Does the mixture of policy instruments matter?
An empirical test of government support for the private provision of public goods

Arjen Mulder

ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2004-073-F&A
Publication	July 2004
Number of pages	45
Email address corresponding author	amulder@rsm.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Rotterdam School of Economics Erasmus Universiteit Rotterdam P.O. Box 1738 3000 DR Rotterdam, The Netherlands Phone: + 31 10 408 1182 Fax: + 31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

Bibliographic data and classifications of all the ERIM reports are also available on the ERIM website:
www.erim.eur.nl

ERASMUS RESEARCH INSTITUTE OF MANAGEMENT

REPORT SERIES
RESEARCH IN MANAGEMENT

BIBLIOGRAPHIC DATA AND CLASSIFICATIONS		
Abstract	Governments wishing to encourage the private sector provision of a public good can choose amongst a wide variety of economic instruments. This paper analyses how governments in the EU(15) countries have succeeded in stimulating investment in wind turbines between 1985 and 2000, using national laws and decrees, IEA/OECD data on wind turbines, and one hypothetical investment project to calculate Tobin's *Q*. The main question addressed is whether the portfolio of policy instruments matters, or whether government support for the private provision of a public good is a matter of a pecuniary transferral.	
Library of Congress Classification (LCC) LCC Webpage	Mission: HF 5001-6182	
	Programme: HF 4001-4280.7	
	Paper: HJ 193	Public Goods, public finance
Journal of Economic Literature (JEL) JEL Webpage	Mission: M	
	Programme : G 3	
	Paper: E62, H23, H41, Q48	Fiscal Policy, Public Expenditures Externaties Public Goods Energy Government Policy
Gemeenschappelijke Onderwerpsontsluiting (GOO)		
Classification GOO	Mission: 85.00	
	Programme: 85.30	
	Paper: 83.52	Overheidseconomie
Keywords GOO	Mission: Bedrijfskunde / Bedrijfseconomie	
	Programme: Financieel management, besliskunde	
	Paper: Public Goods, Particuliere sector, Windturbines, EU-landen, 1985-2000,	
Free keywords	Private provision of public goods, Tobin'sQ, subsidies, fiscal investment incentives, renewable energy	

Does the mixture of policy instruments matter? An empirical test of government support for the private provision of public goods

Arjen Mulder
Rotterdam School of Management, Erasmus University

This version: August 6, 2004

Abstract

Governments wishing to encourage the private sector provision of a public good can choose amongst a wide variety of economic instruments. This paper analyses how governments in the EU(15) countries have succeeded in stimulating investment in wind turbines between 1985 and 2000, using national laws and decrees, IEA/OECD data on wind turbines, and one hypothetical investment project to calculate Tobin's Q. The main question addressed is whether the portfolio of policy instruments matters, or whether government support for the private provision of a public good is a matter of a pecuniary transferral.

keywords: Private provision of public goods, Tobin's Q, subsidies, fiscal investment incentives, renewable energy

J.E.L. codes: E62, H23, H41, Q48

Contact information:
Arjen Mulder
Office F4.67
Rotterdam School of Management
Erasmus University
P.O. Box 1738
3000 DR Rotterdam
The Netherlands
Phone: +31 10 408 1929
E-mail: amulder@rsm.eur.nl

1 Introduction

Government support for the private provision of public goods is a much-debated issue in the public economics literature. If voluntary contributions to the public good provision were the base case, then each individual might contribute as much as she values the public good which (ignoring the free rider problem) should yield an efficient outcome. Both the free rider problem and the impossibility of government to impose taxation based upon individual preferences result in inefficient taxation, and therewith in an inefficient private provision of a public good. Kirchsteiger and Puppe (1997), for example, show how taxation may indeed raise the total supply of a public good, but the taxation is unlikely to match the individual utility of the good, a result which can also be found in Lahiri and Raimondos-Moeller (1998). The 'crowding-out thesis' shows how government support on top of voluntary contributions leads to a 'dollar-to-dollar decrease' in the voluntary contributions (see e.g. Roberts (1987), Andreoni (1993), or Nyborg and Rege (2003)). In spite of all inefficiencies associated with each possible type of taxation, fiscal and financial support still remain important instruments for encouraging the private provision of public goods.

Independent the economic arguments against taxation and government support, this paper addresses the question whether government support works in the encouragement of private provision of public goods. Using a multi-case study, it analyses the effect of green policies of the EU(15) countries on wind turbine investments in the 1985-2000 period. The effects of these policies are evaluated by means of a uniform hypothetical investment project in a 1MW wind power plant for an overall evaluation criterion is proposed, based on Tobin's Q. The following specific questions will be addressed. First, why would government support be necessary? Does the base-case yield sufficient financial attractiveness for private sector investments, or do private sector investors need additional support? Second, what support schemes are offered, and how do they affect the Q of the investment project? Third, does the private sector provide the public good if Q becomes nonnegative? In other words, should Q exceed unity for investors, or are nonnegative values sufficient? Given both the present value of the support schemes, and given the response in investments, how have governments implicitly valued the public good? In other words, how much value-for-money have the taxpayers received?

2 An evaluation criterion

Government support for the private provision of public goods through non-coercive instruments can *de facto* be considered a nested optimisation problem within which government designs a support scheme based on the anticipated response of the entrepreneurs. Therefore, any evaluation criterion to be used here must take into account *when* it is economically attractive for firms to invest. If the government support schemes analysed would only consist of fiscal measures, then the calculation of an adjusted net corporate tax rate (*cf.* EC (2001), or Devereux and Griffith (1998)) would be a logical choice. The green policies of the EU(15) countries for the stimulation of wind turbine investments, however, consisted of a wide variety of both fiscal and financial incentives, making it difficult to determine tax rates as referred to above.

Now it might be possible to come up with a utility maximisation problem, where firms maximise profits, and government her overall utility of the provision of the public good (adjusted for the support given). Unfortunately, however, in the absence of a uniformly accepted valuation method for the public good 'clean air' (particularly when analysing multiple countries over a longer time horizon), this exercise would become a theoretical one, difficult to put into operation. Therefore, the focus is initially directed towards finding the minimal participation constraints for the private sector to invest, and then analyse the suitable government policies that should give the incentive to invest. The calculation of the firms' participation constraint forms the input for government's expenditure minimisation problem. The entire model floats on the intuition provided by Baumol (1990). In that paper, Baumol shows how governments may influence the private sector's activities without altering the preference structure of firms. All government has to do is altering the payoff structure of the different production options available to these firms.

A model that meets the criteria of calculating the corporate participation constraint, while capable of incorporating any type of fiscal or financial incentive, translated into a uniform evaluation criterion is the combination of the Hall-Jorgensonian neoclassical investment model, combined with Tobin's Q. The generalised forms of that combined model is readily worked out by authors as Hayashi (1982), Auerbach (1983), or Abel, Dixit, Eberly, and Pindyck (1996). Although the current paper formalises some additional functional forms of the fiscal and financial incentives observed in the field, its main contribution lies in the empirical test, rather than in the model itself.

2.1 A model

Wind turbines produce a private good 'electricity', X, sold at p_x, and a public good 'avoided emissions', Y, which stems from a linear relationship with X:

$$Y_{jt} = \theta_{jt} * X_{jt} \tag{1}$$

where θ_{jt} represents the avoided emissions in country j during year t. Firms investing in wind turbines only receive the electricity wholesale market price, p_x, which is insufficient to make a profit.[1] Let w_t be the wind regime determining total output of X. The wind regime may vary over time and particularly geographical space. The public good Y arises costless as a direct spin-off of the production of X. Wind turbines, installed in isolation or grouped as a wind power plant, seem to be characterised by constant returns-to-scale.[2] The production technology yields a net income R_t, net of production costs $C(X, k)$ where k is capital stock:

$$R_t = p_{xt} w_t X_t(k_t) - w_t C_t(X_t, k_t) \tag{2}$$

[1] I.e., wind turbine plants are price-takers in the market for the private good. If they were not, they might have added a mark-up on the private good in order to compensate for the costlier production technology that also yields a public good (cf. the lighthouse in economics problem, specified by Coase (1974)). Obviously, such setting requires a different optimisation technique, for which it turns out very difficult to calculate an observable Q (see Hayashi (1982)).

[2] See, for example, a recent Worldbank paper 'Statistical analysis of wind farm costs and policy regimes', available at: www.worldbank.org/astae/windfarmcosts.pdf.

for which the evolution of the firm's capital stock is described as follows. Let the next-period value of the firm's capital k_{t+1} be represented by:

$$k_{t+1} = (1 - \delta)k_t + \psi(I_t) \tag{3}$$

where δ is the *physical* depreciation rate (see Abel (1982)), and I_t the investment in capital goods at time t. Since not all investments I_t are necessarily turned into capital, Uzawa (1969) introduces the so-called 'installation function' $\psi(I_t)$, which implies that only $\psi * I_t$ percent of investment is turned into capital. Note that, when defining $\dot{k} \equiv k_t - k_{t-1}$, then (3) can be rewritten as:

$$\dot{k} = -\delta k_t + \psi(I_t) \tag{4}$$

This expression provides the necessary condition for maintaining a long-run capital stock, constant over time (*cf.* Gould (1968)). Let the initial present value of a firm now be given by:

$$V_0 = \int_{t=0}^{\infty} \pi_t e^{-r_{wacc}t} dt \tag{5}$$

where π_t are the after-tax net profits, discounted at the CAPM-based average cost of capital, r_{wacc}, for which:

$$\pi_t = (1 - T_c)R_t + T_c(r_{dt}D_t + Depr_t m_t I_t) - (1 - S_{inv})m_t I_t + \int_0^{\infty} A_{s,t-s} ds \tag{6}$$

where T_c is the corporate tax rate, $T_c Depr_t m_t I_t$ the tax shield on the economic depreciation $Depr_t$, applicable to the initial investment. Investments may be subsidised or given another rebate at rate S_{inv} in year 0. All allowances applicable to past investments of age s are captured in the last integral, $A_{s,t-s}$, referring to the sum of all allowances for investments of age s, concerning policies initiated at time $t - s$. The idea behind this notion of age is that changes in policies do not have a retrospective effect. In order to avoid the necessity for adjusting these equations for each individual economic instrument analysed in this paper, table 1 summarises the present value of each of them.

Insert Table 1 about here

The generalised objective function for a firm becomes:

$$\max_{\{I_t,k_t\}_0^\infty} V_t = \int_{t=0}^{\infty} \Big[(1-T_c)R_t + T_c(r_{dt}D_t + Depr_t m_t I_t) - (1-S_{inv})m_t I_t + \int_0^\infty A_{s,t-s}ds\Big] e^{-rt}dt, \tag{7}$$

subject to: $\dot{k} = \psi(I_t)$.

Introducing λ_t as the Lagrange multipliers for this problem, and defining $q_t \equiv \lambda_t e^{rt}$, the *current* value Hamiltonian can now be specified as:

$$H_c = (1-T_c)R_t + T_c(r_{dt}D_t + Depr_t m_t I_t) - (1-S_{inv})m_t I_t + \int_0^\infty A_{s,t-s}ds + q_t\Big[\psi(I_t) - \dot{k}_t\Big], \tag{8}$$

In this expression, the firm can freely determine the control variable I_t. The state-variable (the one determined by past decisions) is the capital stock k_t, and the shadow value of the state variable (i.e., the co-state variable) is q_t. Analyzing the case for which $A_{s,t-s} = A_t$, the first-order condition (f.o.c.) with respect to investment now becomes:[3]

$$\frac{\partial H_c}{\partial I_t} = \Big[T_c Depr_t m_t - (1-S_{inv,t})m_t + \frac{\partial A_t}{\partial I_t} + q_t \frac{\partial \psi(I_t)}{\partial I_t}\Big] e^{-rt} = 0$$

$$\Leftrightarrow q_t = \frac{(T_c Depr_t + S_{inv,t} - 1)m_t + \frac{\partial A_t}{\partial I_t}}{\dot{\psi}(I_t)} \tag{9}$$

This expression immediately illustrates the long-run equilibrium notion of $q = 1$: The nominator, namely, equals the net benefit of installing an additional unit of capital stock; it includes all tax benefits, subsidies and allowances, and is corrected for the purchase price of

[3] The terminal endpoint transversality conditions have been defined such that at $t = T$, the capital stock k_t should be zero. With a little rewriting, as $T \to \infty$, this yields $\lim_{t\to\infty} q_t e^{-rt}[-\delta k_t + \psi(I_t) - \dot{k}_t] = 0$. The initial endowments are set equal to zero (i.e., $k_0 = 0$).

an additional unit of capital stock. The denominator, on the other hand, gives the costs of an additional unit of capital stock. One the nominator equals the denominator, the firm should be indifferent with respect to investing. The other f.o.c.s are ignored here.[4]

The obvious drawback of the marginal Q derived in this model, is that it need not be observable. Nevertheless, since the model assumes firms are price-takers in the market for the private good output, and both the production and installation functions are homogeneous, we can follow Hayashi (1982), by equalling marginal and average Q. Hayashi expresses the latter as:

$$\overline{q_t} = \frac{V_t}{m_t k_t}$$

$$= \frac{1}{m_t k_t} \int_{t=0}^{\infty} \left[(1-T_c)R_t + T_c(r_{dt}D_t + Depr_t m_t I_t) - (1-S_{inv})m_t I_t + \int_0^{\infty} A_{s,t-s} ds \right] e^{-rt} dt \quad (10)$$

This average Q will be used throughout this paper as the central evaluation criterion for the impact of fiscal and financial incentives on a (hypothetical) investment decision. It captures the impact of each instrument on the Q value of the investment decision, which essentially represents an NPV subject to a long-run sustainability restriction.

3 The base-case

At the heart of this paper lies a 1MW wind turbine investment project, for which the financial attractiveness is calculated both in the base-case as well as in the alternative scenarios (including fiscal and financial incentives). Before making these calculations, the base-case assumptions are specified.

3.1 Base-case assumptions and data sources

The main variables used for the base-case are summarised below.

[4]Obviously, $\partial H/\partial Q_t$ gives an expression for $\dot{k}_t$, whereas $\partial H/\partial k_t$ yields some $\dot{q}_t$. Only $\partial H/\partial k_t$ will be derived in 5.1. For $\partial H/\partial Q_t$, the reader is either asked to do the derivations, or to look up Hayashi (1982), Auerbach (1983), or Abel (1982).

Investment costs and annual costs

The costs of wind turbines have decreased rapidly over time. The exact figures vary per manufacturer, but in general terms investment costs have dropped with about 5.5% per annum over the 1985-1995 period, and have decreased with about 3% afterwards.[5] In concrete terms, the investment costs of a 1MW wind power plant have dropped from about €1.8m in 1985 to about €900k in the year 2000. Apart from the investment costs, the annual operation and maintenance costs have dropped as well. Simultaneously, however, the average costs of land use have risen over time. These two costs developments are assumed to offset each other, so that constant annual operating and maintenance costs (including land rental) are set at €40k for the entire period.

Financing costs and the use of debt

Many wind power projects are fully debt financed.[6] Full debt financing not only lowers the discount rate, but also maximises the tax shield from debt. In order to let full debt financing de realistic, a collateral is assumed to be present, which is uncorrelated with the market value of the installed capital stock, and which is provided at zero cost. Though an annual 6% interest rate is assumed on bank debt, the project may still suffer from some contingencies. Therefore, a somewhat higher discount rate of 7.36% will be used for the analyses.[7]

Economic lifespan and depreciation

The choice for the economic lifespan of a wind turbine varies between 10 and 15 years: commercial banks assume an economic life span of 10 years, whereas advocates of wind power use a longer lifespan. Here, a 15 years' lifespan has been used. In the base case, a linear depreciation for that lifespan is used in order to calculate the tax shield on depreciation.

Prices and currencies

For the sake of uniformity, all prices, costs, and benefits have been expressed in Euros.[8] Most

[5]This estimate is consistent with the ones reported by Faber, Green, Gual, Haas, Huber, Resch, Ruijgrok, and Twidell (2001), EC (1997), and BTM (1999). These sources, however, use a broader bandwith within which the figures used for this paper fit. See also UCE, STS, ECN, Ecofys, and RIVM (2001), for a review of the long-run cost projections of both onshore and offshore wind farms.

[6]A 2001 report by Bear Stearns 'German wind farm developers', *European Equity Research*, described how leverage ratios of 0.6 to 0.7 are commonplace.

[7]This discount rate is the result of a CAPM analysis, using an r_f of 5%, an r_d of 6%, an asset β of 0.69, and an $E(r_m)$ of 10%. When numerically increasing leverage ratios, the r_{wacc} increases up to some 7.36%.

[8]Since the Euro did not exist before 01 January 2002, the DMark has been used as a reference for calculating the exchange rate with the Euro, ECU, and pre-ECU standards.

countries have applied output-related incentives as fixed feed-in tariffs or production subsidies. For the years where no price-related regulation was available (for most countries, this was the 1985-1990 period), wind power producers were assumed to could have sold their electricity at wholesale prices (representing avoided costs of production). Since it proved difficult to obtain wholesale prices for all countries, particularly in the pre-1990 period (most electricity sectors were nationalised) the ex-tax industry price has been used as a proxy. Of course, industry prices may have been subsidised, and do not represent truly avoided costs of production, but in the absence of better data the IEA uses the same methodology.

For some countries, other specific assumptions have been made. For example, wherever price deflation occurred in Italy, Sweden, Greece, Portugal, and Austria, the electricity retail price index has been used, due to an absent wholesale price deflator for the electricity sector. For Spain, the National Renewable Energy plans (starting back in 1986) regulated favourable buy-back tariffs. The 1998 Royal Decree explicitly gave wind power producers the option to choose between (a) the wholesale price plus a premium, or (b) a fixed price of about €62.6/MWh. For the sake of simplicity, and to avoid the aforementioned problem of obtaining the true wholesale prices, the fixed price has been applied. Since no exact regulated price data could be obtained for the 1986-96 period, the fixed €62.6/MWh price has been applied to that entire period. Since in Spain the government has traditionally determined the electricity prices for the different consumer categories, no electricity wholesale price index was available to deflate the fixed tariff.

In Greece, the feed-in tariff for independent power producers (IPPs) has been regulated since 1985. Since no historical feed-in tariff data were obtained, the 1994 legislation (where IPPs receive 90% of the grid price) has also been applied to the pre-1994 period (deflated at the wholesale price index).

In Portugal, the conditions for IPPs to deliver to the national grid have been regulated since 1988. In 1998, wind power was guaranteed a PTE10.48/kWh price. Since no historical data were obtained, and since no wholesale price index was available, this price has been deflated by using the electricity retail price index.

For Luxembourg, neither industry nor wholesale price data were available, as holds for the price indices. Given the relatively high retail prices, and furthermore the enormous interconnection with the Belgium economy (e.g., during the entire period observed the currencies of both countries were interchangeable) the data for the Belgium market have been applied to the Luxembourg case for the period before specific feed-in tariff regulations occurred (that is, before 1994).

For constructing a base-case feed-in tariff, the average 1985 ex-tax industry prices have been used for the EU(15), deflated by the real energy price index for industrial end-users in OECD Europe. This results in base-case prices varying from €51.9/MWh in the year 1985 (start), via €53.8/MWh in 1990 (highest), to €44.9/MWh in the year 2000 (lowest and last). These prices have been applied uniformly to all countries in the sample. The rationale for uniform base-case feed-in tariffs is that it was impossible to obtain wholesale prices for the sample period. Most countries did not have a true wholesale market in that era, and their prices were in fact artefacts determined by law or Parliament. For example, in Spain government set all prices, varying between industries, etc. Industry-specific energy prices have been frequently applied, and have often been used as some form of subsidies. Therefore, using country-neutral base-case prices may eliminate some part of this implicit subsidisation. As a consequence, however, the present value of the differences between the real-price vectors and base-case price vectors may yield negative subsidies there.

Wind regime

A crucial factor that affects the profitability of a wind turbine investment project in the various countries is the wind regime. The wind regimes given by BTM (2000) have been used, cross-checked with the data provided by the European Wind Energy Association.

Fiscal regime

For most countries, the statutory corporate tax rates provided by the Institute of Fiscal Studies (IFS) have been used. Since the IFS data do not cover Denmark and Luxembourg, these corporate tax rates were assumed to equal 32% and 37% respectively for the entire sample period.

3.2 Base-case Q

Using the above assumptions, the base-case Qs calculated for investment in wind turbines have steadily remained below unity over time. Figure 1 shows the calculated Qs of an investment in a hypothetical 1MW wind power plant in the 1985-2000 period. The base case shows that not a single positive Q (let alone one exceeding unity) was calculated.

Insert Figure 1 about here

A sensitivity analysis on these results with respect to the assumptions yields the following results. The capital-intensive nature of wind turbine projects by definition makes the outcomes very vulnerable to changes in the level of the initial investment. A change of 10% in the investment costs triggers similar responses in the base-case Qs. Jumping ahead to the net analysis (including fiscal and financial incentives) this sensitivity is smoothened for most of the individual countries, either due to investment subsidies, or due to the tax shield on depreciation, investment reliefs, etc. Changes in the discount rate show a similar pattern. For example, if the debt-to-equity ratio changes from full debt financing to a D/E ratio of one, the WACC slightly increases to 7.9%. More important, however, is the fact that the tax shield from debt decreases. For the base-case, this has a moderate effect. For countries as Denmark and Spain (corporate tax rate comparable to the base-case) the impact is smoothened. In the case of Spain, this is because of the investment subsidy-given a lower capital need, the impact of a change in the finance structure is more limited too. In the case of Denmark, the income is much higher than in the base-case (due to production subsidies and high feed-in tariff), which limits the impact of changes in the tax shield, etc. In the case of Germany, however, the tax benefits drop dramatically, which can be attributed to the high corporate tax rate of 52%. These effects are multiplied for a full equity financed project. If the asset beta is increased from 0.69 to 1.00, the discount rate increases to 8.9%. The base-case Qs then drop slightly, an effect that is replicated in the case of Germany. In Denmark and Spain the increased discount rate hardly has any effect on Q. An increase of the operating costs with 10% (i.e., €4k per annum) is of minor importance to the project. Overall, it appears that the Q calculations are rather stable. The variables most sensitive to changes are related to the capital structure and to the investment amount. Particularly the tax shield from debt has a multiplying effect here.

4 Policies affecting Q

4.1 Description of green policies

Table 2 reviews the national policies for encouraging wind turbine investments during the 1985-2000 period. For some countries as Austria, Spain, and Belgium, table 2 includes some regional policies as well. These governments have transferred some policies to non-central governments, so that inclusion of these regional policies makes the overview more accurate. Nevertheless, the empirical assessment has been predominantly restricted to the policies at the national level. Legislation that has come into force after 31 December 2000 has not been included in this review, since the available data on installed wind turbine capacity have at least a two years' time lag before being published, which would hamper an assessment of the effects of these policies. Since the focus is on a 1MW wind power plant, stimuli for households (such as auto-consumption projects for rural areas), as well as niche-market applications of wind power have been excluded. Production subsidies and subsidies on capital investments appear to be the two most popular instruments in the various national policies. Favourable feed-in tariffs have also been a common practice.

Insert Table 2 about here

4.2 Present value of green policies

Given the policies listed in table 2, and given the analytical framework provided in section 2.1 (in particular the specifications given in table 1), it now becomes possible to calculate the present value of the various fiscal and financial incentives, given a base-case 1MW wind turbine investment project. Figure 2 shows the present value of all economic instruments listed in table 2.

Insert Figure 2 about here

Any discussion of the financial attractiveness of the different economic instruments should emphasize the fundamental difference between the 'bidding programme' countries, and the others. Under a non-bidding programme, firms apply for a subsidy or other incentive, and may increase their capital stock up to the long-run economic equilibrium. The governments of both the UK and Ireland, however, decided to launch bidding programmes for encouraging investments in renewable energy. Under such programme, the number of eligible projects (and therewith the capital stock) is specified on forehand, as is the budget available. Firms can join a tender and demand for subsidies. The firms demanding the lowest subsidies are eligible, whereas all the other projects (demanding too much support) are not. In theory, this is a very nice mechanism. That shield yield efficient outcomes. Particularly when assessing ex post how high the granted support has been in the UK, then it turns out that the NFFO bidding programme was anything but efficient (particularly the 1990-94 period is striking).

A more technical issue with respect to the bidding programmes is concerned with the impulse-response function, as will be tested in the regression analysis below. When the number of projects eligible for government support is uncapped, then the market determines the efficient investment response. Under a bidding programme, however, it is the number of eligible projects that has been fixed on forehand, whatever the financial attractiveness of the measures. Thus, for any Q above unity (even if it were 3), the response is the same. Therefore, the UK and Ireland are considered outliers in the sample, and will not be included in the econometric analysis.

4.3 Q including incentives

When including the present value of the various economic instruments, the Qs increase enormously relative to the base-case. Figure 3 gives the 'net Qs'. This graph shows a grid surface that intersects with the Q=1 value. Even though this Q=1 value need not represent the long-run equilibrium value for which $\dot{q} = 0$ (this will be discussed in the next section), it does provide a minimum value for that condition.

Insert Figure 3 about here

When analysing the Q values including incentives, it appears that none of the countries in the sample provided positive Qs at the start of the sample period. Also, all countries had nonnegative Qs at the end of the sample period. Though strictly speaking Q should at least be one for a long-run sustainable industry, nonnegative Qs might attract 'single shot' investments. These do not generate sufficient income to ensure an infinitely lived industry, but they might attract some investments.

Of all countries, the Qs for the UK can safely be labelled excessive. As the present value of the economic instruments already suggested, wind turbine investments were very profitable during the 1990-94 period in the UK. Though some countries provided little incentives, relatively high Qs were obtained. For example, the Dutch government has hardly provided serious incentives before 1995, but the Qs during the pre-1995 period have not been dramatically low (oscillating around the Q=0 value). Such anomalies are attributed to the favourable wind regimes of such countries, or the relatively low corporate tax rates.

On the downside, the Qs obtained for Ireland are dramatically low, and in fact (given the investments in turbines revealed in the next section) also low Qs were obtained for Denmark. In this particular case, it must be noted that in Denmark, households own about 50% of all wind turbines. Since the stimuli given in table 2 did not include stimuli for households, the Qs obtained for Denmark have a downward bias relative to the empirical reality.

Also, a general comment holds for all countries with low accumulated levels of wind turbines. Usually, when a product-market is in its start-up phase, additional subsidies are available for market development. For renewable energy, both national governments and the EU have specific subsidy programmes. Including these may explain the residual growth observed with currently negative Qs.

5 Investment response to green policies

Annual IEA/OECD data on the installed wind turbine capacity have been used for each country. These data have some limitations. First, since only some countries have reported wind turbine capacity per ownership class (public, NGO, private) whilst these distinctions have not been made from the start, aggregates have been used for all countries similarly for the sake of uniformity. As a consequence, even if the calculated Qs would be negative, one may observe growth in investments. This 'autonomous' growth is attributed to either (a) public sector investments, since public enterprises are assumed to use another evaluation criterion than micro-level Q, or (b) the fact that for premature markets, additional market development subsidies are often available. Table 2 does not include these kinds of subsidies, which might lead to an underestimate of Qs for markets with low levels of accumulated turbine capacity. A second remark concerns replacements. Since only aggregate figures were available, the data reflect net investments, and should actually be corrected for replacement investments. Therefore, the gross investment figures might be higher. A consequence of this data limitation is that we may now observe a negative growth in turbine capacity in Luxembourg between 1998 and 1999, whilst in reality there might have been a positive gross investment in that period.

Figure 4 gives an impression of the cumulative investment figures for the four largest investing countries (ranked by their year 2000 capital stock). The net investment data for all countries in the sample can be found in table 3 in the appendix to this paper.

Insert Figure 4 about here

Germany, Denmark, and Spain are by large the biggest investors in wind turbines. Particularly when assessing the cumulative year 2000 figures, the gap between these three countries and the rest of the sample becomes even more apparent. When calculating the marginal growth rates of the capital stock in all countries, then it appears that the largest investors in cumulative terms have had their peak in the late 1980s or early-1990s. Ever since, these growth rates have been lower than 100%.

Interpreting declining growth rates (for example in the three largest investing countries) as saturation, it seems that if there is growth to be expected it should come from the smaller wind turbine countries. As such, declining growth need not be bad: if an industry approaches her long-run equilibrium, the only investments that should be made are the replacement investments, necessary to cover the depreciation of the existing capital stock. In order to analyse this equilibrium hypothesis, we need to analyse the phase diagrams. Before turning to the phase diagrams, however, the average Qs are calculated given the realised capital stock. The reason for this calculation is that–opposed to figure 3–some incentives have been capped per annum, or per eligible project. Consequently, the calculations visualised in figure 3 may be characterised by an upward bias in Qs. Imposing a cap thus gives the minimum level of Qs possible.

Two approaches have been worked out. First, it was assumed that each country were served by a single investor-that is, all investments made in year t represented a single investment project. Under this assumption, the subsidies and tax allowances have been capped for a number of countries, limiting the value of Q. Figure 5 outlines the results. The most striking Q-values were obtained for the UK (about 5 in 1991), Italy (over 3 in 1995), and Ireland (over 3 in 1996). The only two other countries for which Qs bigger than unity were obtained, were Belgium (1997) and Germany (1989 and 1993). In the second approach, the restriction that all investments represented atomistic projects was removed, and allowed the maximum incentives possible. Under this scenario, the Qs had to be bigger than under the first approach, but still less than in figure 3. Figure 6 shows how much bigger they were.

In the remainder, the second approach (the higher values for average Q)has been used for making two types of analysis. First, the relationship between Q and capital stock is discussed theoretically (analysed from the perspective of phase diagrams), in order to critically assess the long-run equilibrium implications. Second, a panel data regression analysis is performed.

Insert Figure 5 about here

Insert Figure 6 about here

5.1 From Q to capital stock: Phase diagrams

In economic dynamics, the relationship between a state variable (i.e., the one determined by past decisions, which is capital stock k_t here) on the horizontal axis and a co-state variable (i.e., the shadow value of the state variable, which is Q_t here) can be readily expressed by means of a so-called phase diagram. In such diagram, the long-run equilibrium is determined by the intersection of two lines: the line for which $\dot{k}_t = 0$, and for which $\dot{Q}_t = 0$. The first line, for which $\dot{k}_t = 0$ implies that, by equation 4, $\psi(I_t) = \delta k_t$. In words, net investment equals physical depreciation. When assuming that wind turbines do not face a significant *physical* depreciation over their economic lifespan, then $\delta = 0$, which implies $\psi(I_t)$ is a horizontal line.[9] By equation 9, we know it should intersect the vertical axis at $q = 1$.

The second line, for which $\dot{Q}_t = 0$, needs some small calculations before it can be interpreted. $\dot{Q}_t = 0$ is obtained by means of the f.o.c. of the Hamiltonian with respect to capital stock, that is, $\partial H / \partial k_t$. When firms optimise the *present*-value Hamiltonian, the motion of the co-state variable would have been described by $\partial H / \partial k_t = -\dot{\lambda}_t$.[10] When plugging in

[9]If δ were postive, then increases in k would lead to higher depreciation, so that the slope of this line were upwards. See Abel (1982) for a full proof of this statement.

[10]Note that equation 8 represents a *current*-value Hamiltonian.

the definition of q_t, and by differentiating q_t on the left-hand side, a little rewriting yields: $\dot{q}_t e^{-rt} - r q_t e^{-rt} = -\frac{\partial H_c}{\partial q_t} e^{-rt}$, which can be rewritten as:

$$\dot{q}_t = -\frac{\partial H_c}{\partial q_t} + r q_t \tag{11}$$

Thus, Q is constant ($\dot{q}_t = 0$), when the user cost of capital (rq_t) equals the marginal revenue product of capital. Since wind turbines are characterised by constant returns-to-scale, $\partial H_c / \partial q_t$ is decreasing in k.[11] Thus, in (k, Q) space, the line for which $\dot{q}_t = 0$ is downward-sloping in k.

At a glance, it seems we have sufficient theoretical grounds for plotting the long-run equilibrium of the capital stock. Unfortunately, however, the partial derivative $\partial H_c / \partial q_t$ is unobservable. In the absence of sound theoretical conditions for which the marginal effects would equal the average ones, a phase diagram cannot be used in practice. Nevertheless, we can make a first step by plotting all (k, Q) pairs in a diagram. Figure 7 gives such plot for the same four countries used in figure 4.

Insert Figure 7 about here

This graph shows how the (k, Q) pairs for Germany and Spain nicely oscillate around the $\dot{k}_t = 0$ line. Ignoring the results for Denmark (see the note in section 4.3), we can see how the incentives given in the Netherlands do not meet a long-run sustainability criterion: Having peaked in 1996 at a 0.96 value, the Qs for wind turbines in the Netherlands have steadily diverted from unity. Although the wind turbines' capital stock in the Netherlands still increases after its 1996 peak, the marginal growth figures are clearly declining.

[11] This assumption holds if the demand curve for the industry's output is downward sloping. Then, optimisation of the *present*-value Hamiltonian with respect to k_t would be downward sloping in k. This is equal to a downward-sloping partial derivative of the *current*-value Hamiltonian with respect to q.

5.2 From Q to capital stock: A panel data regression

There exist numerous regression models for estimating a relationship between Tobin's Q and corporate investment-varying from relatively simple OLS models to dynamic panel data models using GMM estimates. The common denominator in all econometric models is the problem of the unobservable installation function. Net investments can be observed, but gross investments cannot. It is beyond the scope of this study to come up with a 'new' regression model. The only purpose any regression model would have here is to confirm that higher Q's yield more investments, and that such relationship has a consistent pattern. A simple model that meets these criteria is given by Blundell, Bond, Devereux, and Schantarelli (1992), which is very similar to the one provided by Hayashi (1982). The intuition is as follows. First, investment is triggered by changes in Q and the partial derivative of the firm's profit maximisation problem with respect to investment (i.e., $\partial H_c/\partial I_t$), of which the latter yielded (see 9):

$$\frac{\partial H_c}{\partial I_t} = \Big[T_c Depr_t m_t - (1 - S_{inv,t})m_t + \frac{\partial A_t}{\partial I_t} + q_t \frac{\partial \psi(I_t)}{\partial I_t}\Big] e^{-rt} = 0$$

A little rewriting gives:

$$-T_c Depr_t m_t + (1 - S_{inv,t})m_t - \frac{\partial A_t}{\partial I_t} = q_t \frac{\partial \psi(I_t)}{\partial I_t} \tag{12}$$

The next step is to recall the Euler equation describing the evolution in Q, which is given by:

$$\frac{\partial H_c}{\partial k_t} = \Big(1 - T_c\Big)\frac{\partial R_t}{\partial k_t} + \frac{\partial A_t}{\partial k_t} + q_t \frac{\partial \psi(I_t)}{\partial k_t} - q_t \frac{\partial \dot{k}_t}{\partial k_t} = 0$$

Rearranging this equation yields:

$$q_t \frac{\partial \dot{k}_t}{\partial k_t} - \Big(1 - T_c\Big)\frac{\partial R_t}{\partial k_t} - \frac{\partial A_t}{\partial k_t} = q_t \frac{\partial \psi(I_t)}{\partial k_t} \tag{13}$$

Multiplying (12) by I_t, and (13) by k_t, and taking the difference of the resulting equations now yields:[12]

$$\dot{k}_t q_t = m_t I_t \Big(1 - S_{inv,t} - T_c Depr_t\Big) - (1 - T_c) R_t$$

The left-hand side of this equation expresses the market value of I units of additional investments. On the right-hand side, we find the market costs of the additional unit of investment. The direct investment costs $m_t I_t$ are lowered by the investment subsidies and investment tax credits. With each additional unit of investment also an amount of revenues R are foregone, due to the constant returns to scale and the downward sloping demand curve. Firms will thus invest up to the point where the benefits of an additional unit of investment equal the costs. Following Lucas Jr. (1967), the first derivative of the gross investment function (which is assumed to be homogeneous of degree one) with respect to I can be treated as a function of the ratio I/k. Then, equation (12) can be rewritten as:

$$\frac{q_t}{(1 - S_{inv}) m_t - T_c Depr_t m_t - \frac{\partial A_t}{\partial I_t}} = \frac{1}{\frac{\partial \psi(I_t)}{\partial I_t}}, \tag{14}$$

which we can solve for I to obtain the optimal investment rule:

$$I = \gamma\Big(\tilde{q}_t, k_t\Big),$$

where $\tilde{q}_t$ (hereafter referred to as 'modified Q') is the left-hand side of equation (14), being:

$$\tilde{q}_t = \frac{q_t}{(1 - S_{inv}) m_t - T_c Depr_t m_t - \frac{\partial A_t}{\partial I_t}}. \tag{15}$$

In words, modified Q is essentially equal to the marginal Q derived above, albeit that it is adjusted for the fiscal and financial investment incentives. Following Hayashi (1982), (15) can

[12] This trick was inspired by Poterba and Summers (1982). Note that since the revenues R are decreasing in k, $\partial R/\partial k$ must be negative. After multiplying equation (13) with k, a negative sign has been added to R.

be reduced to:

$$\frac{I_t}{k_t} = \beta(\tilde{q}_t), \qquad (16)$$

for which the OLS regression becomes:

$$\left(\frac{I}{k}\right)_{it} = \alpha_i + \beta_i(\tilde{q}_{it}) + \epsilon_{it} \qquad (17)$$

The biggest objection to running individual time series regressions, however, is that many countries have very little variation in the dependent (see table 3). That data limitation can be overcome by means of a panel data regression. Assuming that all investors respond in a similar fashion to Q, a common effects panel data model of the following form will be used:[13]

$$\left(\frac{I}{k}\right)_{it} = \alpha + \beta(\tilde{q}_{it}) + \epsilon_{it} \qquad (18)$$

The regression analysis yields a β of 0.74, with a standard error of 0.082, and a t-statistic of 8.897, which suggests the β is very significant. A Durbin-Watson statistic of 1.89 suggests there is very little serial correlation in the error term. An important implication of this regression analysis is that it does not seem to matter too much what exact policy instruments are used, as long as the project becomes financially sustainable. Hence, it seems that firms have equal preferences for investment subsidies or tax rebates, as long as they yield the same results. Probably, this result only holds for a macro-context within which macroeconomic and political stability are present, and where government commitment to whatever instrument is guaranteed for a minimum time period. If this would not be the case, then the international business literature suggests that entrepreneurs prefer those incentives that have immediate spin off, such as an investment subsidy. Other instruments, as production subsidies or tax holidays over a longer time span become less attractive when macroeconomic or political instability increase.

[13] In addition to this model, a non-linear panel data model has been regressed (with a breakpoint at $Q = 1$). Due to the limited number of observations for $Q \geq 1$, however, the breakpoint dummy could not be made statistically significant.

6 Government valuation

Although the core of this paper has focused on the participation constraint for the private sector to invest, one may wonder how the generosity of governments pays off. In other words, how much 'value for money' have the taxpayers received? A first step is an analysis of the average CO_2 emissions from power generation per country, shown in figure 8.

Insert Figure 8 about here

The production of every MWh of renewable energy not only implies an avoidance of these emissions, but also helps to lower the average emissions of the sector. Therewith, by every installment of renewable energy generating capacity, the marginal benefits for government (society) decreases, and so might government support.

When dividing the present value of all fiscal and financial incentives a 1MW wind power plant may receive over its 15 years' lifespan by the product of the average emissions (in tonnes CO_2/MWh) times the wind regime (in hours per annum), we obtain the implicit 'value for money' for the taxpayer, or the implicit government valuation (expressed in €/tonne CO_2). Table 4 gives the results.

Insert Table 4 about here

Most studies valuing the the marginal abatement costs of CO_2 vary between nil and €250 per tonne.[14] The results obtained in table 4 seem to fit fine within that bandwidth.

Most important, however, is that these figures provide a completely different interpretation of the 'generosity' of the various governments. In the above analysis of the Tobin's Q values, countries as the UK seemed to exaggerate their economic incentives. When relating the tax

[14] See for example Blok, Jager, Hendriks, Kouvaritakis, and Mantzos (2001).

money spent to the avoided emissions in such country over the lifespan of a wind turbine, however, then it appears the the UK has been generous, but not so much as France (ignoring the environmental costs of nuclear power production in the latter country), or Luxembourg.

7 Conclusions

The literature on the private provision of public goods emphasizes the funding problem, and is sceptical about government support. For example, in the case where the private provision of public goods relies on voluntary donations, government support would 'crowd out' these donations. This paper has shown that in a market where firms are price-takers and where the provision of the public good is coupled with the provision of a private good (the latter combination being a popular setting for most research in the private provision of public goods) government support does encourage firms to invest. Using a framework based on Tobin's Q, the empirical analysis suggest that for nonnegative Qs investments are boosted. This result represents a major relaxation of the theoretical benchmark, requiring Qs to exceed unity. Apparently, although Q equalling unity is necessary and sufficient condition for long-run sustainability, investors suffice with a nonnegative NPV on their investment. This result is very informative on the possibility for governments to intervene in the private sector investment process.

In addition, the results also suggest that it is the financial attractiveness of that government support which matters, and not so much the mixture of instruments applied. This result would provide a major relaxation for investment support programmes, as at the end of the day, investors only seem interested in earning a reasonable return on their investment. Probably, this result only holds in stable economies (no hyperinflation, etc.) and for credible government commitment (i.e., promised measures must be executed).

The main conclusions of the paper can be summarised as follows. First, wind turbine investments appear to be very sensitive to higher marginal revenue products of capital. Second, investments do not seem to respond differently to tax incentives or subsidies; what matters is the financial attractiveness of these measures. The most frequently observed instruments were the capital investment subsidy, the production subsidy, and the tax relief on investments. Other measures, including accelerated depreciation, or even soft loans were utilised, but were less frequent. Third, in countries where the national average emissions per unit of electricity output are high, governments provide more generous incentives for renewable energy production. Fourth, the countries with the largest wind turbines investment figures (absolute levels) have faced decreasing growth levels since the mid-1990s. This is attributed to congestion of suitable sites. Fifth, the realized spin-off from the fiscal and financial measures varies widely over both time and space, but it is difficult to obtain a consistent pattern here.

A major limitation of the study is rooted in the available data. The annualised national wind turbine data did not allow for testing a very extended model, due to the limited variation in the dependent variable, a low frequency of the data, and no consistent discrimination on ownership types (i.e., investments owned by government, NGOs, private sector companies, or households). Though these limitations make it extremely difficult to come up with a very precise relationship between incentives and investment response, the data do suggest a clear pattern between financial attractiveness on the one hand, and net investments on the other. Theoretically, it would be possible to determine the long-run equilibrium of the investments (and therewith also the support necessary to reach that equilibrium) by means of phase diagrams. In practice, however, it appears to be extremely difficult to come up with such a diagram. Nevertheless, some elements of such diagrams have been sketched.

References

Abel, Andrew B., 1982, Dynamic effects of permanent and temporary tax policies in a q model of investment, *Journal of Monetary Economics* 9, 353–73.

Abel, Andrew B., Avinash K. Dixit, Janice C. Eberly, and Robert S. Pindyck, 1996, Options, the value of capital, and investment, *Quarterly Journal of Economics* 111, 753–77.

Andreoni, James, 1993, An experimental test of the public-goods crowding out hypothesis, *American Economic Review* 83, 1317–27.

Auerbach, Alan J., 1983, Taxation, corporate financial policy and the cost of capital, *Journal of Economic Literature* XXI, 905–40.

Baumol, William J., 1990, Entrepreneurship: Productive, unproductive, destructive, *The Journal of Political Economy* 98, 893–922.

Blok, Cornelis, David de Jager, Chris Hendriks, Nikos Kouvaritakis, and Leonidas Mantzos, 2001, Economic valuation of sectoral emission reduction objectives for climate change: Comparison of 'top-down' and 'bottom-up' analysis for emission reduction opportunities for CO2 in the European Union, .

Blundell, Richard, Stephen Bond, Michael Devereux, and Fabio Schantarelli, 1992, Investment and Tobin's Q, *Journal of Econometrics* 51, 233–57.

BTM, 1999, *World Market Update.* (BTM Consult Aps Ringkøbing).

BTM, 2000, *World Market Update.* (BTM Consult Aps Ringkøbing).

Coase, Ronald H., 1974, The lighthouse in economics, *Journal of Law and Economics* 17, 357–76.

Devereux, Michael P., and Rachel Griffith, 1998, Taxes and the location of production: Evidence from a panel of US multinationals, *Journal of Public Economics* 68, 335–67.

EC, 1997, Energy Technology: The Next Steps, Working paper, Directorate General for Energy (DG XVII).

EC, 2001, Company Taxation in the Internal Market, Working paper, COM(2001)582 Final Commision of the European Communities.

EC, 2002, *2001 – Annual Energy Review.* (Office for Official Publications of the European Communities Luxembourg).

Faber, Thomas, John Green, Miguel Gual, Reinhard Haas, Claus Huber, Gustav Resch, Walter Ruijgrok, and John Twidell, 2001, Promotion strategies for electricity from renewable energy source in EU countries, Working paper, Institute of Energy Economics, Vienna University of Technology.

Gould, John P., 1968, Adjustment costs in the theory of investment of the firm, *Review of Economic Studies* 35, 47–55.

Hayashi, Fumio, 1982, Tobin's marginal q and average q: A neoclassical interpretation, *Econometrica* 50, 213–24.

Kirchsteiger, Georg, and Clemens Puppe, 1997, On the possiblity of efficient private provision of public goods through government subsidies, *Journal of Public Economics* 66, 489–504.

Lahiri, Sajal, and Pascalis Raimondos-Moeller, 1998, Public good provision and the welfare effects of indirect tax harmonisation, *Journal of Public Economics* 67.

Lucas Jr., Robert E., 1967, Adjustment costs and the theory of supply, *Journal of Political Economy* 75, 321–34.

Nyborg, Karine, and Mari Rege, 2003, Does public policy crowd out private provisions to public goods?, *Public Choice* 115, 397–418.

Poterba, James M., and Lawrence H. Summers, 1982, Dividend taxes, corporate investment, and 'Q', *Journal of Public Economics* 22, 135–67.

Roberts, Russel D., 1987, Financing public goods, *Journal of Political Economy* 95, 420–37.

UCE, STS, ECN, Ecofys, and RIVM, 2001, DACES 2050: Database Clean Energy Supply 2050: Final Report, Working paper, UCE (Utrecht Centre for Energy Research), ECN

(Netherlands Energy Research Foundation), Ecofys Energy and Environment, and RIVM (National Institute of Public Health and the Environment).

Uzawa, Hirofumi, 1969, Time preference and the Penrose effect in a two-class model of economic growth, *Journal of Political Economy* 77, 628–52.

8 Tables and figures

Table 1: *Present value of some economic instruments*

Economic instrument	**Present value**
Favourable, guaranteed feed-in tariffs (fixed prices)	$(1-T_c)\int_0^T(p_{x,s,t-s}-p_{x,s,t-s})w_tX_te^{-r_f(t-s)}ds$
Production subsidy (per unit of output)	$(1-T_c)\int_0^T S_{output,s,t-s}w_{t-s}X_{t-s}e^{-r_f(t-s)}ds$
Production subsidy (per unit of capacity installed)	$(1-T_c)\int_0^T S_{capacity,s,t-s}k_{s,t-s}e^{-r_f(t-s)}ds$
Subsidy on capital investment	$S_{inv,t}m_tI_t$
Subsidy on interest rates	$\int_0^T \pi_t(e^{-r_{wacc}^{new}(t-s)}-e^{-r_{wacc}^{old}(t-s)})ds$ - $T_c\int_0^T(r_{d,t}-r_{soft,s,t-s})D_{t-s}e^{-r_{wacc}(t-s)}ds$
Tax relief on investments (percentage deduction of capital investment costs)	$T_cA_{inv,t-s}m_{s,t-s}I_{s,t-s}$
Reduced corporate tax rate	$(T_c^{regular}-T_c^{reduced})\int_0^T(R_t-r_{d,t}D_t-\delta_tm_tI_t)e^{-r_{wacc}t}dt$
Accelerated depreciation	$\int_0^{1/\tilde{\delta}} T_cDepr_{s,t-s}^{accel}m_{s,t-s}I_{s,t-s}e^{-r_{wacc}(t-s)}ds$ - $\int_0^{1/\delta} T_cDepr_{s,t-s}^{base-case}m_{s,t-s}I_{s,t-s}e^{-r_{wacc}(t-s)}ds$

Note: In this table, $\tilde{p}$ refers to the favourable price; r_f is the risk-free interest rate, used for discounting all guaranteed (and thus risk-free) policy measures; S_{output} is a production subsidy per unit of output; $S_{capacity}$ a subsidy for adding additional capacity to the grid; D is the amount of debt used for financing the investment; r_d the coupon rate of conventional (bank) debt; r_{soft} the coupon rate of a so-called 'soft loan'; δ is the rate of economic depreciation for which holds $\delta = 1/T$; and $\tilde{\delta}$ the rate of accelerated depreciation.

Table 2: *Overview of green policies*

Country	**Description of fiscal and financial measures**
Germany	**Other fiscal measures**: The 1990 'Electricity Feed-In Law' (in force in 1991) requires utility firms to purchase renewable energy generated from third parties at prices between 65-90% of average consumer electricity prices (wind power at 90%). These prices have fluctuated over time. The succeeding 'Renewable Energy Sources Act' (01 April 2000) has similar conditions, albeit that the feed-in tariffs are nowadays not paid by the utility firms, but by the grid operators. The 'Renewable Energy Sources Act' guarantees a €91/MWh price for the first 5 years of operation, whereas for the remaining years a €61.7/MWh price was guaranteed. From January 2002 onwards, the minimum compensation will be reduced by 1.5% p.a. for newly commissioned installations. Jurisprudence shows that this obligation is not considered a subsidy or state aid, but instead it is defined as a non-tax fiscal measure (since the tariffs paid do not derive from tax revenues but from the profits of the grid operators). **Subsidy on capital investment**: Since 1989 (extended in 1991) max of 25% with a max of €46,016 of tot. inv. cost. The last grants were approved by the end of 1996, with last projects realised in 1998. **Subsidised interest rates on loans**: The June 1989 '100MW Wind Programme', as well as its February 1991 successor '250MW Wind Programme' The public Deutsche Ausgleichsbank grants low-interest loans up to 50% of tot. inv. cost, with interest rates at about 5% p.a. for 10 years (for construction projects up to 20 years), with 2-5 starting years without credit repayment. **Production subsidy**: Support of €30.7/MWh delivered to the grid (starting in 1989) under the 100MW programme and its successor, the 250MW Programme. The closing date for proposals for the 250MW programme was 31 December 1995, whereas the last approvals concerned projects erected in 1998. The programme ends around the year 2008.

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Denmark	**Other fiscal measures**: In the 1984 '10-year Agreement', the Association of Danish Electric Utilities (DEF) agreed to purchase all wind power delivered to the grid at 85% of the consumer end price (excluding taxes), on the condition that the capital investment subsidy would prevail. Even after the removal of that capital subsidy in 1989, the fixed purchase price remained. By the end of 2000, the 85% rule has been terminated in favour of a fixed nominal payment. The new rules guarantee a minimum payment of Øre60/kWh for turbines installed before 01.01.2000, whereas onshore turbines installed after 01.01.2000 are guaranteed Øre43/kWh (widespread criticism has changed these rules again per 19.06.2002). **Subsidy on capital investment**: As per January 1985, government subsidised 25% of capital investments (this policy started in 1979, and previous percentages fluctuated between 30% and 20%). As per June 1985, this percentage was cut to 20%. From January 1986 until the end of 1988, the percentage was cut to 15% (under the 100MW Agreement). From January 1989, this subsidy was reduced to 10%, and finally abandoned in August 1989. **Production subsidy**: From 1984 to the end of 1990, the Ministry of Taxation has subsidised RES production with €31/MWh (Øre23/kWh). From 1991 to 1999, this subsidy was differentiated into two different production subsidies: (a) The reimbursement on CO_2 tax of €13/MWh (the Øre10/kWh measure), and (b) An additional direct subsidy of €23/MWh (Øre17/kWh) for wind hydro and biogas electricity, which was not applicable to utility firms. From 2000 till 2003, a transition period is established for introducing green labels. The expected value of a green label is between DDK100-270/MWh. As per 2002, electricity from new plants connected to the grid after January 2000 receives DDK330/MWh for the first 22,000 full load hours (about ten years of operation). Above that cap, remaining electricity is sold at market prices. In addition (until the green certificate market has been established) producers receive DDK100/MWh–once green certificates have been established, they replace this subsidy.

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Spain	**Tax relief on investments**: The national Law 43/1995 (in force from 30.10.1997) provides a 10% tax liability deduction for investment in environmentally friendly tangible fixed assets. The Foral Laws in Basque country (all three provinces) provide a 15% deduction of investment costs in environmentally friendly fixed assets (all in force by mid-1996). The Navarra region allows a 15% deduction from the corporation tax liability in environmentally friendly fixed assets (in force from 01.10.1997). **Subsidy on capital investment**: The national 'Energy Savings and Efficiency Plan' provides capital subsidies up to 30% of project investment costs (1991-2000). The regional Andalusian PROSOL programme promotes renewable energy installations for the 2000-2006 period. Wind energy may receive up to €893/MW installed (in force from 12.05.2000). The 31.01.1997 Resolution of the Asturias region establishes a subsidy of 60% of eligible investment costs, with a maximum of ESP5mln (by then ECU29,762) for stand-alone or grid-connected wind turbines (in force from 01.02.1997). The La Rioja region offers some subsidies for demonstration projects in RES (incl. wind) as well as the extension of energy infrastructures (in force from 24.11.2000 till 15.12.2000). The Balearic Islands have offered a maximum subsidy of ESP300/W installed (by then ECU1.79) for wind turbines (in force 27.04.1997 only for projects undertaken in 1997). The Castilla-Leon region provides subsidies for wind energy (in force from 01.01.1996). The Murcia region provides subsidies for RES investments, up to 50% of the project implementation budget (in force from 06.05.1997). **Production subsidy**: The national 'Renewable Energy Plans' (of 1986-89, 1989-90, and 1991-2000) regulate favourable buy-back rates for renewable energy from facilities smaller than 100MW. According to the Royal Decree 2818/1998, wind power producers can choose between receiving either (a) The 'final average hourly price' on the wholesale market, plus a €0.0288/kWh premium, or (b) A fixed price of €0.0626/kWh. Decree 170/94 of the Aragon region grants subsidies for the exploitation of renewable energy sources, incl. wind (in force from 30.07.1994).

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Netherlands	**Accelerated depreciation**: Since 1996, wind turbine investments are allowed to apply a 'free depreciation' under the VAMIL facility (VAMIL already existed since 1991). This facility allows, for example, a complete depreciation in the first year of operation. **Tax relief on investments**: From 01.01.1997 till 01.10.2002 the EIA (Energy Investment Deduction) allows to deduce 40 to 52% (dependent on the investment amount) from the fiscal profits (with a cap of NLG 50 mln., about €22.7mln.). **Capital investment subsidy**: In May 1986, the 5-years lasting IPW (Integral Programme Wind energy) was launched. In 1986 and 1987, the IPW subsidised about €300/kW installed. From 1988 to 1990, a percentage of the total investment costs was subsidised, with its cap decreasing from 50% (1988) to 37% (1990). In 1986, the Ministry of VROM provided an additional subsidy (MPW-Environmental Premium Wind energy) of €115/kW, an amount that gradually decreased to €45/kW in 1990. From 1991 to 1995, the TWIN programme provided capital investment subsidies, capped at 35% of total investment costs. During 1993 and 1994, the total amount of subsidies available decreased significantly. For 1995, the maximum was set at 30% of total investment costs. From 1996 onwards, the CO_2 Reduction Plan provides capital investment subsidies of about 5% of total investment costs. **Production subsidy**: In addition to all subsidies, RES producers receive a standard buy-back tariff from the regional energy distribution companies. In August 1994, an arbitraging committee determined that wind power should receive a standard tariff of NLG0.079/kWh-an amount that proved disappointing to most wind turbine owners. This dissatisfaction has led to a revision for 1995 and 1996. For turbines installed in 1995 and 1996, the standard tariff became NLG0.133/kWh plus an NLG0.054/kWh subsidy. From 1997 onwards, the marginal production subsidy was replaced by a transferred levy (the REB), discussed below. The standard buy-back tariff remained equal. For 1999, it was NLG0.081/kWh. From 1996 onwards, small and medium-sized electricity consumers (i.e., households and small companies) pay a marginal levy on their power consumption (REB-Regulatory Energy Tax), which is largely transferred to the RES producer. That transfer increased over time from NLG0.0295/kwh (1996) to NLG0.0354/kWh (2000).

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Italy	**Subsidy on capital investment**: Though Law 10/91 provides subsidies of 30%-80 of the capital investment in a renewables plant, Iea/Oecd (1998: 142) states that no subsidies were disbursed due to governmental budget constraints. Instead, incentives were derived from Law 9/91 (via Directive CIP6/1992) provided favourable buyback rates for independent RES producers. **Production subsidy**: Directive CIP6/1992 provided favourable buyback rates for independent RES producers (in force from 1992 to 1997) of about ITL270/kWh. These buy-back rates applied for the first eight years of operation, after which a lower price has paid of about ITL90/kWh. From 1997 onwards, both rates have become unregulated, and are considerably lower (about ITL200/kWh for the first 8 years, but about ITL100/kWh for remainder).
UK[1]	**Production subsidy**: Since 1990, the Non-Fossil Fuel Obligation (NFFO) has provided output subsidies for renewables. Five programmes in a row (NFFO-1, to 5) have seen the light, all with declining output subsidies. For wind (with 1MW net capacity) NFFO-1 (1990-1998) paid GBP0.10/kWh, NFFO-2 (1992-1998) paid GBP0.11/kWh delivered. The next NFFO programmes run for 15 years, with a longer lifespan. On average, NFFO-3 (1995-2012) paid GBP0.0529/kWh, whereas NFFO-4 (1997-2017) paid GBP0.0457/kWh. NFFO-5 (1998-2019) pays GBP0.0418/kWh.
Sweden	**Subsidy on capital investment**: The 1991 Energy Policy Bill (1991-1996) facilitated investment support to wind power. Originally, a 25% subsidy was granted, but later this became 35% for plants >60kW. From mid-1996 to mid-1997, no subsidies were available. The June 1997 parliamentary decision on energy policy grants 15% of the capital costs for new wind turbines >200kW (this subsidy is expected to be reduced to 10% soon). **Production subsidy**: Since 01.07.1994, wind power producers receive a so-called 'Environmental Bonus', equalling the excise tax on electricity for households. This bonus differs per region (highest in southern and central Sweden), and equalled SEK113/MWh (1996), SEK138/MWh (1997), SEK152/MWh (1998), and SEK181/MWh (2000). In addition to the regular price paid for electricity (and the environmental bonus), from 1997 until the end of 2001, a special subsidy of SEK0.09/kWh was given for small-scale wind power production units (<1.5MW).

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Greece	**Subsidy on capital investment**: Law 1892/1990 provides (a.o.) capital investment subsidies up to 45% (1990-1993). The 'Operational Programme for Energy' OPE (1994-1998) accompanying Law 2244/1994 subsidises wind energy projects with 40% (up to GRD350,000/kW subsidised project costs). Law 2601/1998 (in force 1999-onwards) gives firms investing in RES plants the choice of either receiving: (a) A 40% capital subsidy, plus an interest rate subsidy (40% of the interest paid on loans for RES equipment investments), plus a 40% leasing subsidy, or (b) A tax deduction equalling 100% of the investment costs, plus the aforementioned interest rate subsidy. The tax deduction creates a tax-exempt reserve that accumulates until total investment costs have been recuperated (within up to 10 years). **Production subsidy**: Under law 1559/1985, auto-producers and IPPs were allowed to sell a limited amount of renewable energy to the state-owned electricity company PPC. In 1988, the tariff structure for purchasing renewable electricity by PPC was regulated. Under law 2244/1994, auto-producers and IPPs were allowed to install up to 50MW. Furthermore, it regulates prices between PPC and independent power producers, consisting of an energy and a capacity component. The energy component for IPPs selling to an interconnected grid is 90% of the sales price. In 1997, for wind plants delivering at medium voltage (6.6-22kV), this sales price equalled GRD18.79/kWh (ECU0.057); when delivering at the high-voltage grid (150kV), three sub-zones have their own prices. The capacity component equals 50% of the amount PPC charges at the end-users, which is multiplied by 0.50 for wind energy. In 1997, the capacity credit for wind producers delivering at the medium voltage grid was GRD241/kW (.5*.5*GRD964) per month (ECU0.726), calculated over the maximum measured power production over the billing period. The high voltage grid remunerates higher capacity payments calculated on the basis of the maximum measured power production between two successive measurements in the peak hour zone. Both remunerations thus show seasonality aspects.

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Ireland	**Accelerated depreciation**: It is assumed (though this is debated) that investments in wind turbines may opt for the 15% tax depreciation p.a. allowance for plants and machineries (*vis-à-vis* the 4% p.a. for industrial buildings). **Tax relief on investments**: Since 1980, a 10% tax rate applies to a specified range of economic activities, including electricity generation (the current 'normal' tax rate is 28%). Since 18.03.1999 (operating for 2 years), the 1998 Finance Bill allows a tax relief for equity investments in RES projects under certain restrictive conditions. **Subsidy on capital investment**: The AER-3 programme offered capital grants €80,000 per MW installed. **Production subsidy**: Since 1994, five 'Alternative Energy Requirement' (AER) programmes have been launched, of which AER-1 AER-3, and AER-5 apply to wind power. The AERs arrange 15-years' purchase contracts with the Irish utility ESB; the prices increase annually with RPI inflation. The AERs regulate the price cap, but the real prices are settled through a bidding process. Under AER-1 (1994-1996), RES producers were paid a fixed tariff for a 15-years' period of IEP0.061-0.064/kWh during weekdays (about ECU0.08), and EIP0.024-0.025/kWh during the weekends. AER-3 (1997-1999) regulates a price cap for wind energy, whereas the successful bids ended at IEP0.0221/kWh (ECU0.028), while the maximum wind power plant had been fixed at 15MW. AER-5 has been announced in August 2001, and is not discussed here.
Portugal	**Subsidy on capital investment**: In Portugal, investment subsidies have been considered the key instrument to promote the use of RES. Two programmes have provided capital investment subsidies: the Energia Programme and the MAPE/POE Programme. The Energia Programme (1994-1999) grants up to 50% capital subsidies of total investment costs for dissemination (commercialisation) projects, with a cap of PTE50mln (about ECU249k) for wind projects. **Production subsidy**: The 1988 Decree Law 189 regulates conditions under which IPPs may deliver to the national grid; it furthermore includes provisions for favourable prices. In 1998, the price for wind energy was PTE10.48/kWh.

Table 2: *Overview of green policies*

Country	**Description of fiscal and financial measures**
Austria	**Other fiscal measures**: Since 01.08.1995, an Ordinance of the Federal Minster of Foreign Affairs guarantees minimum prices for RES power, varying from ATS0.421/kWh to ATS0.9/kWh (rates for plants <2MW, depending on the time of delivery). The 1998 'Electricity Business and Organisation Law' (ELWOG, in force from 1999 onwards) states that the federal provinces have to fix the feed-in tariffs for RES power. Furthermore, renewable electricity may now be sold directly to any customer. These feed-in tariffs not only differ per province, but also per season (summer or winter), within weeks (working days or weekends), and throughout the day (daytime or nights). On average, the feed-in tariffs vary between €0.040/kWh and €0.049/kWh. **Subsidy on capital investment**: In the 1992-96 period, the Law of Environmental Protection provided up to 30% capital investment subsidies. Since July 1997, the 'Promotion Instrument for Electricity from Renewables' (PIER) provides (a.o.) capital subsidies. The capital subsidies are capped to provide not more than a 7% rate of return for 15 years. **Production subsidy**: In addition to the feed-in tariff, the Ministry of Economic Affairs signed a 'voluntary agreement' (February 1994) with the utility firms of adding a bonus to IPPs for a 3 years' period after the construction of a RES plant (for plants constructed before 31.12.1996–though some utilities continued this bonus package until early 1998). For wind power, this bonus was 100%. This agreement applied to the 1994-1996 period. From July 1997 onwards, the PIER provides all incentives for RES.

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
France[2]	**Accelerated depreciation**: Since 1993, private companies investing in RES projects may depreciate their investments with 100% in one year. **Tax relief on investments**: Since 1993, private companies investing in RES projects may apply for a reduced corporate income tax rate (50% reduction). **Other fiscal measures**: Though the 1946 law concerning the nationalisation of electricity, and a 1955 decree established the basis for obligating EdF to purchase energy produced by co-generators, this measure predominantly focussed on surplus capacities, and did not provide particular incentives for encouraging RES production. Therefore, a new decree was put in place as per November 1994, where EdF was obliged to purchase RES electricity as well. Production subsidy: Under the 'EOLE 2005' wind energy programme (1996-2005), special feed-in tariffs are regulated between EdF and IPPs for 15-years' periods. This programme consists of 3 stages. Under stage 1 (1996), the feed-in tariff was FFR0.38/kWh (€0.058). Stage 2 (1997) applied an FFR0.34/kWh rate. Stage 3 (2001) foresees a €0.0838/kWh rate for the first 5 years, after which a lowered rate is offered for the next 10 years (being €0.0305/kWh for over 3600 hrs. of production, and €0.0838/kWh for less than 2000 hrs.).
Finland	**Subsidy on capital investment**: The 1993 'wind energy programme' put a 30% ceiling to capital investment subsidies. The 1996 Council of State's 'new decision on general conditions for granting energy supports' caps the investment subsidy to wind turbine projects to 40% (decision 54/96). **Production subsidy**: In essence, RES electricity receives the free-market price. In addition, however, some premiums have been added. During 1997, wind power received a production subsidy equal to the tax levied to industrial electricity consumption of FIM0.025/kWh (about €4.2/MWh). As per September 1998, the subsidy equalled the tax levied to household electricity consumption of FIM0.041/kWh (about €6.9/MWh).

Table 2: *Overview of green policies*

Country	Description of fiscal and financial measures
Belgium	**Tax relief on investments**: The national 1992 company tax code (1992-onwards) allows a preferential deduction for investments in RES to be deducted from the profits. This fiscal investment deduction consists of a 'base-percentage' that varies per annum (and fluctuated around 3.5% over the last years) plus a 10% supplementary deduction. Altogether, the allowance has been about 13.5% over the last decade. **Subsidy on capital investment (Flanders)**: Under the header of 'ecology support', the Flanders federation grants 20% capital investment subsidies (1998-onwards). **Production subsidy (Flanders)**: The 'Electricity Generation Fund' (REG) provides a BEF1/kWh (€24.8/MWh) production subsidy for periods up to 10 years, for RES production under the 'Green Franc System' (1995-onwards). In addition, the VIREG programme (1996-onwards) provides a BEF1/kWh (€24.8/MWh) production subsidy for wind, solar, and biomass power with an installed capacity ≤10MW (as per 01.07.1998, this subsidy was increased to BEF2/kWh). **Subsidy on capital investment (Walloon)**: Firms investing in RES can get a 15% investment grant (1993-onwards).
Luxembourg	**Accelerated depreciation**: The 24.12.1996 introduced special depreciation allowances for RES investments that allow to depreciate 60% in the first year. **Subsidy on capital investment**: A 1994 ministerial regulation supported LUF6000 per kW (about €149) installed to non-industrial co-generators (1994-1997). The 21.02.1997 law on economic development and diversification allows a subsidy of LUF3000 per kW (about €74) with a maximum of LUF6mln (€148,736) for wind turbines >50kW. **Production subsidy**: The 1994 Grand Ducal regulation sets the buy-back tariff for RES power equal to the tariff for co-generation. For installations between 151 and 1500kW, the day tariff paid averages LUF2.3/kWh, whereas LUF1.2/kWh is paid overnight. Wind power receives and additional production subsidy of LUF1/kWh. There exists an annual LUF4500/kW subsidy for delivering electricity during peak load.

Sources: Based on national legislations, various issues of the IEA country reviews 'Energy Policies of …', Iea/Oecd (1998), and translations and interpretations in the ENER-IURE project, supported by the EC. For the latter source, see: http://www.jrc.es/cfapp/eneriure/welcome.html.

[1] Specific measures for Scotland and Northern Ireland have not been taken into account in this table.
[2] Legislation for overseas territories is not included.

Table 3: *Net investments in wind turbines ($I_{i,t}$)*

	Ger	**Den**	**Spa**	**Net**	**Ita**	**UK**	**Swe**	**Gre**	**Ire**	**Por**	**Fra**	**Aus**	**Fin**	**Bel**	**Lux**
1985	1	33	0	1	0	0	0	0	0	0	0	0	0	0	0
1986	0	22	0	0	0	0	0	1	0	0	0	0	0	3	0
1987	4	52	0	7	0	0	0	0	0	0	0	0	0	1	0
1988	9	60	7	3	1	4	0	0	0	1	0	0	0	0	0
1989	34	153	0	37	2	6	5	0	0	0	0	0	0	1	0
1990	62	70	0	36	1	4	4	0	0	0	1	0	1	0	0
1991	73	45	39	25	3	36	8	15	6	2	0	0	0	0	0
1992	151	33	5	26	11	81	9	11	0	5	2	0	4	0	0
1993	309	41	24	22	3	22	11	0	0	0	0	0	0	0	0
1994	494	84	40	100	1	47	27	0	0	0	1	1	1	0	0
1995	427	226	96	42	48	38	38	0	0	10	3	9	1	0	0
1996	402	288	244	34	50	84	18	0	46	11	5	9	5	0	3
1997	706	313	379	28	44	9	51	11	8	19	8	8	5	1	7
1998	1466	328	625	48	65	20	22	71	7	9	5	8	21	4	-1
1999	1957	1043	984	33	134	54	13	117	49	26	31	19	0	4	5
2000	2617	138	970	38	301	15	84	44	19	42	25	15	1	12	1

Table 4: *Implicit government valuation of avoided emission per MWh wind power [€/tonne CO_2]*

	Ger	**Den**	**Spa**	**Net**	**Ita**	**UK**	**Swe**	**Gre**	**Ire**	**Por**	**Fra**	**Aus**	**Fin**	**Bel**	**Lux**
1985	16	18	12	25	0	28	22	0	14	0	17	0	0	0	0
1986	17	13	15	4	0	0	0	0	10	0	26	0	0	0	0
1987	21	9	18	0	0	0	0	0	4	0	40	0	0	0	0
1988	20	8	18	35	0	0	0	0	0	0	29	0	0	0	0
1989	59	6	18	32	0	0	0	0	2	0	33	0	0	0	0
1990	55	0	14	20	0	88	0	14	0	0	14	0	0	0	0
1991	87	7	44	22	0	89	119	17	0	0	19	0	0	0	0
1992	94	6	38	19	127	87	0	15	0	0	235	0	0	0	0
1993	98	8	42	19	122	112	0	13	0	0	347	0	10	0	0
1994	103	6	43	3	116	113	71	14	13	16	430	0	11	0	42
1995	108	9	47	63	110	19	184	17	15	19	272	2	22	7	82
1996	77	12	52	56	134	36	0	19	23	27	254	43	30	66	95
1997	86	12	50	44	77	33	79	22	0	24	248	43	38	75	128
1998	87	16	56	44	78	18	74	19	0	25	269	52	48	155	345
1999	91	19	49	18	82	28	194	18	0	21	301	59	43	176	252

Notes: Rounded figures, assuming a 15 years' lifespan of the wind turbines. For each country, the total CO_2 emissions for domestic power generation have been divided by the total domestic electricity production. Due to lacking data for the year 2000, this table only covers the 1985-99 period.
Source: Emission data based on EC (2002).

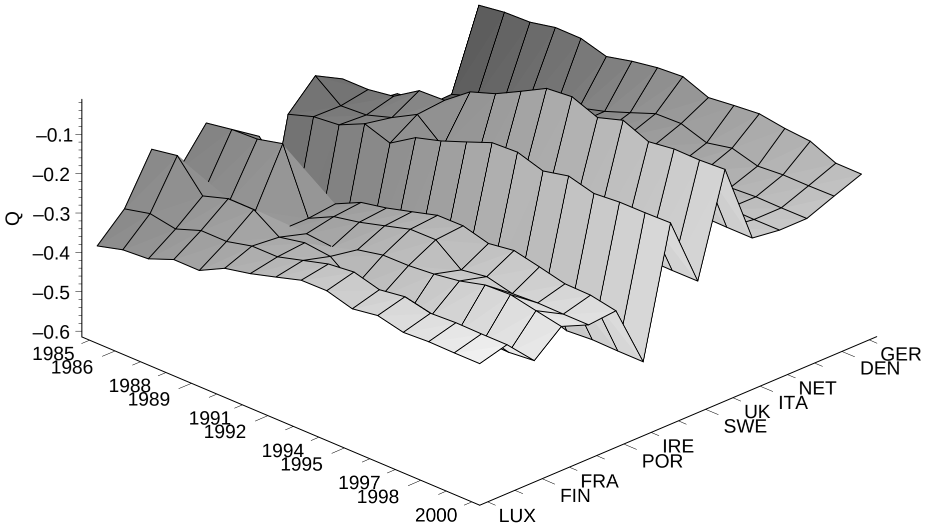

Figure 1: *Base-case Qs*

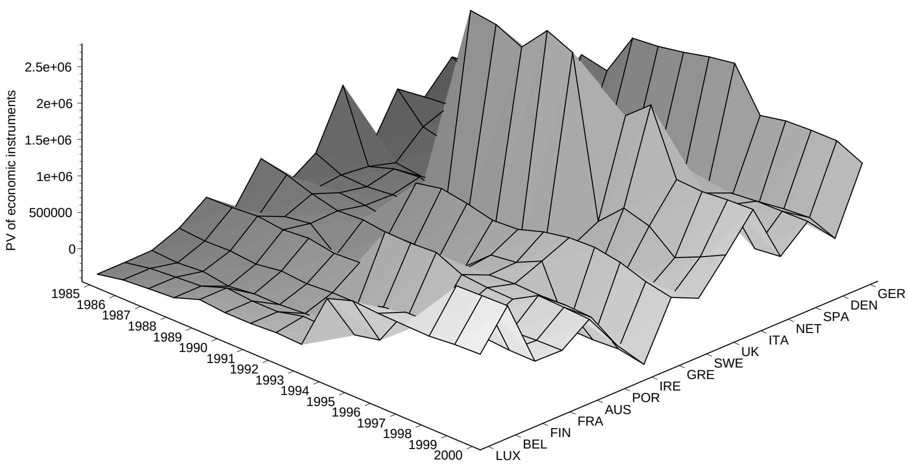

Figure 2: *PV of economic instruments*

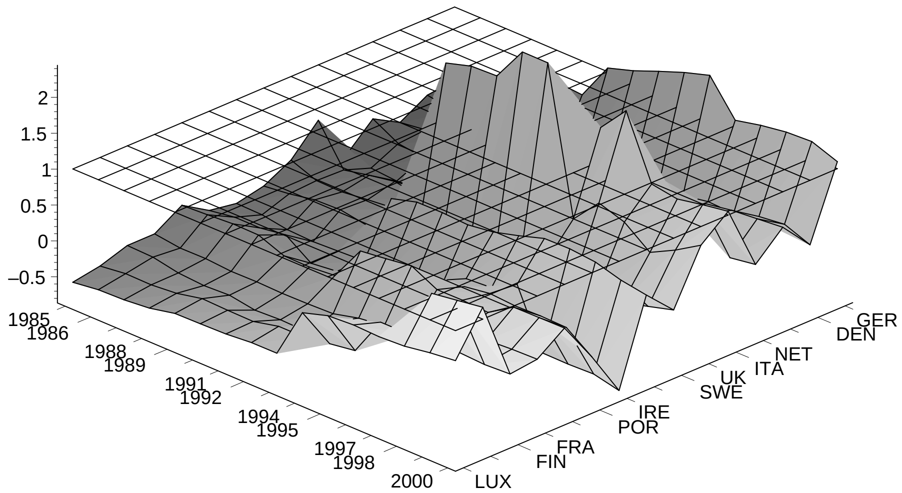

Figure 3: *Q including instruments*

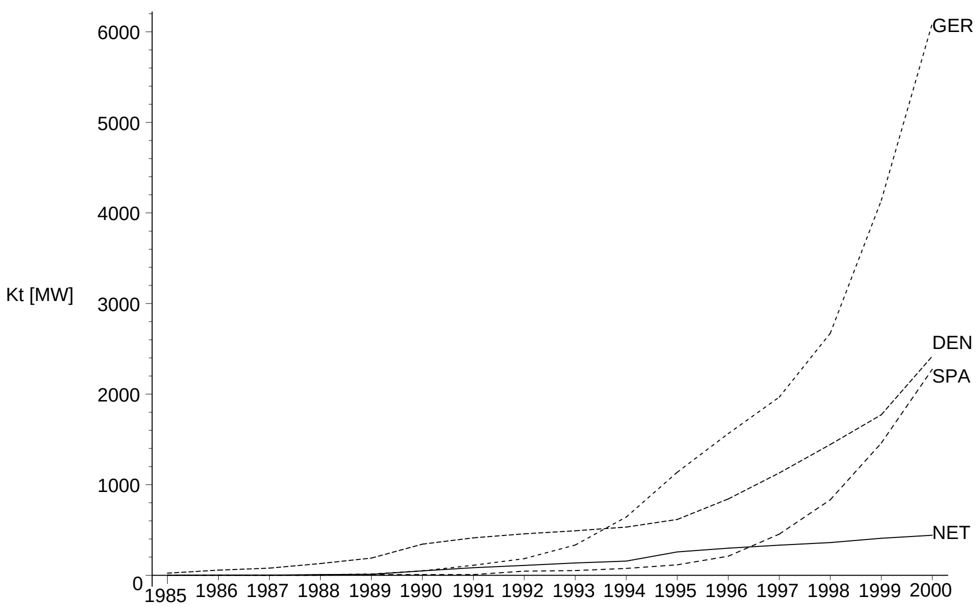

Figure 4: *Capital stock for four selected countries*

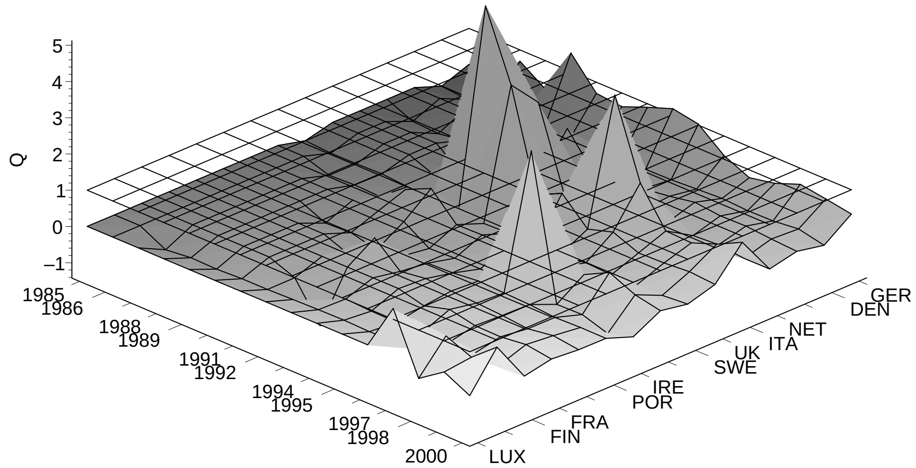

Figure 5: *Qs assuming a single investor per country*

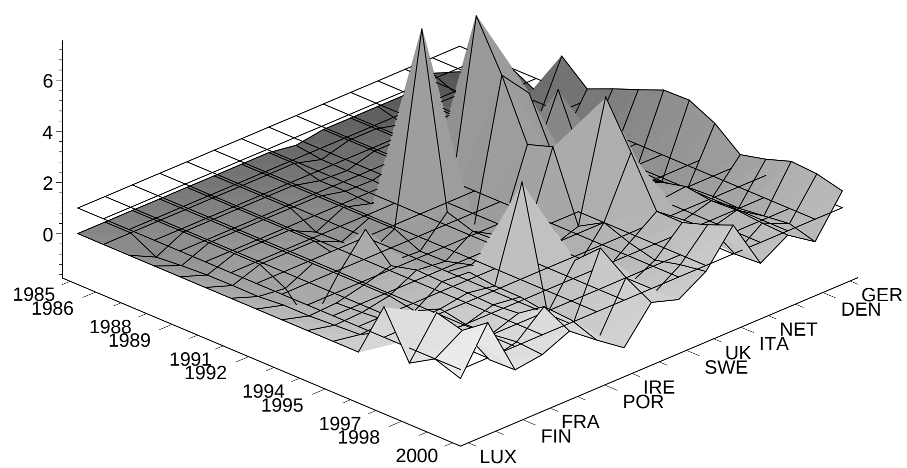

Figure 6: *Qs assuming multiple investors per country*

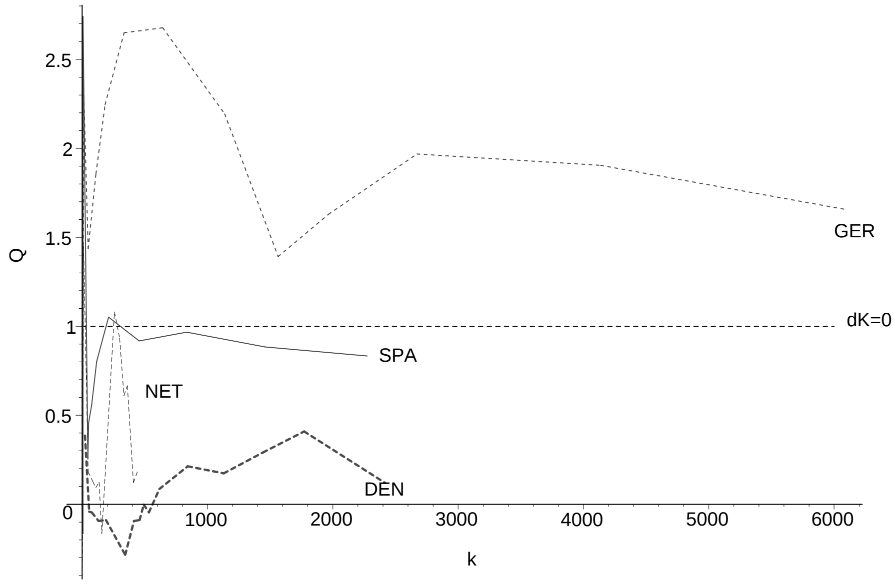

Figure 7: *Combined diagram of four countries in* (k, Q) *space*

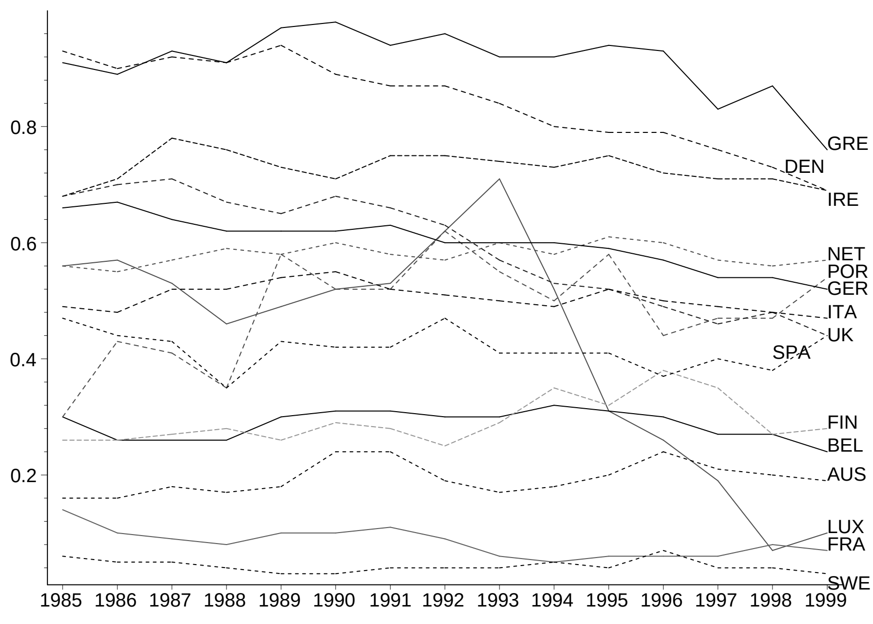

Figure 8: *Average emission in national power generation [tonne* CO_2*/MWh]*

Publications in the Report Series Research* in Management

ERIM Research Program: "Finance and Accounting"

2004

Corporate Finance In Europe Confronting Theory With Practice
Dirk Brounen, Abe de Jong and Kees Koedijk
ERS-2004-002-F&A
http://hdl.handle.net/1765/1111

Downside Risk And Asset Pricing
Thierry Post and Pim van Vliet
ERS-2004-018-F&A
http://hdl.handle.net/1765/1424

An Alternative Decomposition Of The Fisher Index
Winfried G. Hallerbach
ERS-2004-022-F&A
http://hdl.handle.net/1765/1220

A Gmm Test For Ssd Efficiency
Thierry Post And Philippe Versijp
ERS-2004-024-0F&A
http://hdl.handle.net/1765/1426

Purchasing Power Parity and the Euro Area
Kees G. Koedijk, Ben Tims and Mathijs A. van Dijk
ERS-2004-025-F&A
http://hdl.handle.net/1765/1442

The effects of systemic crises when investors can be crisis ignorant
Erik Kole, Kees Koedijk & Marno Verbeek
ERS-2004-027-F&A
http://hdl.handle.net/1765/1270

Shareholders' Voting at General Meetings: Evidence from the Netherlands
Abe De Jong, Gerard Mertens And Peter Roosenboom
ERS-2004-039-F&A
http://hdl.handle.net/1765/1332

Do banks influence the capital structure choices of firms?
Petra Daniševská, Abe de Jong & Marno Verbeek
ERS-2004-040-F&A
http://hdl.handle.net/1765/1333

---

* A complete overview of the ERIM Report Series Research in Management:
https://ep.eur.nl/handle/1765/1

ERIM Research Programs:
LIS Business Processes, Logistics and Information Systems
ORG Organizing for Performance
MKT Marketing
F&A Finance and Accounting
STR Strategy and Entrepreneurship

The Eco-Efficiency Premium Puzzle
Jeroen Derwall, Nadja Günster, Rob Bauer and Kees Koedijk
ERS-2004-043-F&A
http://hdl.handle.net/1765/1296

Conditional Downside Risk and the CAPM
Thierry Post And Pim Van Vliet
ERS-2004-048-F&A
http://hdl.handle.net/1765/1425

It Takes Two To Tango: An Empirical Tale Of Distressed Firms And Assisting Banks
Oscar Couwenberg and Abe de Jong
ERS-2004-049-F&A
http://hdl.handle.net/1765/1444

An Improved Estimator For Black-Scholes-Merton Implied Volatility
Winfried G. Hallerbach
ERS-2004-054-F&A
http://hdl.handle.net/1765/1472

Being in Balance: Economic Efficiency in the Dutch Power Market
Ronald Huisman and Christian Huurman
ERS-2004-065-F&A
http://hdl.handle.net/1765/1493

Does the mixture of policy instruments matter? An empirical test of government support for the private provision of public goods
Arjen Mulder
ERS-2004-073-F&A