which is determined by demand and *constrained* supply forces in the various resource markets – serves as a throughput or absolute scarcity tax to facilitate the efficient allocation of the incoming resource flow.<sup>2</sup> Hence, permit systems achieve everything that is likely to be generated by depletion and pollution taxes except they go one step further and ensure ecological sustainability.<sup>3</sup>

### *3.2 Why can tax-adjusted resource prices not achieve ecological sustainability?*

Whether tax-adjusted resource prices can negate the Jevons’ effect and bring about ecological sustainability depends essentially on whether they can adequately reflect the absolute scarcity of the total resource stock. Ecological economists believe they cannot. Their position can be summarised by the following. Firstly, relative prices are generated by interacting market demand and supply forces that are essentially flow-based forces. By flow-based forces I mean the inflowing quantity of low entropy resources demanded at various prices by resource buyers and, on the supply-side, the inflowing quantity of the various types and grades of low entropy resources supplied at various prices by resource sellers.<sup>4</sup>

Secondly, while the stock of a particular resource has some bearing over the inflowing quantity being supplied, the supply of a particular incoming flow at any point in time is much less restricted than the supply of the same incoming flow over time. For

example, if timber suppliers double the quantity of timber supplied to a particular timber market, they can continue to do this for some limited period even if the rate of supply exceeds the capacity of forests/timber plantations to supply the same quantity of timber over time. As for the suppliers of a non-renewable resource, any quantity supplied at a particular point in time cannot be continued indefinitely. However, until the stock of the resource is close to exhaustion, it is still possible for its short-term supply to be increased.

Thirdly, in the short-term, when a larger yet unsustainable quantity of a particular resource is being supplied, it is possible, at least during the initial depletion phase of the resource, for the price-influencing effect of flow-based forces to dominate the stock effect. Should this be occurring, the relative price of a dwindling resource will fall not rise – as one would expect of the short-run price for crude oil if, for example, OPEC countries immediately increased oil production. Would this fall in price be a reflection of its declining absolute scarcity? No. It would be a reflection of a higher inflowing quantity (declining relative scarcity) at a time when the remaining stock was shrinking (increasing absolute scarcity).

It is true that the stock effect on resource prices must eventually outweigh the flow effect since, on the supply-side, resource prices are also influenced by the cost of extraction/harvesting. This cost is likely to rise sharply as it becomes increasingly difficult to sustain the same inflowing quantity from an ever-diminishing stock. Clearly, resource prices must eventually reflect an increase in the absolute scarcity of low entropy matter-energy. But there are three main reasons why the conveyance of this information in markets is likely to be delayed or not be properly conveyed at all. To begin with, resources themselves are required to extract/harvest resources. If the prices of the resources used to extract/harvest new resources are understated, so is the cost of extraction. This, in turn, understates the cost of future extraction, and so on. Secondly, futures markets are imperfect at best and non-existent at worst. Thirdly, where futures markets exist, they are designed to capture the stock effect on the future supplies of particular resources. For example, if the stock of a particular resource is severely limited, so are future supplies. One would expect the price of a rapidly dwindling resource in a futures contract to be very high to reflect the shortage of future supplies. While the price might well be higher, it is unlikely to be sufficiently high because people have the tendency to discount future values, including the cost to future generations of having smaller resource stocks. Furthermore, future generations, the very people most likely to be adversely affected by increasing resource scarcity, have no way of bidding in the present for the future availability of resources. Taken together, these factors may or may not threaten the intergenerational efficiency of resource use. However, intergenerational efficiency does not guarantee intergenerational equity (sustainability) in the same way intragenerational efficiency need not coincide with intragenerational equity (Howarth and Norgaard, 1990; Daly, 1991). In all, the price signals generated by resource markets, including futures markets, are likely to be ineffective at ensuring natural capital maintenance and a sustainable resource flow.

I might also point out that a recent simulation exercise (Lawn, 2004b) appears to theoretically support the ecological economic position on resource prices and resource scarcity. Based on a welfare-maximising natural resource model, the exercise suggests that the price of an increasingly scarce resource is likely to decline in the initial depletion phase. Only as stock-based supply forces eventually overwhelm flow-based supply forces does the price of the resource rise rapidly. Importantly, this only occurs once the stock of the resource approaches total exhaustion.

Furthermore, the above study suggests that the initial fall in the resource price and the rapid rate of depletion is accentuated by a number of factors. The first occurs whenever the resource price is to some extent a function of its past price – something that is critical given that the extraction of many resource types requires the use of the resource being extracted (*e.g.*, oil is invariably used to power the oil extraction process). The second involves the use of high discount rates, while the third occurs if governments, as they have a tendency to do, subsidise resource extraction industries in order to promote the growth of the nation's Gross Domestic Product (GDP).

## **4 Evidence of ETR performances**

### *4.1 Previous assessments*

In this sub-section, I shall briefly reveal some of the evidence already obtained regarding the success or otherwise of ETR. A great deal of the work conducted on ETR has focused on simulation exercises designed to predict the likely outcome of various ETR measures (*e.g.*, Felder and Schleiniger, 2002). Much less has involved the analysis of data to assess the efficacy of ETR measures previously implemented in various countries. Consequently, very little of the work has led to conclusive statements about the role and value of ETR.

One of the most significant recent surveys on ETR was conducted by Bosquet (2000). The survey consisted of 56 studies of *ex ante* modelling exercises (*i.e.*, simulation studies designed to predict the likely impact of ETR measures rather than *ex post* studies examining the actual economic and environmental impacts of ETR measures already imposed). On the whole, the simulation exercises predicted that ETR measures should lower carbon emissions, reduce the rate of energy use, and relieve environmental stress. Moreover, since CO<sub>2</sub> emissions taxes and energy taxes have considerable revenue potential, it was anticipated that environmental taxes would allow governments to lighten the tax burden on personal income and on the employment of labour (Bosquet, 2000).<sup>5</sup> This, it seemed, provided widespread support for the ability of ETR to deliver the double dividend of ecological sustainability and low unemployment.

Of course, one of the limitations of *ex ante* analyses is that simulation models ignore the role of dynamic efficiency, technological progress, and complex feedback processes. As such, their predictive power is highly questionable. In all, the success of any policy can only be ascertained via an *ex post* examination of relevant data. Unfortunately, *ex post* assessments of ETR are few in number. One such example is a study by Larsen and Nesbakken (1997) which claims that, from 1991 to 1993, carbon taxes assisted Norway to reduce carbon emissions from stationary sources in the manufacturing and service sectors by 3%–4%, with similar reductions observed in relation to household stationary and mobile sources.<sup>6</sup> With the benefit of time, it can be revealed that Norway's CO<sub>2</sub> emissions rose significantly between 1993 and 1997 and were only tempered by the introduction of a new round of carbon taxes in 1999 (Statistics Norway various, 1999–2002). Overall, Norway's CO<sub>2</sub> emissions increased by over 10% between 1990 and 2002 (Statistics Norway various, 1999–2002).

A study by the Swedish EPA (1997) also claims that Swedish ETR measures have reduced CO<sub>2</sub> emissions. Regrettably, the Swedish EPA provides no quantitative estimate of the reductions. As we shall see in an upcoming section of the paper, Swedish ETR

measures in the mid-1990s were only successful in the short-term at reducing CO<sub>2</sub> emissions. Increases in real GDP after 1999 appeared to overwhelm the efficiency benefits induced by the Swedish ETR measures that, in turn, led to a rise in CO<sub>2</sub> emissions in each year from 2000 to 2003.

The same has also occurred where ETR has been used to target other pollutants. Ekins (1999) has shown that a Swedish nitrogen oxide (NO<sub>x</sub>) tax announced in 1990 and imposed in 1992 led to massive reductions in NO<sub>x</sub> emission levels between 1990 and 1995. However, by 2000, Swedish NO<sub>x</sub> emissions had risen by 23.1% on their 1995 levels (WRI, various). Interestingly, most of the initial decline in NO<sub>x</sub> emissions between 1990 and 1995 occurred in 1991, the year following the announcement of the tax. Hence, the announcement effect proved to be more powerful than the tax itself.

In what appears to be an example of the Jevons' effect, Ekins (1999) has also provided evidence of the impact of a 5% per annum increase in road fuel duties that was introduced by the UK Government in 1993. In 1995, petrol and diesel demand fell by 1% despite a rise in the volume of economic activity (as measured by real GDP). However, over the next two years, demand for petrol and diesel increased by 5%. The continuing rise in economic activity more than offset whatever efficiency gains were made such that increased road fuel duties could not prevent an eventual rise in petrol and diesel usage. This pattern has persisted in the UK where the use of road fuel continues to increase in the face of higher fuel taxes.

#### *4.2 Analysis of the ETR performances of Sweden, Denmark, The Netherlands, and Finland*

In this sub-section of the paper, the ETR measures of Sweden, Denmark, The Netherlands, and Finland are summarised as is the timing of their introduction. Empirical evidence is then provided in both tabulated and diagrammatical form with an assessment made of the impact of the respective ETR packages.

##### *4.2.1 Sweden*

Sweden first introduced ETR measures in 1991 that entailed a range of environmental taxes and levies such as an excise tax on CO<sub>2</sub> emissions and a reduction in income tax rates. In 1993, following claims by energy-intensive industries that the 1991 measures were impacting on international competitiveness, the CO<sub>2</sub> tax rate for industry and horticulture was significantly reduced (Hoerner and Bosquet, 2001). However, by 1997, and following a small rise in the CO<sub>2</sub> tax rate in 1996, CO<sub>2</sub> taxes were increased to just short of their 1991 rates. In addition, it was decided that CO<sub>2</sub> tax rates should be adjusted to take account of inflation. This aside, fuels used for electricity generation remained exempt from CO<sub>2</sub> taxes and other energy taxes, while many other energy-intensive industries continued to enjoy a cap on CO<sub>2</sub> tax obligations provided their total CO<sub>2</sub> tax impost exceeded 0.8% of sales (Hoerner and Bosquet, 2001).

In 2001, the Swedish Government, in an attempt to quell the rise in CO<sub>2</sub> and other emissions, decided to widen the scope of its environmental taxes. In addition, CO<sub>2</sub> tax rates were further increased. These tax rises were matched by income tax rate reductions and a cut to employees' social security contributions to the national pension fund.



**Table 1** Ecological Tax Reform performance of Sweden, 1990–2004

Year	Real GDP (SEK billions) (2000 prices)	CO <sub>2</sub> emissions (000s tonnes)	CO <sub>2</sub> emissions (1990 = 100.0)	Real GDP/CO <sub>2</sub> emissions ratio (SE per tonne) (a/b)	Index of real GDP/CO <sub>2</sub> (1990 = 100.0)	Employment numbers (000s)	Unemployment rate (%)	Real GDP/empl. ratio (SEK per emp. person) (a/f)	ETR environmental element	ETR employment element
	a	b	c	d	e	f	g	h	j	k
1990	1,828.6	51,733.64	100.0	35,346.5	100.0	4,636.1	1.8	394,426.5		
1991	1,808.9	52,484.16	101.5	34,464.9	97.5	4,536.3	3.1	398,752.6	CO <sub>2</sub> tax introduced <sup>A</sup>	Income tax rates reduced <sup>B</sup>
1992	1,787.5	52,397.47	101.3	34,113.7	96.5	4,351.9	5.1	410,734.0		
1993	1,751.8	51,850.19	100.2	33,786.0	95.6	4,087.4	9.6	428,587.4	CO <sub>2</sub> tax rates modified <sup>C</sup>	
1994	1,820.2	54,268.90	104.9	33,539.9	94.9	4,080.9	8.8	446,022.0		
1995	1,891.3	53,310.37	103.0	35,476.3	100.4	4,173.7	8.3	453,136.3		
1996	1,916.6	56,905.56	110.0	33,680.6	95.3	4,133.9	8.8	463,633.4	CO <sub>2</sub> tax rates increased <sup>D</sup>	
1997	1,961.3	52,551.64	101.6	37,322.2	105.6	4,091.5	9.1	479,370.4	CO <sub>2</sub> tax rates increased <sup>E</sup>	
1998	2,033.2	53,006.47	102.5	38,357.5	108.5	4,160.4	8.0	488,701.6	CO <sub>2</sub> tax rates indexed <sup>F</sup>	
1999	2,125.2	50,402.79	97.4	42,164.4	119.3	4,253.0	6.4	499,694.8	CO <sub>2</sub> tax rates indexed <sup>F</sup>	
2000	2,217.3	48,954.92	94.6	45,292.5	128.1	4,320.2	5.2	513,237.8	CO <sub>2</sub> tax rates indexed <sup>F</sup>	Income tax rates reduced <sup>H</sup>
2001	2,241.0	49,437.24	95.6	45,329.9	128.2	4,396.7	4.2	509,697.0		
2002	2,285.7	50,716.01	98.0	45,069.1	127.5	4,393.5	4.3	520,251.7		
2003	2,324.4	51,621.09	99.8	45,028.6	127.4	4,390.9	5.0	529,373.2		
2004	2,411.5	50,504.80	97.6	47,747.3	135.1	4,402.9	5.6	547,699.7		

Notes: A Industry and horticulture 250 SEK/tCO<sub>2</sub>; H/holds, commercial and motor fuels 250 SEK/tCO<sub>2</sub>  
 B Reduction in income tax rates and highest marginal tax rate capped at 50%  
 C Industry and horticulture 80 SEK/tCO<sub>2</sub>; H/holds, commercial and motor fuels 320 SEK/tCO<sub>2</sub>  
 D Industry and horticulture 92.5 SEK/tCO<sub>2</sub>; H/holds, commercial and motor fuels 370 SEK/tCO<sub>2</sub>  
 E Industry and horticulture 185 SEK/tCO<sub>2</sub>; H/holds, commercial and motor fuels 370 SEK/tCO<sub>2</sub>  
 F New excise taxes on energy and CO<sub>2</sub>; Annual inflation indexation of all CO<sub>2</sub> tax rates  
 G H/holds, commercial and motor fuels 530 SEK/tCO<sub>2</sub>  
 H Reduction in income tax rates and employees' social security contributions

Sources: a Statistics Sweden, www.scb.se/Statistic/NR/NR0102/2004A01A/NR0102\_2004A01A\_DL01\_EN\_BNP1950.xls#Data!A1  
 a In 1993, real GDP was measured using a different method – the values for 1980 to 1992 are adjusted based on the change in accounting method  
 b UNFCCC, Annual Status Report of the Greenhouse Gas Inventory of Sweden  
 f, g Statistics Sweden, www.scb.se

Both the environmental and employment elements of Sweden's ETR measures and the timing of both their introduction and modifications are summarised in Columns *j* and *k* of Table 1. The notes below the table indicate the exact nature of the tax rates. Columns *a–h* of Table 1 also reveal the various indicators relevant to Sweden's ETR performance over the period 1990–2004.

Figure 1, which is drawn from the data in Table 1, graphically illustrates both the CO<sub>2</sub> emissions of Sweden (Column *b* of Table 1) and the ratio of Sweden's real GDP to CO<sub>2</sub> emissions (Column *d* of Table 1). Interestingly, the initial introduction of a CO<sub>2</sub> tax did little to increase the efficiency ratio or reduce Sweden's CO<sub>2</sub> emissions. Only following the increases in CO<sub>2</sub> tax rates in the mid- and late 1990s did the efficiency performance of Sweden improve. Nevertheless, it was short-lived. For example, between 1996 and 2000, the ratio of Sweden's real GDP to CO<sub>2</sub> emissions rose steadily from 33,680.6 SEK per tonne to 45,292.5 SEK per tonne – a 34.5% increase. This contributed to a decline in CO<sub>2</sub> emissions over the same four-year period from 56.9 to 48.9 million tonnes – a 14.0% reduction. However, between 2000 and 2003, the ratio of Sweden's real GDP to CO<sub>2</sub> emissions remained almost unchanged (in fact, fell by 0.6%), while CO<sub>2</sub> emissions rose slightly from 48.9 million tonnes in 2000 to 51.6 million tonnes in 2003 – a 5.4% increase. In 2004, the final year of the study period, the efficiency ratio jumped sharply (45,028.6 SEK per tonne to 47,747.3 SEK per tonne). Conversely, CO<sub>2</sub> emissions declined.

**Figure 1** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Sweden, 1990–2004

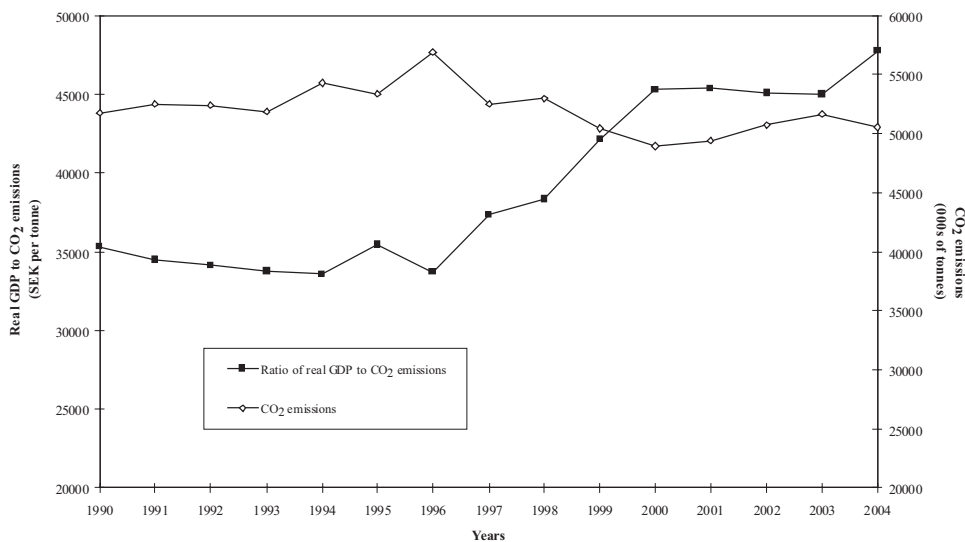
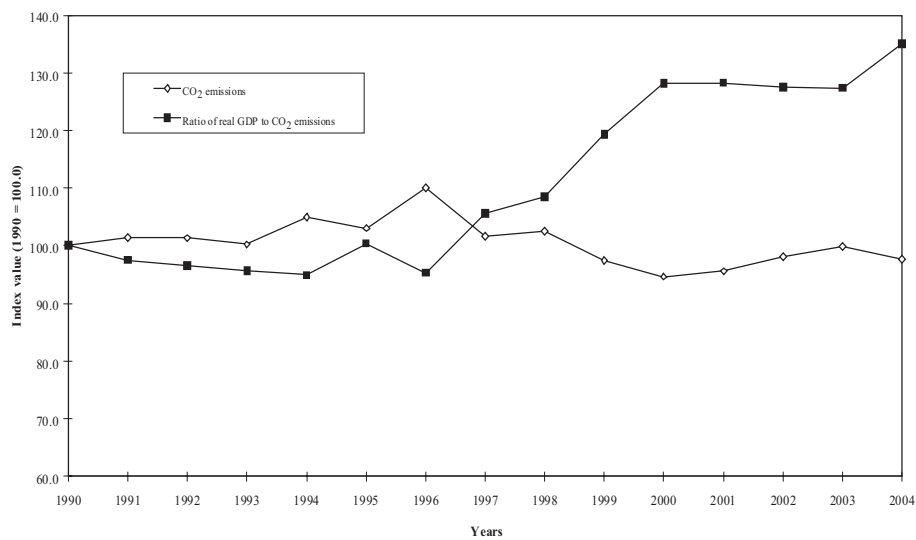


Figure 2 again illustrates Sweden's CO<sub>2</sub> emissions and efficiency ratio except that the data in both cases are set to an index value of 100.0 for the first year of the study period (Columns *c* and *e* of Table 1). This provides a better demonstration of the trend change in both indicators as well as their comparative change in each year. It can be seen quite clearly from Figure 2 that both indicators moved in opposite directions in almost every year during the study period. This suggests that efficiency increases were able to reduce Sweden's environmental stress. In other words, the ETR measures implemented by the Swedish Government appear to have prevented the scale impact of a growing

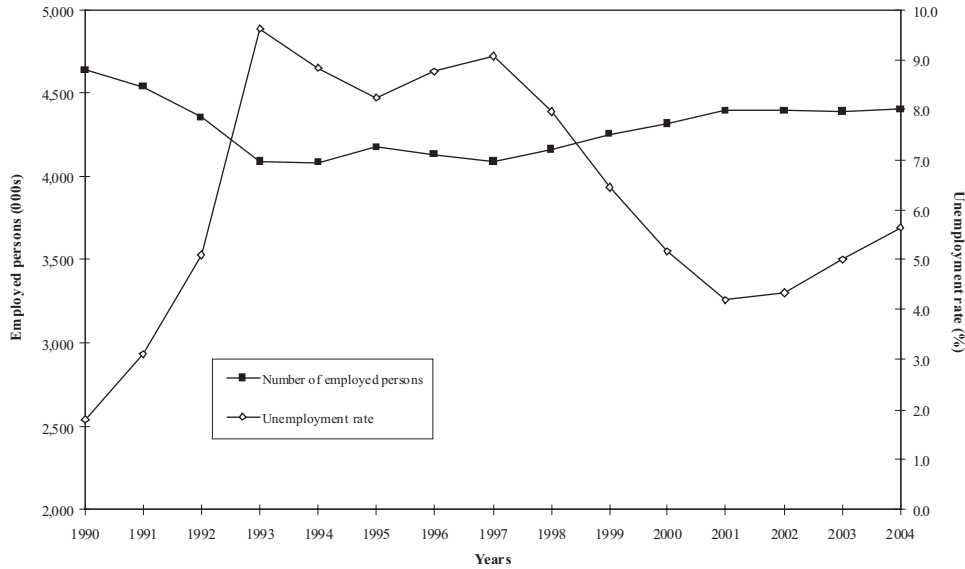
real GDP from entirely overwhelming the efficiency improvements induced. Having said this, the relative rise in the efficiency ratio over the study period was far more pronounced (+35.1%) than the overall fall in Sweden's CO<sub>2</sub> emissions (-2.4%). Given the small margins involved, it cannot be concluded that efficiency gains induced by ETR policy measures will prevent total CO<sub>2</sub> emissions from rising in the future. However, neither can one conclude that the Jevons' effect will eventually take hold as a result of the failure of depletion and pollution taxes to limit resource throughput to an ecologically sustainable rate.

**Figure 2** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Sweden, 1990–2004 (1990 = 100.0)



As for the employment impact of Sweden's ETR measures, such an assessment is more difficult to make. Between 1990 and 1993, employment numbers declined by over half a million while, during the same time, the unemployment rate jumped dramatically from 1.8% to 9.6% (Figure 3 and Columns *f* and *g* from Table 1). With real GDP falling in each year between 1990 and 1993 (Column *a* in Table 1), this employment outcome can be attributed almost entirely to the early 1990s recession experienced in Sweden.

Although Sweden's real GDP rose from 1993 to 1997, the unemployment rate recovered only marginally over the same period (9.6% in 1993 and 9.1% in 1997). Beyond 1997 and until the new ETR measures in 2001, the unemployment rate fell rapidly to 4.2%. This is despite very modest increases in real GDP. Whether the 1997 ETR measures were responsible for the apparent attractiveness of employing labour is difficult to conclude.

**Figure 3** Employed persons and unemployment rate of Sweden, 1990–2004

Unfortunately, and despite continued annual increases in real GDP to 2004, the 2001 ETR measures appear to have overturned the attractiveness of labour with the unemployment rate at the end of the study period finishing at 5.6%. With employment numbers actually rising from 2001 to 2004, the income tax rate cuts of 2001 may have increased the labour force participation rate to such an extent that the net increase in available jobs was unable to keep pace with the rise in the number of people seeking employment. If this is the case, future ETR policies of the Swedish Government will need to do more to encourage people to exit the labour market. Failure of future ETR policies in this regard may result in a growing conflict between CO<sub>2</sub> emissions objectives and the goal of low unemployment.

#### 4.2.2 Denmark

Incentives to promote energy efficiency have long been a feature of the Danish taxation system (Hoerner and Bosquet, 2001). However, the 'Energy Package' introduced in the early 1990s involved not only a broader range of energy and emissions taxes, it included subsidies to encourage the development and uptake of resource-saving technologies and the use of environmental tax revenues to reduce social security contributions.

As part of the Energy Package, a CO<sub>2</sub> emissions tax was introduced in 1992, although the tax rate was halved for manufacturers in the following year because of fears that the initial tax rate of DKK 100 per metric tonne of CO<sub>2</sub> emissions was affecting international competitiveness (Hoerner and Bosquet, 2001). Despite these concerns, energy tax rates were later increased and a host of new energy-based tax rates were introduced in 1996. The CO<sub>2</sub> emissions tax rate, in particular, was increased in every year from 1996 to 2002.

One of the main policy measures that enabled the Danish Government to allay fears concerning the increase in the CO<sub>2</sub> emissions tax rate was the 1994 reduction of labour and income taxes. Indeed, with further modifications to income tax rates in 1997 and

1999 through to 2002, the Danish Government had shifted much of the tax based from earned income onto natural resource depletion and pollution – the very theoretical basis underpinning the concept of ETR (Hoerner and Bosquet, 2001).

Columns *j* and *k* in Table 2 below summarise the environmental and employment elements of Denmark's ETR measures as well as the timing of their introduction and subsequent modifications. As with Table 1 for Sweden, the notes below Table 2 spell out the exact nature of the tax rates in Denmark over the period 1990–2002. Columns *a–h* of Table 2 reveal the various indicators relevant to Denmark's ETR performance over the study period.

Denmark's CO<sub>2</sub> emissions (Column *b* of Table 2) and the ratio of Denmark's real GDP to CO<sub>2</sub> emissions (Column *d* of Table 2) are graphically illustrated in Figure 4 below. Prior to the introduction of a CO<sub>2</sub> tax in 1992, Denmark had experienced a significant rise in CO<sub>2</sub> emissions and a sharp decline in its efficiency ratio (1990 to 1991). While the initial CO<sub>2</sub> tax imposition appeared to have a positive impact in terms of reducing emissions and increasing the efficiency ratio, the change to the CO<sub>2</sub> tax rate in 1993 seems to have reversed this effect. For example, CO<sub>2</sub> emissions increased from 60.1 million tonnes in 1993 to 74.0 million tonnes in 1996 (a 23.3% rise), while the real GDP/CO<sub>2</sub> emissions ratio declined from 15,514.0 DKK per tonne to 13,982.4 DKK per tonne over the same period (a 9.9% reduction).

Following the increases in CO<sub>2</sub> tax rates in 1996 and the subsequent annual increases to 2002, the ratio of Denmark's real GDP to CO<sub>2</sub> emissions increased by a dramatic 55.3% between 1996 and 2000 (13,982.4 DKK per tonne to 21,719.2 DKK per tonne). The ratio declined slightly in 2001 but increased marginally in 2002. As one might probably expect, Denmark's CO<sub>2</sub> emissions fell sharply between 1996 and 2000 (74.0 million tonnes down to 53.1 million tonnes). Emissions increased slightly in 2001 to 54.6 million tonnes but effectively stabilised in 2002 (54.3 million tonnes).

Figure 5 illustrates Denmark's CO<sub>2</sub> emissions and efficiency ratio with both indicators set in 1990 to an index value of 100.0 (Columns *c* and *e* of Table 2). The figure reveals that both indicators moved in opposite directions in every year during the study period. There is little doubt that efficiency improvements played a key role in whatever reductions in environmental stress Denmark secured during the 1990s.

There are, however, two noteworthy aspects to consider. Firstly, during the 'efficiency boom' of 1996–2000, the relative decline in CO<sub>2</sub> emissions between 1996 and 2002 (–26.7%) was not nearly as large as the rise in the real GDP to CO<sub>2</sub> emissions ratio (+54.6%). Secondly, and perhaps more importantly, total CO<sub>2</sub> emissions increased by 2.6% over the entire study period despite there being an overall efficiency increase of 24.8%. Although the scale effect of a rising real GDP did not exceed the 1996–2000 efficiency improvements induced by the more stringent ETR measures of the mid-1990s, it can be concluded that: (a) efficiency gains were becoming more difficult to secure towards the end of the study period (*i.e.*, in 2001 and 2002), and (b) over the entire study period, the efficiency improvements were more than offset by the weight of increase in real GDP. In Denmark, at least, it would appear that the Jevons' effect may have occurred as a consequence of conventional ETR measures being unable to limit the overall rate of resource throughput.

**Table 2** Ecological tax reform performance of Denmark, 1990–2002

Year	Real GDP (DKK billions) (1995 prices)		Real GDP/CO <sub>2</sub> emissions ratio (DKK per tonne) (1990 = 100.0)		Index of real GDP/CO <sub>2</sub> (1990 = 100.0)		Employment numbers (000s)		Unemployment rate (%)		Real GDP/empl. ratio (DKK per emp. person) (adj)		ETR environmental element		ETR employment element	
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
1990	915.9	52,886	100.0	17,318.7	100.0	2,066.2	9.7	443,286.7								
1991	926.1	63,559	120.2	14,571.2	84.1	2,044.3	10.6	453,030.4								
1992	931.8	57,755	109.2	16,133.4	93.2	2,059.0	11.3	452,543.0								
1993	931.8	60,060	113.6	15,514.0	89.6	2,046.1	12.4	455,389.8								
1994	982.7	63,663	120.4	15,436.0	89.1	2,056.9	12.3	477,759.7								
1995	1,009.8	60,609	114.6	16,660.2	96.2	2,088.2	10.4	483,553.3								
1996	1,035.2	74,035	140.0	13,982.4	80.7	2,121.6	8.9	487,928.5								
1997	1,065.9	64,524	122.0	16,519.9	95.4	2,194.0	7.9	485,838.2								
1998	1,092.2	60,409	114.2	18,080.7	104.4	2,244.4	6.6	486,649.9								
1999	1,121.0	57,523	108.8	19,488.2	112.5	2,238.7	5.7	500,745.5								
2000	1,152.8	53,076	100.4	21,719.2	125.4	2,251.2	5.4	512,067.8								
2001	1,167.8	54,615	103.3	21,382.7	123.5	2,261.2	5.2	516,458.1								
2002	1,173.7	54,287	102.6	21,620.0	124.8	2,231.9	5.2	525,869.0								

Notes: A Many energy taxes replaced with 100 DKK/tCO<sub>2</sub> (effective for h/holds on 15 May 1992; effective for industry and commercial sectors on 1 January 1993)

B Reduction in tax to 50 DKK/tCO<sub>2</sub> for manufacturers; other energy tax refunds for industry

C Labour taxes reduced by 2.2% of GDP; marginal tax rates on income to fall by 10% by 1998

D 200 DKK/tCO<sub>2</sub> with concessions for some production processes

E 400 DKK/tCO<sub>2</sub> with reduced concessions for some production processes

F Employee's social security contributions reduced (0.11% in 1997; 0.27% in 1998; 0.32% in 1999; 0.53% in 2000)

G 600 DKK/tCO<sub>2</sub> with reduced concessions for some production processes

H Further reduced concessions on CO<sub>2</sub> taxes for some production processes

I Income tax rates reduced from 1999 to 2002 (–6.2 bn DKK by 2002)

J Increases in green taxes from 2000 to 2002 (+5.6 bn DKK by 2002)

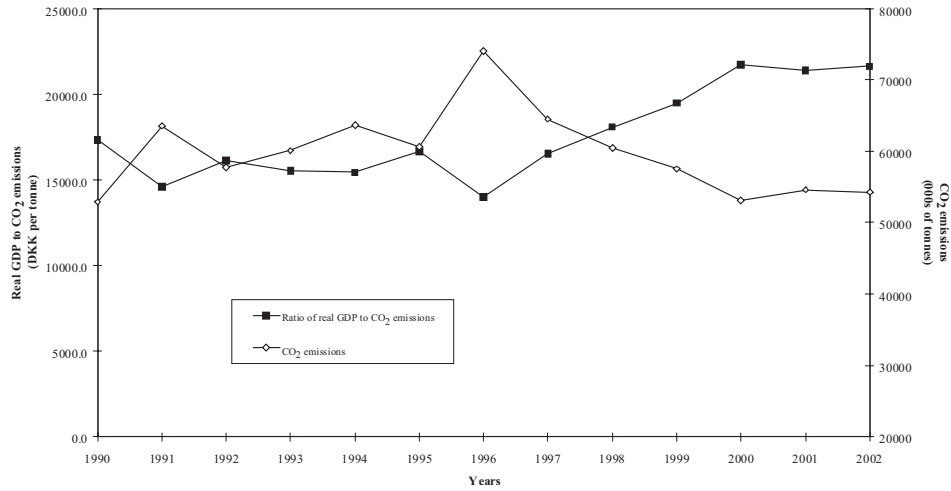
Sources: a Statistics Denmark, [www.statbank.dk/statbank5a/default.asp?w=1024](http://www.statbank.dk/statbank5a/default.asp?w=1024)

b Statistics Denmark, [www.statbank.dk/statbank5a/SelectVarVal/saveselections.asp](http://www.statbank.dk/statbank5a/SelectVarVal/saveselections.asp) (LUFF14: Emissions of greenhouse gases by type, source, and unit)

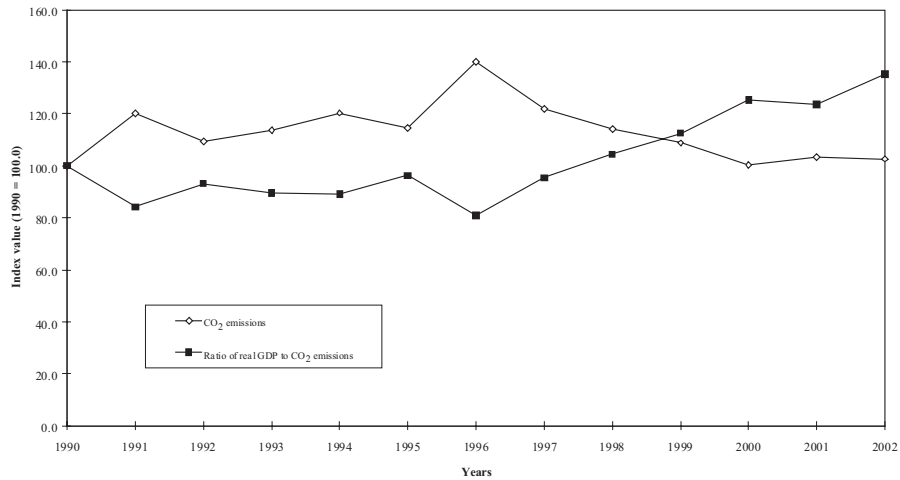
f Statistics Denmark, [www.statbank.dk/statbank5a/SelectVarVal/saveselections.asp](http://www.statbank.dk/statbank5a/SelectVarVal/saveselections.asp) (BESK1C: Full-time equivalent employment by sector (non-seasonal adjustment))

g Statistics Denmark, [www.statbank.dk/statbank5a/default.asp?w=1024](http://www.statbank.dk/statbank5a/default.asp?w=1024) (AARD: Unemployed in percent of labour force by region and sex (year))

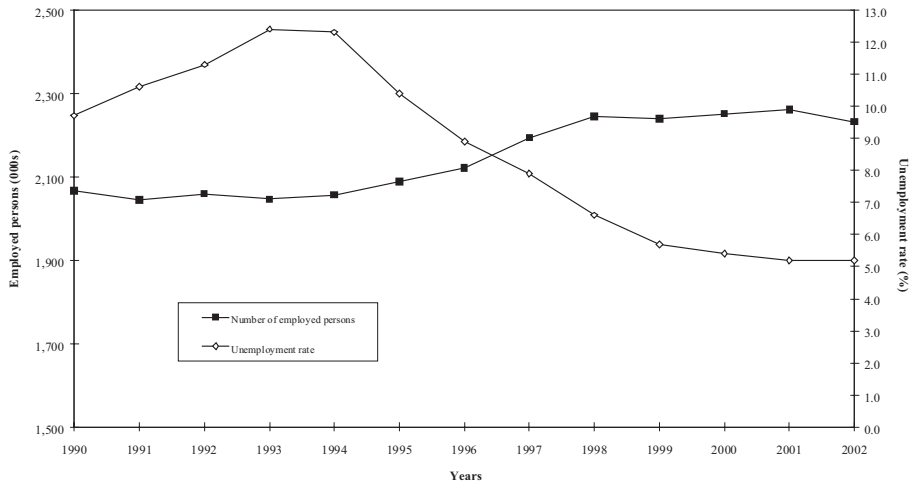
**Figure 4** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Denmark, 1990–2002



**Figure 5** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Denmark, 1990–2002 (1990 = 100.0)



Not unlike the Swedish case, the employment impact of Denmark’s ETR measures are inconclusive (see Figure 6). Similar to Sweden, Denmark also suffered a recession in the early 1990s, although less severe, which led to employment numbers falling and a resultant rise in the unemployment rate. However, because the unemployment rate was already high in 1990 at 9.7%, the rise to 12.4% by 1993 was smaller in magnitude than the Swedish case (Column g of Table 2).

**Figure 6** Employed persons and unemployment rate of Denmark, 1990–2002

From 1993 to the end of the study period, Denmark's unemployment rate fell in each year. By 2002, it was down to 5.2%. In stark contrast to Sweden, the fall in the unemployment rate, particularly following the 1997 ETR measures, was accompanied by only a very small increase in employment numbers. Indeed, the unemployment rate declined in 1999 and remained steady in 2002 despite employment numbers falling slightly. This suggests that the Danish Government's ETR policies have been more successful in reducing the labour force participation rate and increasing the attractiveness of employing labour. By doing so, the Danish approach may be averting the policy conflict between unemployment and environmental goals.

#### 4.2.3 *The Netherlands*

Whilst a general fuel charge was first introduced in The Netherlands in 1988, it was not until 1992 that it was transformed by the Dutch Government into a general fuel tax as a means of collecting tax revenues on all fossil fuels (Hoerner and Bosquet, 2001). Notwithstanding this, fuels used as a raw material were exempted from the tax. Importantly, this meant that electricity remained tax-exempt although the energy resources used to generate electricity did not.

As of 1 January 1996, a new approach to fuel taxes was adopted by the Dutch Government. Rather than having a general fuel tax, a regulatory tax was introduced. This new tax was specifically targeted to alter energy use behaviour, with the express aim of increasing the rate of energy efficiency in light of an apparent stagnation in efficiency advances in the first half of the 1990s (see real GDP/CO<sub>2</sub> emissions ratio from 1990 to 1996 in Table 3).



**Table 3** Ecological tax reform performance of The Netherlands, 1990–2002

Year	Real GDP (Euros millions) (1995 prices)	CO <sub>2</sub> emissions (000s tonnes)	CO <sub>2</sub> emissions (1990 = 100.0)	Real GDP/CO <sub>2</sub> emissions ratio (Euros per tonne)	Index of real GDP/CO <sub>2</sub> (1990 = 100.0)	Employment numbers (000s)	Unemployment rate (%)	Real GDP/empl. ratio (Euros per emp.)	ETR environmental element	ETR employment element
	a	b	c	d	e	f	g	h	j	k
1990	272,633	157,893	100.0	1,726.7	100.0	-	6.2	-	-	-
1991	279,442	166,542	105.5	1,677.9	97.2	-	5.6	-	-	-
1992	284,182	163,726	103.7	1,735.7	100.5	-	5.1	-	Fuel tax introduced <sup>A</sup>	-
1993	286,707	167,144	105.9	1,715.3	99.3	-	5.8	-	-	-
1994	294,140	169,846	107.6	1,731.8	100.3	-	6.9	-	-	-
1995	302,804	170,990	108.3	1,770.9	102.6	-	6.7	-	-	-
1996	312,004	178,281	112.9	1,750.1	101.4	6,954	6.2	44,866.8	Fuel taxes modified <sup>B</sup>	Income taxes modified <sup>C</sup>
1997	323,981	175,812	111.3	1,842.8	106.7	7,171	5.0	45,179.3	Energy-saving tax credit <sup>D</sup>	-
1998	338,073	174,440	110.5	1,938.0	112.2	7,371	3.8	45,865.3	-	-
1999	350,614	169,180	107.1	2,072.4	120.0	7,554	3.5	46,414.4	-	-
2000	362,772	173,886	110.1	2,086.3	120.8	7,733	2.9	46,912.2	-	-
2001	366,857	178,213	112.9	2,058.5	119.2	7,830	2.5	46,852.7	-	-
2002	367,224	178,524	113.1	2,057.0	119.1	7,867	2.8	46,679.0	-	-

Notes:

A General fuel tax collected on all fossil fuels; fuels used as raw materials not subject to tax

 B New general fuel tax regime; tax rates on various fuels based on CO<sub>2</sub>/energy content; special exemptions apply

C Employers' social security contributions reduced by 0.19%; tax credit for self-employed increased to NLG 1,300; corporate profits tax reduced; personal tax rate reduced by 0.6%

D 40% tax credit applied to corporate or personal tax base for investment in energy-saving measures

Sources: a Earthtrends; GDP in constant 1995 US dollars

b Earthtrends; Exchange rate

 c Earthtrends; CO<sub>2</sub> emissions

 Statistics Netherlands, <http://statline.cbs.nl/StatWeb/table.asp?LYR=G1-0&LA=en&DM=SL&PA=37221eng&D1=0.3.6.9.12.15.18&D2=0-1.11&HDR=G2&STB=TCBS> Statline, Statistics Netherlands, Table: Air pollution, actual emissions by all sources

 f Statistics Netherlands, <http://statline.cbs.nl/statweb/start.asp?DM=SL&LA=en&lp=applet&THEME=4160>

g CBS Statline, Statistics Netherlands, Table: Working population, by sex

 Blanchard, O. (2002), *A Macroeconomic Survey of Europe*.

One of the key features of the new regulatory tax was its focus on small users of energy. The decision made by the Dutch Government to minimise the burden on large energy-intensive corporations was based on the understanding that:

- the majority of large companies were already bound by agreements to adopt energy-saving measures
- a unilateral CO<sub>2</sub> emissions tax would adversely affect export competitiveness
- large energy-intensive corporations were covered by the general fuel tax.

Despite the focus on small energy users, the economic activities of 95% of all Dutch companies and individuals were covered by the regulatory fuel tax (Hoerner and Bosquet, 2001).

Other important features of the 1996 ETR measures adopted by the Dutch Government were the reductions in the rate of employers' social security contributions, the rise in the tax credit for the self-employed, the 3% cut in the corporate tax rate, and the 0.6% reduction in the personal income tax rate. Designed to be revenue-neutral, these measures ensured the 1996 ETR package incorporated both labour and income tax cuts.

In order to complement the 1996 ETR measures, a 40% tax credit on corporate and personal income was introduced in 1997 for companies and individuals investing in energy-saving measures. A system of voluntary agreements to encourage additional resource-saving investments was also introduced, thereby allowing firms to choose their preferred depreciation schedule for environmental investments (Hoerner and Bosquet, 2001).

Table 3 describes the nature and the timing of the environmental and employment elements of The Netherlands ETR policy (Columns *j* and *k*), while the various indicators in Columns *a–h* reveal the ETR performance of The Netherlands over the period 1990–2002. The more precise details are again found in the notes below Table 3.

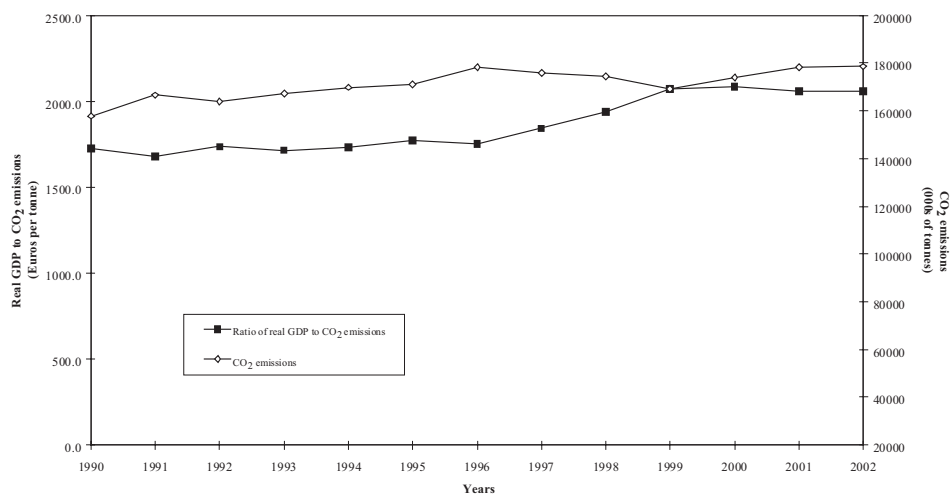
Figure 7 graphically reveals both the CO<sub>2</sub> emissions of The Netherlands (Column *b* of Table 3) and the ratio of its real GDP to CO<sub>2</sub> emissions (Column *d* of Table 3). It can be clearly seen that, prior to the introduction of the regulatory fuel tax in 1996, the 1992 transformation of the general fuel charge to a general fuel tax did little to increase the Dutch efficiency ratio (1,735.7 Euros per tonne of CO<sub>2</sub> emissions in 1992 and 1,750.1 Euros per tonne of CO<sub>2</sub> emissions in 1996). The adoption of the general fuel tax also failed to drastically reduce CO<sub>2</sub> emissions. To the contrary, emissions rose from 163.7 million tonnes in 1992 to 178.3 million tonnes in 1996 – an 8.9% increase in just four years.

Initially, at least, the 1996 introduction of the regulatory fuel tax appears to have had a positive impact on both the Dutch efficiency ratio and total CO<sub>2</sub> emissions. Between 1996 and 1999, the efficiency ratio grew steadily from 1,750.1 to 2,072.4 Euros per tonne of CO<sub>2</sub> emissions. At the same, total CO<sub>2</sub> emissions fell from 178.3 to 169.2 million tonnes.

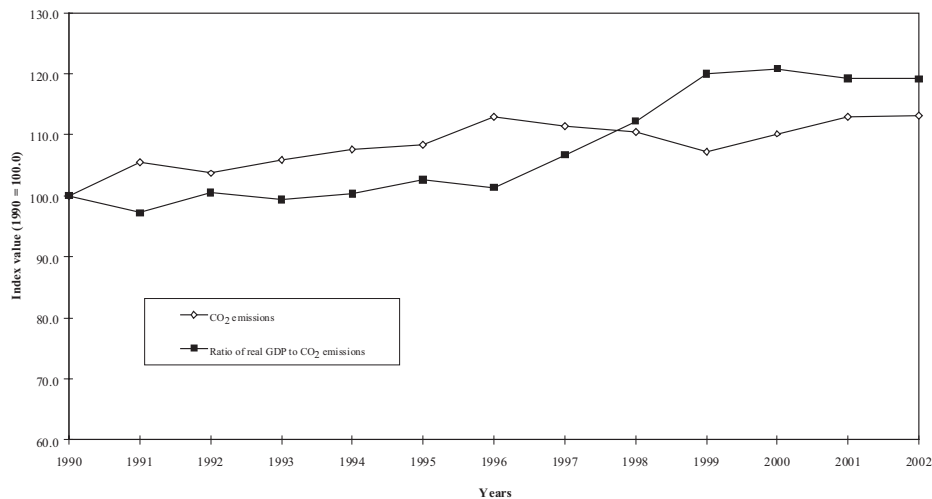
However, the potency of the regulatory fuel tax waned considerably after 1999. Whilst the efficiency ratio rose marginally in 2000, it fell in both 2001 and 2002. Not surprisingly, Dutch CO<sub>2</sub> emissions increased from 1999 to 2002. Worse still, at 178.5 million tonnes in 2002, CO<sub>2</sub> emissions were slightly advanced of their 1996 peak.

The trend change in the efficiency ratio and CO<sub>2</sub> emissions is starkly evidenced by the index values of both indicators presented in Figure 8 (also Columns *c* and *e* of Table 3). Although both indicators moved in opposite directions in most years during the study period, this was not the case during the short period prior to the introduction of the regulatory fuel tax in 1996. The same occurred following the apparent impotency of the tax after 1999. As a consequence, it was only during the rapid efficiency-advancing period of 1996–1999, following the imposition of the regulatory fuel tax, that efficiency increases reduced environmental stress levels in The Netherlands.

**Figure 7** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of The Netherlands, 1990–2002



**Figure 8** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of The Netherlands, 1990–2002 (1990 = 100.0)



Over the entire study period (1990–2002), the real GDP/CO<sub>2</sub> emissions ratio increased by 19.1% while Dutch CO<sub>2</sub> emissions rose by 13.1%. Clearly, the scale impact of a rising real GDP completely overwhelmed the efficiency improvements induced by the ETR measures implemented by the Dutch Government. Moreover, something resembling the Jevons' effect appears to have taken place after 1999.

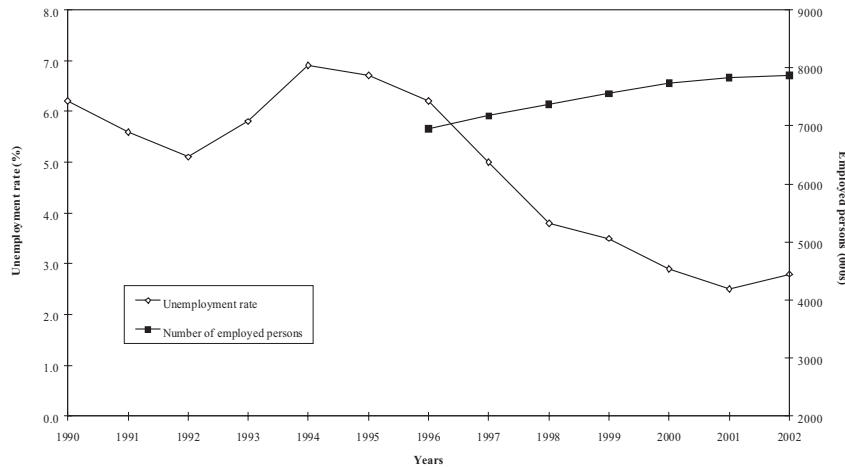
It should be noted, however, that the efficiency advances achieved in The Netherlands (+19.1%) were much lower than the gains experienced in both Sweden (+35.1%) and Denmark (+24.8%). As such, one might reasonably question whether the ETR measures introduced in The Netherlands were as potent and/or as appropriately targeted as those imposed in both Sweden and Denmark. Furthermore, it begs the question as to whether a better designed ETR package in The Netherlands might have increased efficiency levels sufficiently enough to have prevented the rise in Dutch CO<sub>2</sub> emissions, particularly after 1999. Thus, despite the strong evidential support for the ecological economic position on conventional ETR measures, the position is not conclusively proven in the Dutch case.

The employment implications of the Dutch ETR measures are difficult to assess because of the lack of employment numbers for the period 1990–1995. This aside, Figure 9 suggests that the Dutch unemployment rate was much less volatile than in Sweden and Denmark. In addition, the unemployment rate never reached the 1993 heights of 9.6% in Sweden and 12.4% in Denmark (note: the Dutch rate peaks at 6.9% in 1994). The lower unemployment rate in The Netherlands can be largely attributed to institutional factors and labour market programmes explicitly undertaken by the Dutch Government policy to keep unemployment as low as possible.

Figure 9 and Column *g* in Table 3 indicate that the Dutch unemployment rate fell more sharply following the income tax rate cuts and the reduction in employers' social security contributions in 1996. Indeed, without any additional rate of growth in real GDP from 1996 to 2001, the unemployment rate rapidly declined from 6.2% to 2.5%. It is also interesting to note that the real GDP/employment ratio of The Netherlands (Column *h* in Table 3) did not vary much between 1996 and 2002. There were, conversely, much greater increases in the real GDP/employment ratio for both Sweden and Denmark during this period (Column *h* in Tables 1 and 2). In a relative sense, this indicates that the employment elements of the Dutch ETR measures were better able to maintain if not increase the attractiveness of labour as real GDP continued to grow and as CO<sub>2</sub> emissions predominantly fell in the post-1996 period. In other words, there was a greater degree of substitution between labour and energy in The Netherlands than in Sweden and Denmark.<sup>7</sup>

#### 4.2.4 *Finland*

In 1990, Finland became the first country to introduce an environmentally-motivated CO<sub>2</sub> tax. However, the tax was, until 1994, based entirely on a fuel's carbon content. During the period 1994–1996, the Finnish Government varied the environmental component of the tax to reflect a fuel's carbon and energy content (based on a 60:40 ratio). Except for electricity generation, this variation of the tax was reversed in 1997 (Hoerner and Bosquet, 2001). Nevertheless, the tax rate on the carbon content was increased significantly at the beginning of each year between 1996 and 1999 (from 14 FIM per tonne of CO<sub>2</sub> emissions in 1996 to 102 FIM per tonne of CO<sub>2</sub> emissions by 1999).

**Figure 9** Employed persons and unemployment rate of The Netherlands, 1990–2004

Finland's tax shifting measures began to resemble the conventional ETR model in 1997 following cuts to personal income tax rates and employers' social security contributions. Following an agreement between private corporations and labour unions to limit wage rises in 1998 and 1999, the Finnish Government cut labour taxes by a further FIM 1.5 billion in 1998 and FIM 3.5 billion in 1999 (Hoerner and Bosquet, 2001). During these two years it was predicted that government tax revenues would decline by FIM 1.5 billion and FIM 2.5 billion, respectively. As a consequence, the Finnish Government was able to allay the public fears of an increased tax burden by adopting a short-term budget-deficit approach in the knowledge that the deficit was likely to diminish in the medium- and long-term in response to increasing tax revenues brought about by rising employment levels.

Columns *j* and *k* in Table 4 summarise the environmental and employment elements of Finland's ETR. Columns *a–h* reveal the various indicators relevant to Finland's ETR performance over the study period (1990–2002), while the precise nature of the ETR measures are explained in the notes below the table.

Finland's CO<sub>2</sub> emissions (Column *b* of Table 4) and the ratio of Finland's real GDP to CO<sub>2</sub> emissions (Column *d* of Table 4) are graphically presented in Figure 10 below. Figure 10 shows that the CO<sub>2</sub> tax introduced in 1990 and its modification in the mid-1990s had no positive effect on Finland's efficiency ratio. Between 1990 and 1996, the real GDP/CO<sub>2</sub> emissions ratio actually declined slightly from 1,539 to 1,413 Euros per tonne – an 8.2% fall. At the same time, total CO<sub>2</sub> emissions rose from 70.5 million to 76.9 million tonnes – a 9.1% increase.

The more significant CO<sub>2</sub> tax rate rises imposed between 1996 and 1999 triggered an immediate and dramatic reversal. Between 1996 and 2000, the real GDP/CO<sub>2</sub> emissions ratio shot up by 33.3% from 1,413 to 1,884 Euros per tonne, while total CO<sub>2</sub> emissions fell to 70.2 million tonnes – an 8.7% decrease over the four years and a level lower than that generated in 1990. Strangely, despite no change to the CO<sub>2</sub> tax rate, the efficiency of resource use fell slightly in both 2001 and 2002. With real GDP still rising, CO<sub>2</sub> emissions increased beyond their 2000 levels to 77.3 million tonnes by the end of the study period.

**Table 4** Ecological tax reform performance of Finland, 1990–2002

Year	Real GDP (Euros billions) (2000 prices)		Real GDP/CO <sub>2</sub> emissions ratio (Euros per tonne) (1990 = 100.0)		Index of real GDP/CO <sub>2</sub> (1990 = 100.0)		Employment numbers (000s)		Unemployment rate (%)		Real GDP/empl. ratio (Euros per emp. person) (1990 = 100.0)		ETR environmental element		ETR employment element		
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	
1990	108.5	70,500	100.0	1,539.0	100.0	–	–	–	–	–	–	–	–	–	–	–	–
1991	102.2	69,500	98.6	1,469.9	95.5	–	–	–	–	–	–	–	–	–	–	–	–
1992	99.0	66,800	94.8	1,481.8	96.3	–	–	–	–	–	–	–	–	–	–	–	–
1993	98.2	67,900	96.3	1,446.5	94.0	–	–	–	–	–	–	–	–	–	–	–	–
1994	101.1	74,400	105.5	1,358.4	88.3	–	–	–	–	–	–	–	–	–	–	–	–
1995	104.8	71,600	101.6	1,463.4	95.1	2,099	15.4	49,919.0	–	–	–	–	–	–	–	–	–
1996	108.7	76,900	109.1	1,412.9	91.8	2,127	14.6	51,081.3	–	–	–	–	–	–	–	–	–
1997	115.3	76,000	107.8	1,516.7	98.5	2,169	12.7	53,143.4	–	–	–	–	–	–	–	–	–
1998	121.2	72,900	103.4	1,663.2	108.1	2,222	11.4	54,566.2	–	–	–	–	–	–	–	–	–
1999	126.0	72,500	102.8	1,737.4	112.9	2,296	10.2	54,860.6	–	–	–	–	–	–	–	–	–
2000	132.3	70,200	99.6	1,884.2	122.4	2,335	9.8	56,647.5	–	–	–	–	–	–	–	–	–
2001	135.8	75,800	107.5	1,791.0	116.4	2,367	9.1	57,354.9	–	–	–	–	–	–	–	–	–
2002	138.0	77,300	109.6	1,785.1	116.0	2,372	9.1	58,174.1	–	–	–	–	–	–	–	–	–

Notes: A Energy tax on various fuels based on the fuel's carbon content (6.7 FIM/TCO<sub>2</sub>)

B Tax rates on carbon component of fuels increased to 14 FIM/CO<sub>2</sub>

C Energy tax rates adapted to be based on both carbon and energy contents (60:40 ratio)

D Energy tax based solely on carbon component, except for electricity; tax rates on carbon component of fuels increased to 38 FIM/CO<sub>2</sub>

E Tax rates on carbon component of fuels increased to 71 FIM/CO<sub>2</sub>

F Reductions in personal income tax rates; reduced employer social security contributions

G Tax rates on carbon component of fuels increased to 82 FIM/CO<sub>2</sub>

H Labour taxes reduced by FIM 1.5 bn (0.25% of GDP)

I Tax rates on carbon component of fuels increased to 102 FIM/CO<sub>2</sub>

J Labour taxes reduced by FIM 3.5 bn (0.5% of GDP)

Sources:

a [www.odyssee-indicators.org/Publication/PDF/fimland\\_r04.pdf](http://www.odyssee-indicators.org/Publication/PDF/fimland_r04.pdf)

b Statistics Finland, [www.stat.fi/tup/suoluk/suoluk\\_kansantalous\\_en.html](http://www.stat.fi/tup/suoluk/suoluk_kansantalous_en.html) (Gross Domestic Product at market prices, 1995–2004)

c Statistics Finland, [www.stat.fi/tk/yr/khkaasut\\_uusin\\_paatolaskelma\\_en.html](http://www.stat.fi/tk/yr/khkaasut_uusin_paatolaskelma_en.html) (Finland's greenhouse gas emissions by gas, 1990–2003)

d Statistics Finland, [www.stat.fi/tup/suoluk/suoluk\\_tyoelama\\_en.html](http://www.stat.fi/tup/suoluk/suoluk_tyoelama_en.html) (Labour market, population by activity)

**Figure 10** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Finland, 1990–2002

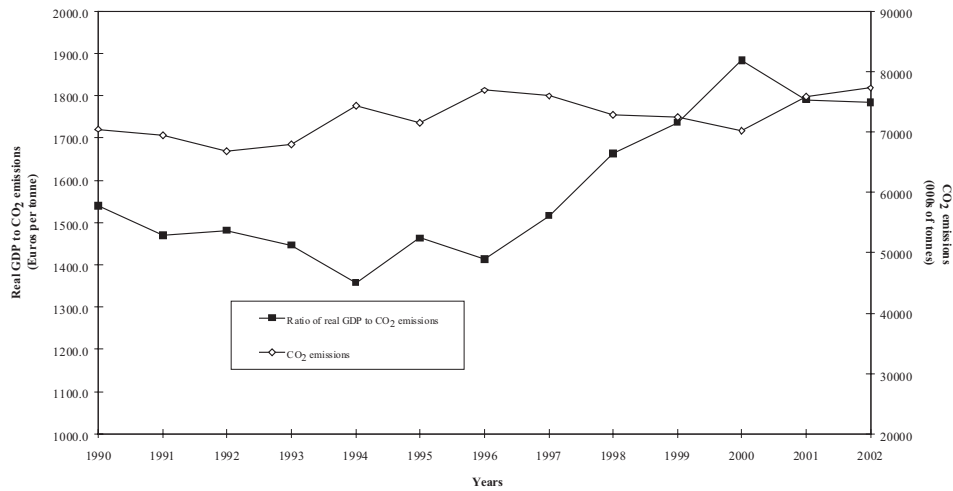
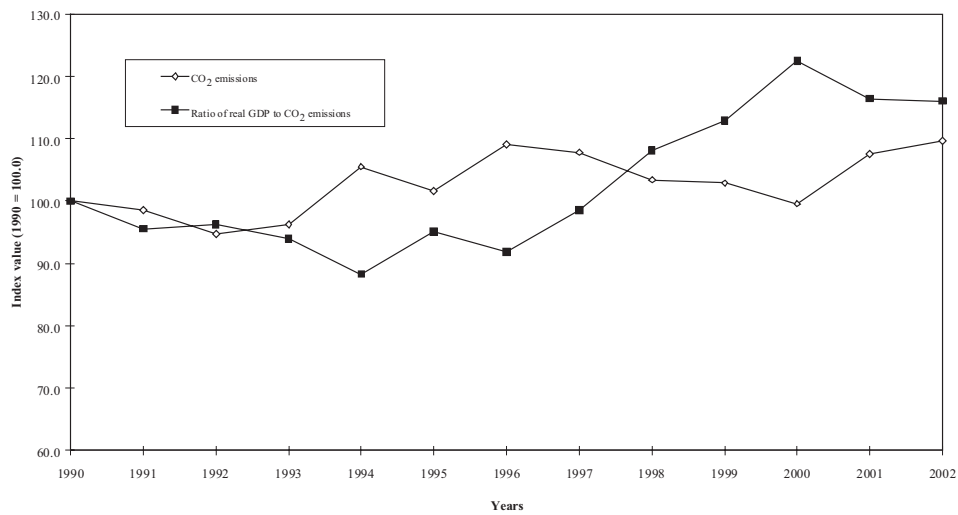


Figure 11 graphically presents the index values of the efficiency ratio and CO<sub>2</sub> emissions so as to reveal the trend change in both indicators (also Columns *c* and *e* of Table 4). In the very early stages (1990–1993), both indicators trend downwards – largely the consequence of a sharp recession experienced by Finland in the early 1990s. From this point until the end of the study period, both indicators moved in opposite directions. Overall, Finland’s CO<sub>2</sub> emissions rose by 9.6% between 1990 and 2002. What’s more, Finland’s real GDP/CO<sub>2</sub> emissions ratio increased by a mere 16.0%, the lowest of all the four countries examined in this paper.

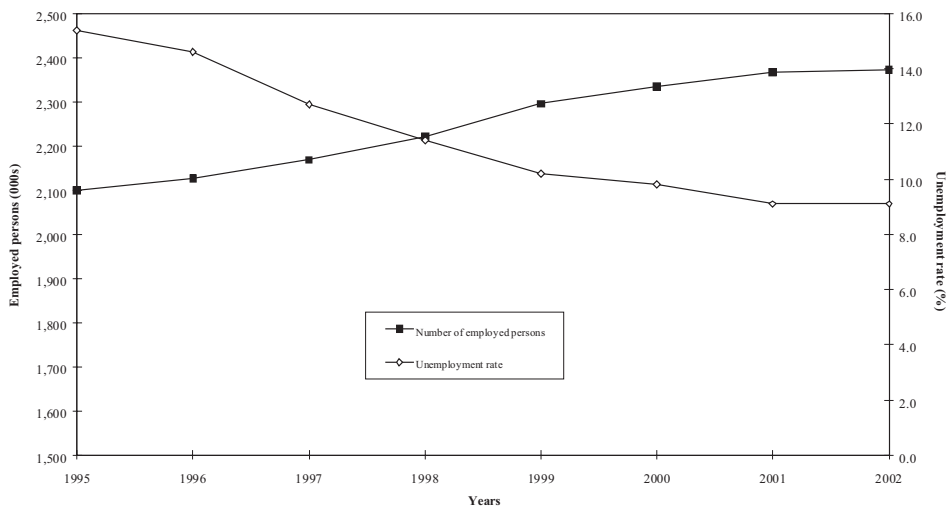
**Figure 11** CO<sub>2</sub> emissions and CO<sub>2</sub> efficiency of Finland, 1990–2002 (1990 = 100.0)



Conclusions regarding the ecological economic position on conventional ETR measures are difficult to make in the Finnish case. This is because each of the years where Finland's efficiency ratio increased, it was accompanied by a fall in Finland's CO<sub>2</sub> emissions. However, efficiency gains were made in only six of the 12 years during the study period. Thus, while at no stage did the scale of economic activity in these six years more than offset the environmental stress-relieving impact of increased efficiency, the efficiency performance of Finland was weak over the study period. Of greater concern is the fact that the Finnish case constitutes a clear example of total CO<sub>2</sub> emissions rising in the face of ETR policies designed to quell their increase. With this last point in mind, the evidence leans more strongly towards the Jevons' effect having taken place in Finland than it having been averted.

Consider, now, Figure 12 which shows the employment impact of the ETR measures introduced by the Finnish Government from 1995 to 2002. Due to a recession as severe in Finland as anywhere else in the industrial world, the unemployment rate reached 15.4% in 1995. By 2002, the unemployment rate had declined to 9.1% – still very high when compared to the other three counties examined in this paper. The fall in the unemployment rate can be mostly attributed to the recovery of the growth rate in real GDP from 1995 to 2002. Whilst the reduction in labour tax rates in 1997, 1998, and 1999 may have had a positive impact on the unemployment rate and the attractiveness of labour, this certainly cannot be concluded from a casual observation of the data in Table 4. If anything, the employment elements of Finland's ETR measures appear to have had very little impact given that the real GDP/employment ratio increased at about the same rate before and after the policies were implemented.

**Figure 12** Employed persons and unemployment rate of Finland, 1995–2002





### 4.3 *Comments on the evidence*

When the evidence of all four countries is drawn together, a relatively clear and uniform picture emerges. It is one which reveals that conventional ETR measures – *i.e.*, taxes on pollution rather than quantitative throughput controls – led to greater efficiency and lower CO<sub>2</sub> emissions, *but only in the short-term*. Whether it be the consequence of diminishing efficiency advances or the scale impact of increased economic activity, conventional ETR measures failed to prevent CO<sub>2</sub> emissions from eventually rising. Worse still, the CO<sub>2</sub> emissions of Finland and the Netherlands were significantly higher at the end of the study period than they were at the beginning. Only in Sweden did CO<sub>2</sub> emissions fall but, as previously highlighted, the decline was a meagre 2.4%. One can therefore conclude that the Jevons' effect generally took place within three to four years of the introduction of ETR.

The employment impact of the tax cuts to labour and income was much less conclusive. About all that can be said about the employment elements of the respective ETR packages was that: (a) the possible tension between the policy goals of ecological sustainability and low unemployment might be far less in Denmark than elsewhere, and (b) some limited degree of substitutability between labour and energy may have occurred in The Netherlands.

In summary, the evidence provided in this paper supports the ecological economic position that conventional ETR measures cannot achieve the double dividend of ecological sustainability and low unemployment. However, the support remains cautionary for a number of reasons. Firstly, the empirical analysis conducted in this paper is based on casual observation of the data presented. The inferences made are not based on rigorous statistical tests.<sup>8</sup> Secondly, it has been assumed that the impact of the introduced policy measures is immediate rather than lagged. Clearly, the duration it takes for ETR policies to impact fully on the economy is a crucial consideration when judging their success or failure. Having said this, the apparent impotency of the ETR measures some three to four years following their imposition suggests that any lagged effect could be negative rather than positive, although it is possible that the policy lag could be a decade or more.

Thirdly, the potential influence of exogenous factors have been overlooked or ignored. There is little doubt that international forces, domestic institutional factors, and government decisions in other policy domains can greatly effect the environmental and employment outcomes of a particular country (Bosquet, 2000). It is conceivable that one or more of these factors may have contributed to the medium-term failure of the conventional ETR measures introduced and not the lack of quantitative throughput controls recommended by many ecological economists.

Finally, it is possible that the ETR measures imposed in all four countries were innocuous or inappropriately targeted. If so, it still leaves open the possibility that better devised ETR policies of the conventional kind could achieve the double dividend of ecological sustainability and low unemployment.

## 5 Concluding remarks

Despite considerable benefits arising from the ETR packages implemented in Sweden, Denmark, The Netherlands, and Finland, their success in terms of reducing CO<sub>2</sub> emissions appear to have been short-lived. Whilst the ETR packages may have had a positive employment effect, the ultimate success of ETR is likely to depend, as some ecological economists believe, on ‘cap and trade’ systems that involve the use of tradeable resource use and pollution permits.

From the point of view of CO<sub>2</sub> emissions and their contribution to global climate change, there would appear to be an urgent need to go beyond carbon taxes and establish carbon trading systems at both the intra- and international levels. Recent statements by the British Prime Minister, Tony Blair, and the introduction of carbon trading initiatives in the US state of California and the Australian states of New South Wales, Victoria, and South Australia are all positive developments. Above all, however, appropriate responses must not continue to be corrupted by mainstream economic arguments that allocative efficiency – facilitated by the internalisation of environmental spillover costs into market prices (*i.e.*, conventional ETR measures) – can deliver sustainable environmental outcomes and, therefore, the double dividend of ecological sustainability and low unemployment.

## References

- Baron, R., Dower, R., Morgenstern, D., Martinez-Lopez, M., Johansen, H., Johnsen, T., Alfsen, K., Ezban, R. and Gronlykke, M. (1996) *Policies and Measures for Common Action*, Annex I Experts Group on the UNFCCC, International Energy Agency, Paris.
- Bosquet, B. (2000) ‘Environmental tax reform: does it work? A survey of the empirical evidence’, *Ecological Economics*, Vol. 34, pp.19–32.
- Cansier, D. and Krumm, R. (1997) ‘Air pollution taxation: an empirical study’, *Ecological Economics*, Vol. 23, pp.59–70.
- Cowling, S., Mitchell, W. and Watts, M. (2006) ‘The right to work versus the right to income’, *International Journal of Environment, Workplace, and Employment*, Vol. 2, No. 1, pp.89–113.
- Daly, H. (1991) *Steady-State Economics*, 2nd ed., Washington, DC: Island Press.
- Daly, H. (1996) *Beyond Growth*, Boston: Beacon Press.
- Ekins, P. (1999) ‘European environmental taxes and charges: recent experience, issues, and trends’, *Ecological Economics*, Vol. 31, pp.39–62.
- Felder, S. and Schleiniger, R. (2002) ‘Environmental tax reform: efficiency and political feasibility’, *Ecological Economics*, Vol. 42, pp.107–116.
- Forstater, M. (2004) ‘Green jobs: addressing the critical issues surrounding the environment, workplace and employment’, *International Journal of Environment, Workplace, and Employment*, Vol. 1, No. 1, pp.53–61.
- Goulder (1995) ‘Effects of carbon taxes in an economy with prior tax distortions: an intertemporal general equilibrium analysis’, *Journal of Environmental Economics and Management*, Vol. 29, No. 3, pp.271–297.
- Harrison, G. and Kriström, B. (1999) ‘General equilibrium effects of increasing carbon taxes in Sweden’, in R. Brännlund and I-M. Gren (Eds.) *Green Taxes*, Cheltenham, UK: Edward Elgar.
- Hoerner, J.A. and Bosquet, B. (2001) *Environmental Tax Reform: The European Experience*, Centre for a Sustainable Economy, Washington, DC.

- Howarth, R. and Norgaard, R. (1990) 'Intergenerational resource rights, efficiency, and social optimality', *Land Economics*, Vol. 66, pp.1–11.
- Larsen, B. and Nesbakken, R. (1997) 'Norwegian emissions of CO<sub>2</sub> 1987–1994: a study of some effects of the CO<sub>2</sub> tax', *Environmental and Resource Economics*, Vol. 9, No. 3, pp.275–290.
- Lawn, P. (2000) 'Ecological tax reform: many know why but few know how', *Environment, Development, and Sustainability*, Vol. 2, pp.143–164.
- Lawn, P. (2003) 'How important is natural capital in terms of sustaining real output? Revisiting the natural capital/human-made capital substitutability debate', *International Journal of Global Environmental Issues*, Vol. 3, No. 4, pp.418–435.
- Lawn, P. (2004a) 'Environment, workplace, and employment: an introduction', *International Journal of Environment, Workplace, and Employment*, Vol. 1, No. 1, pp.4–39.
- Lawn, P. (2004b) 'How well are resource prices likely to serve as indicators of natural resource scarcity?', *International Journal of Sustainable Development*, Vol. 7, No. 4, pp.369–397.
- Lawn, P. (forthcoming) *Frontier Issues in Ecological Economics*, Cheltenham, UK: Edward Elgar.
- O'Riordan, T. (Ed.) (1997) *Ecotaxation*, Earthscan, London.
- Roodman, D. (1998) *The Natural Wealth of Nations*, Worldwatch Institute, Washington, DC.
- Statistics Norway (various) (1999–2002) *National Accounts and the Environment: Table 1 – Norway's Total Value Added, Employment, and Air Emissions*, www.ssb.no.
- Swedish Environmental Protection Agency (EPA) (1997) 'Environmental taxes in Sweden: economic instruments of environmental policy', *Report*, Swedish EPA, Stockholm, No. 4745.
- Tindale, S. and Holtham, G. (1996) *Green Tax Reform: Pollution Payments and Labour Tax Cuts*, Institute for Public Policy Research, London.
- Victor, P. (forthcoming) 'Managing without growth', *Ecological Economics*.
- World Resources Institute (WRI) (various) *EarthTrends – Climate and Atmosphere*, <http://earthtrends.wri.org> – Air Pollution: Nitrogen oxide emissions.

## Notes

- 1 A more detailed description of a system of tradeable resource use permits can be found in Lawn (forthcoming).
- 2 It is the constrained supply forces that ensures ecological limits are internalised into resource prices.
- 3 Of course, whether permit systems achieve ecological sustainability still depends on the rate of throughput being within the regenerative and waste assimilative capacities of the natural environment which, moreover, depends upon the human capacity to determine such a rate and auctioning the appropriate number of permits. Should the sustainable rate of throughput be overestimated and too many permits are auctioned, ecological sustainability will not be achieved. Since the natural environment is a complex system whereby exact knowledge of the sustainable limit is infeasible, a precautionary approach should be adopted. That is, for example, the number of permits auctioned should approximate around 75% of the estimated sustainable rate of throughput.
- 4 To understand what is meant by low and high entropy matter-energy, the importance of the first and second laws of thermodynamics must be revealed. The first law of thermodynamics is the *law of conservation of energy and matter*. It declares that energy and matter can never be created or destroyed. The second law is the *Entropy Law*. It declares that whenever energy is used in physical transformation processes, the amount of usable or 'available' energy always declines. While the first law ensures the maintenance of a given quantity of energy and matter, the Entropy Law determines that which is usable. This is critical since, from a physical viewpoint, it is not the total quantity of matter-energy that is of primary concern, but the amount that exists in a readily available form.

The best way to illustrate the relevance of these two laws is to provide a simple example. Consider a piece of coal. When it is burned, the matter-energy embodied within the coal is transformed into heat and ash. While the first law ensures the total amount of matter-energy in the heat and ashes equals that previously embodied in the piece of coal, the second law ensures the usable quantity of matter-energy does not. In other words, the dispersed heat and ashes can no longer be used in a way similar to the original piece of coal. To make matters worse, any attempt to reconcentrate the dispersed matter-energy, which requires the input of additional energy, results in more usable energy being expended than that reconcentrated. Hence, all physical transformation processes involve an irrevocable loss of available energy or what is sometimes referred to as a 'net entropy deficit'. This enables one to understand the use of the term *low entropy* and to distinguish it from *high entropy*. Low entropy refers to a highly ordered physical structure embodying energy and matter in a readily available form, such as a piece of coal. Conversely, high entropy refers to a highly disordered and degraded physical structure embodying energy and matter that is, by itself, in an unusable or unavailable form, such as heat and ash. By definition, the matter-energy used in economic processes can be considered low entropy resources whereas unusable by-products can be considered high entropy wastes.

- 5 For those interested in a few of the more elaborate simulation exercises, see Goulder (1995), Cansier and Krumm (1997), Tindale and Holtham (1996), Baron *et al.* (1996), and Harrison and Kriström (1999).
- 6 Stationary sources in the manufacturing and services sectors along with stationary and mobile sources in the case of households represents approximately 40% of Norway's CO<sub>2</sub> emissions.
- 7 There is, nonetheless, a severe limit on the substitutability of labour for energy. To understand why, see Lawn (2003).
- 8 Rigorous statistical analysis of the impact of ETR is the subject of my current research in this area. More conclusive results can be expected in the foreseeable future.