

SEARCHING FOR A SUSTAINABLE SCOTLAND: AN ECONOMIC AND ENVIRONMENTAL EVALUATION

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'Tis very true my sovereign king,
My skill may weel be doubted,
but facts are chiels that winna ding,
and downa be disputed.

Robert Burns, 'A dream'

INTRODUCTION

Inevitably the current debate on Scotland's constitutional future must be conducted at many levels. Issues like security, environment, material welfare, social welfare and that indefinable factor, national self-confidence each tend to have their roots in whether, in the view of the individual voter, 'Scotland can go it alone'. On the face of it, with a current significant apparent subsidy from central government, the Right would seem to have an argument in favour of the status quo. The real issue, however, is what the future potential is were Scotland to be independent, and responsible for its own welfare.

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Snapshots of past balance sheets offer no more guide to the future than do the published accounts of large firms. To address such a question one must look ahead; in other words it is necessary to develop a formal dynamic model of the economy that can spell out the longer term effects of new policies and situations.

We have been involved in the development of a new type of macro-economic model called Natural Capital Accounting (NCA). Unlike econometric modelling, which will reflect the choice of the consumer in response to future price, NCA models compute the growth potential of the system in the light of user-defined policies, technologies and environmental objectives. Hence to use such a model on Scotland we needed the views of each political party. We contacted every political party in Scotland, stressing that our model could only determine the potential of the country in the context of user-imposed policies. We urged that those policies should include environmental and resource objectives that could move Scotland to a more sustainable state. Only the SNP responded, and then only with very broad objectives. Thus the authors have had to place themselves in the role of a future Scottish government, positing policies that enhance Scotland's potential, while meeting social, environmental and economic criteria. Some of these derive from SNP objectives.

The NCA model we used derived from a model of the United Kingdom, which we then split into Scotland and the rest of the UK, which we called Regional Ecco (Slessor et al 1994a, 1994b).

Had it not been for the exposure given to our results in the press (Bain 1995; Houston 1995; Macleod 1995; Slessor 1995; Stevens 1995), none of this would have reached the public domain. We find the lack of interest of the Scottish Office, Enterprise agencies and political parties to the model strange, if not alarming. Indeed, following the **Scotland on Sunday** publication (Bain 1995), Labour party representatives took it upon themselves to rubbish our 'Independence scenario' without taking the trouble to look at the model (see Houston 1995), and what it could do for their assessment of Scotland's future in the context of their preferred policies. In our view as objective modellers, Unionist parties could find much to support their positions.

DYNAMIC VERSUS STATIC ACCOUNTING

Much of the debate on the economic viability of Scotland has centred on 'Budgets', with the political parties 'proving' their points with numbers dug out of yesterday's statistics and heroic assumptions about the future price of this or that.

Natural Capital Accounting, as exemplified by our ECCO (Evolution of Capital Creation Options) model, is a dynamic decision analysis tool in which the user can test any policy, technology option or environmental objective that has a physical resource implication (see Appendix and Slesser et al 1994a, 1994b). Such policies may be social, fiscal, physical or demographic. ECCO takes account of demography, the economy, the environment, resources and land use, and of the interactions between these sectors. Because it measures all activities primarily in terms of the human-made capital (that is, physical infrastructure) and energy required to make them possible, it can call upon verified natural laws where appropriate. It can thus side-step many of the uncertainties associated with purely money-based projections, in which human preferences or beliefs are taken as the bottom line - things that cannot be changed. In this way, ECCO can project future possibilities in a robust, more credible way than econometric models, and considerably better than budgetary snapshots.

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Given the lack of interest in our work by the majority of the political parties, we have had to generate our own policies for Scotland. We have done this with some reluctance, for it is not our role as modellers to advocate particular policies. The reader should bear in mind that the policies we propose here are but a small subset of those that the model is capable of examining; the policies and the modelling methodology should not be confused with each other.

Nonetheless, the essentials of the positions adopted by the SNP (representing independence), Labour and Liberal Democrats (representing devolution) and Conservative and Unionist (representing the status quo) are well enough known. We have taken the status quo to be current policies carried forward for a further twenty-five years. While we agree that this is unlikely, such an evolution of the model provides a base or reference profile against which to compare other scenarios. We feel it incumbent upon the 'status quo' parties to

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offer their prescription if this one is seen as inappropriate. The results of these policies, summarised here, are discussed in greater detail in our technical reports (Slesser and Crane 1995; Slesser et al 1995a, 1995b).

The data base for the regional model depends heavily on the recently developed input-output study by the Scottish Office Industry Department (1995), to whom we are grateful for an early release of the data. The UK model from which the regional model 'RegEcco' (Crane et al 1995) was developed is described in full detail elsewhere (Slesser et al 1994a).

USER-DEFINED POLICIES

Like every developed country in the world, Scotland is at present intrinsically unsustainable in the long term. Our aim then must surely be to identify a set of policies which move the country towards 'sustainability' (as defined below). Thus in our analysis we set a distant time horizon of twenty-four years, taking us to 2019. We apply our knowledge and understanding to propose what we believe to be appropriate policies. We will have overlooked many possibilities or been too timid.

One advantage of RegEcco is that policies can be separately imposed (post-independence or post-devolution) for Scotland and the rest of the UK.

No single event or policy can secure a sustainable future for any country. Nor can the promise of potential always turn into reality. It is important to emphasise again that the outcomes we present here represent the potential of the economy when deploying only fiscal, economic and technology instruments. Possible life-style or cultural changes are not, at this time, treated. In our view, turning potential into reality depends very much upon the wisdom of the government (whether devolved or autonomous) and how the policies pursued are presented to and viewed by the outside world.

For the moment we have avoided issues like land ownership, European Union membership, fishing rights, foreign ownership of companies and organisations, GATT and many others that do concern the populace and which would loom large in any future Scottish parliament. On independence we re-allocate oil and gas royalties. Initially Scotland acquires 68% of UK royalties, but by 2019 this has fallen to 30%, as oil resources in the Scottish sector diminish and gas extraction in the rest of the UK expands.

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We start by offering an interpretation of sustainability that has been widely accepted:

A sustainable society is one that is engaged in wealth production of such a nature, and at such a rate, that:

- the natural physical environment is able to assimilate the wastes from that society and sustain the physical means of economic support on a continuing basis (often referred to as environmental space), and
- the economic system can maintain an adequate level of human welfare

(Slessor et al 1994b, p.2)

This is, of course, a very anthropocentric view of nature. What in effect we are saying is that we want to preserve the natural environment so that we can continue to exploit its resources and enjoy its benefits on a sustained basis. We do not address the issue of intrinsic value of nature here, largely because we feel that it is not quantifiable.

POLICIES FOR SUSTAINABILITY

The policies that we explored were dictated by our definition above, and had the following objectives:

- zero or positive balance of international payments;
- taxation meeting all government outlays;
- sufficient growth in wealth generation so as to finance environmental measures, improve housing, pay for energy conservation, improved medical services, better pensions, improved transport infrastructure, etc;
- enhanced measures of environmental conservation to at least match the targets set by the Great Britain Royal Commission on Environmental Pollution (1994);
- investment that decreases Scotland's dependence on oil and gas, as these are finite resources likely to be scarce within the lifetimes of today's teenagers.

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Note that these desiderata all require investment. In other words we are not here proposing sustainability on the back of a reformed and less material populace, though that is certainly a path worthy of consideration.

These desiderata are translated into the following fourteen policies, each of which we explored separately by way of assessment. Each is set in motion in the year 2000, an arbitrarily selected date, and maintained to the year 2019. These give rise to two policy scenarios. In scenario 3, Scotland is an integrated part of the UK, but the policies apply only to Scotland (and we record the outcome for Scotland only in this paper). In scenario 4, Scotland is autonomous, and again the policies are applied only to Scotland. Scenario 1 is the reference UK scenario, in which none of these policies are implemented in either Scotland or the UK. In scenario 2, Scotland is autonomous, but continues to run the business-as-usual policies in place in scenario 1.

The policies explored in scenarios 3 and 4 are:

- 1 Massive energy conservation. Here we divert up to 15% of annual investment in industry, services and domestic housing specifically to energy saving measures. Though this cuts back on the rate of growth of the economy initially, the economy still grows, and energy use continues to rise. At first, this rise is slow, but it increases over time. Jobs are not greatly affected as reduced industrial investment is offset by increased jobs in energy conservation activities.
- 2 Following the recommendations of the Great Britain Royal Commission on Environmental Pollution (1994), we explore what happens if there is a shift to public transport in which passenger-kilometres travelled by car in 2009 are 75% of the current rate of car usage. Nitrogen oxides emissions fall substantially, with little effect on economic growth. Reduced expenditure on private cars is swallowed up by consumption elsewhere.
- 3 We postulate that the average private car occupancy rate rises from the present value (just over 1.5 people per car) to 2 people per car by 2009. This has a much more powerful effect on nitrogen oxides and carbon dioxide emissions than policy 2.
- 4 UK government objectives for sulphur dioxide emissions (Department of the Environment 1994) are implemented from 2000 onwards.

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- 5 The government funds investment in environmental measures on a substantial scale. In the model, we permit this only when unemployment levels fall below 5%.
- 6 Pensions are increased by 50% in real terms, funded by a rise in taxes.
- 7 Unemployment benefit is increased by 50% in real terms, funded by a rise in taxes.
- 8 Investment in the National Health Service is increased by 20% in real terms.
- 9 Investment in state education is increased by 20% in real terms.
- 10 Government financed housing grants are increased 300%.
- 11 Following the identification of a feasible 1500 MW of renewable energy sources for electricity (Hydro-Electric et al 1994), that potential is implemented at the rate of 75MW per year from 2004. This is expensive, but well within the country's ability to finance.
- 12 Experiments with the UK model have demonstrated that even massive investment in renewable energy cannot replace fossil energy on any substantial scale before North Sea oil becomes prohibitively expensive to extract (Crane 1994), and that carbon dioxide outputs rise well above internationally agreed targets under the reference scenario. While recognising the great uncertainty regarding its long-term safety, nuclear power represents a means of extending the time-scale over which renewable energy sources can penetrate the market for electricity. The uncertainty of radioactive waste management issues makes this policy something of a gamble.

We activate this policy by increasing the existing Non-Fossil Fuel Obligation of 20% to 70% in 2004. This makes sense because, in 1995, Scotland already had a high non-fossil electricity generation capacity, and this maintains that objective. The result of this policy is the requirement for a new 1320MW nuclear power plant to be operating by 2006. Without it, carbon dioxide emission rates rise even higher, to levels that are quite embarrassing. Coal demand still remains higher than in 1995. Note that an alternative option might have been to extend the life of existing nuclear power stations, but without a direct proposal from Scottish Nuclear that this is possible or likely, we leave this aside.

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- 13 From 2004 onwards the government restricts the rate of exploitation of offshore oil to 75% of the year-2000 rate, in order to lengthen the period of its physical viability.
- 14 The government, whether UK or Scottish, will have to convince holders of capital located within Scotland that there will be sound financial management. We run scenarios 3 and 4, therefore, in such a way that there will be no public sector borrowing requirement. Taxes levied in Scotland will pay for all government expenditure. In addition, there should be a balance of international payments. The importance of this point cannot be overstressed because Scottish industry today is to a substantial extent foreign-owned (including the rest of the UK in this definition of 'foreign'), and is largely a processor of intermediate goods. This implies considerable imports, though these are partly balanced by substantial exports. The relatively small size of Scotland's consumer goods sector also implies large imports in order to satisfy consumer demand. Having got into this position, Scotland can only balance her books by export of physical resources, superior manufacturing technology and intellectual services (including a strong financial sector). Fortunately the oil surplus and a substantial export of electricity to the rest of the UK provide a valuable cushion, but no long term solution to sustainability.

PROBLEMS AND PARADOXES OF GOVERNANCE

The problem facing the governments of developed economies today, including the UK and any Scottish government, is that objectives of higher employment through economic growth and lower environmental impact are mutually incompatible, unless, and we emphasise this, some of the country's investment potential is directed towards mitigating harmful effects on the environment. This redirection diminishes the country's economic growth, and so influences employment potential. Another joker in the pack is the fact that new investment is to a large extent concerned with the replacement of labour. An analysis of the employment data (King 1995) reveals that for employment to increase, net investment has to exceed a certain critical level. In other words, the rate of investment has to be much higher than the rate of capital consumption, and when investment is diverted to environmental objectives this situation is exacerbated.

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It follows that only an economy that can generate a substantial surplus for investment can hope to solve the twin objectives of higher employment and an improved environment. Yet there is a Catch-22 in this also, because a 'substantial surplus' implies a higher rate of economic activity, hence more energy use and therefore more pollution. Increased technological efficiency may create some room for manoeuvre, but, in the absence of some qualitative change, it cannot get us out of this situation. Some would advocate reduced material consumption or redirection of human aspirations from full employment (for example, through a citizen's wage) as solutions to this problem. We do not enter into these arguments here, although the methodology that we employ could be used to explore some of the ramifications.

Another paradox facing developed economies is that energy conservation, while reducing energy use per unit service, makes the economy more efficient, so that, after a delay of some years, it grows more rapidly than before, eventually consuming more energy than ever (albeit more efficiently!). This effect has been described as the rebound effect (Crane 1995). Again, breaking this cycle requires a qualitative change, such as a constraint on consumption. No government would find such a policy easy to pursue. It is, of course, perfectly possible to stabilise energy use with a stagnant economy, but this holds no attractions. Other solutions must be found.

Our model, when applied to the United Kingdom as a whole, shows a declining total employment prospect, even with a rising output. A simple switch of the benefits of oil resources accruing to Scotland (and no other policy) results in steeply rising energy use, with all its polluting side-effects (carbon dioxide, sulphur dioxide, nitrogen oxides, etc). As a result, within twenty years Scotland is less sustainable than now because wealth has been diverted to consumption rather than investment. This mirrors the events that have occurred in the UK as a whole since oil was first brought ashore at St. Fergus. Thus, ownership of oil resources alone is no long-term panacea, and other policies are essential.

EXPLORING SOLUTIONS IN THE SCOTTISH CONTEXT

We assume, arbitrarily, that Scotland attains autonomous status in the year 2000 (in scenarios 2 and 4). An autonomous government of that day would find itself in a position of being a significant beneficiary of oil royalties with

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two thousand million tonnes of proven reserves still untapped. In this study we assume that it will also inherit a substantial portion of the UK national debt, and a current account imbalance.

The RegEcco model produces some two thousand outputs. Since there are two over-riding considerations, jobs and environment, we select from this profusion of potential indicators six criteria that will help the reader to assess the outcome of the policy trials. The criteria are:

- 1 Material Affluence Index, expressed as a ratio of the 1994 value
- 2 Average hours of work available per head of the working population, ignoring whether all choose to work (i.e. ignoring participation rate)
- 3 Carbon dioxide output, both total and sectoral breakdowns
- 4 Sulphur dioxide generated, and emitted to the atmosphere
- 5 Long-term physical sustainability: the fraction of energy use arising from renewable sources (i.e. not fossil fuels or nuclear energy)
- 6 Percentage of national wealth creation rate diverted as tax to government, whether central or local (i.e. average overall taxation rate)

INTERPRETATION OF RESULTS

These indicators are plotted in figures 1 to 6, with results from all four scenarios shown side by side for comparison. Broadly, implementation of the fourteen policies can be seen to enhance Scotland's position both economically and environmentally, whether Scotland is autonomous or not. However, in neither case are they enough to lead to a sustainable Scotland in the full sense of our definition.

Independence provides a growing surplus for investment. The Scottish economy has the potential to generate more jobs (figure 2), more economic development, develop more renewable energy, stimulate efficient energy use and still generate a substantial surplus for environmental initiatives. Yet all environmental indicators (figures 3 and 4, for example) continue to show deterioration (that is, pollutant generation continues to rise) in the long term. Even the sustainability options pursued in scenarios 3 and 4 fail to do more than stabilise emissions at current rates. That is to say, economic

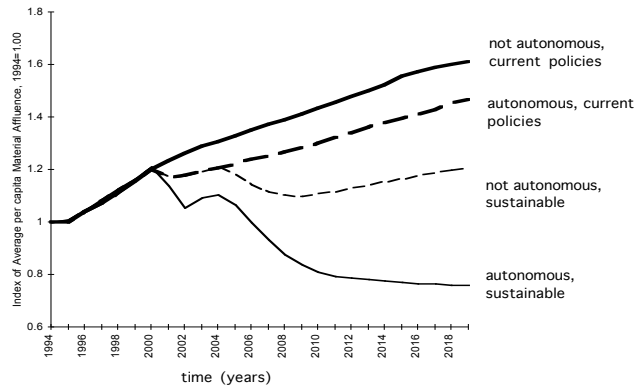
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development coupled to real environmental improvement proves elusive. Worse still, the country's long-term dependence on non-sustainable energy resources (that part of energy requirements not accounted for by the trends in figure 5) remains all too high at over 95%, even with 1500MW of extra renewable-sourced electricity in place under scenarios 3 and 4! The problem is simply one of increasing affluence driving up consumption.

The positive environmental impacts that are attained by scenarios 3 and 4 do reduce the growth of material affluence under both governmental regimes (figure 1), although for the autonomous Scotland the level stabilises above the 1995 level in the long-term. This is in spite of increased employment opportunities (figure 2); the increased wealth generation capacity is slow to trickle down to the populace, reflecting the nature of much of the Scottish manufacturing base. The overall health of the economy and high employment contribute to a reduced taxation rate under autonomy (figure 6), even with the additional government expenditure entailed by the sustainability policies.

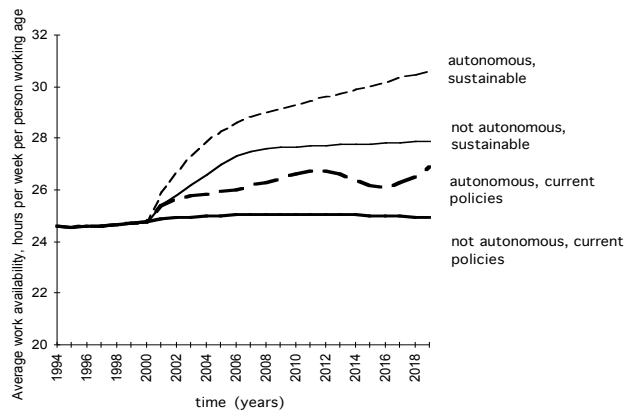
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Figure 1
Evolution of Per Capita Material Affluence Indicator under Scenarios 1 to 4



This indicator is a simple average, saying nothing about wealth distribution patterns. It is not intended as a quality of life indicator, and the decline seen under the 'sustainable' scenarios should not necessarily be viewed as negative. Note, for example, that under scenario 3 the indicator stabilises above the current value.

Figure 2
Evolution of Average Work Availability under Scenarios 1 to 4



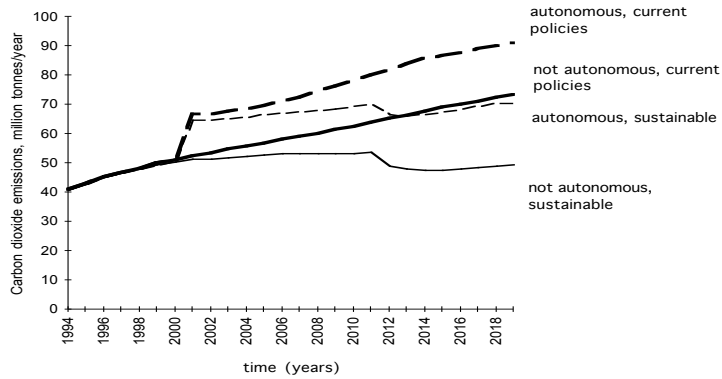
This indicator represents an average value for all people of working age; that is, not taking account of full-time students, house-workers and those pursuing other lifestyles. In 1994, the UK

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average participation rate was approximately 75%, yielding an average working week of roughly 33 hours for those actively seeking work when applied to the Scottish population.

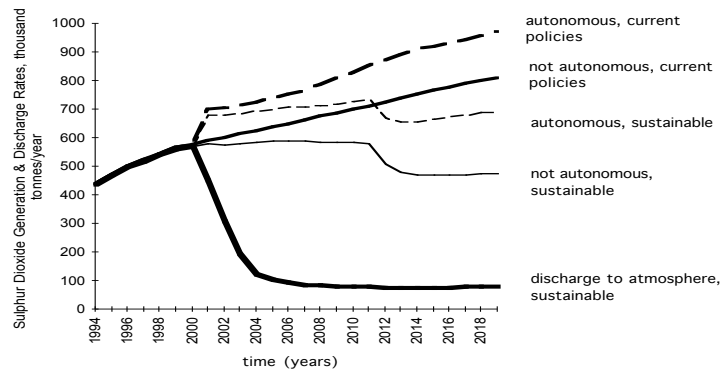
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Figure 3
Evolution of Carbon Dioxide Emission Rates under Scenarios 1 to 4



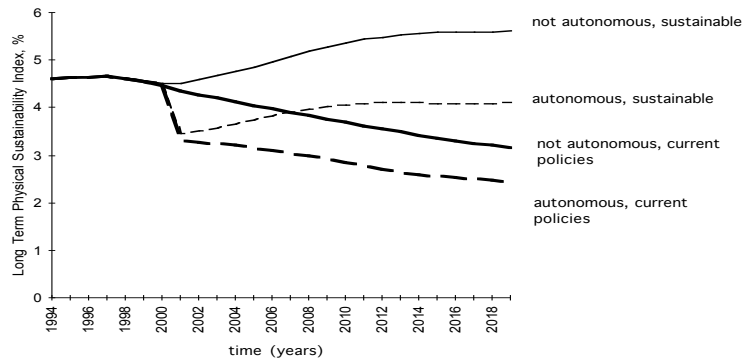
Carbon dioxide is implicated in global warming mechanisms. The total carbon dioxide emission rate is shown here. The decrease in the indicators for the 'sustainable' scenarios around 2014 is a result of the completion of the new nuclear power station (see text) and an attendant reduction in coal-fired electricity generation.

Figure 4
Evolution of Sulphur Dioxide Emission Rates under Scenarios 1 to 4



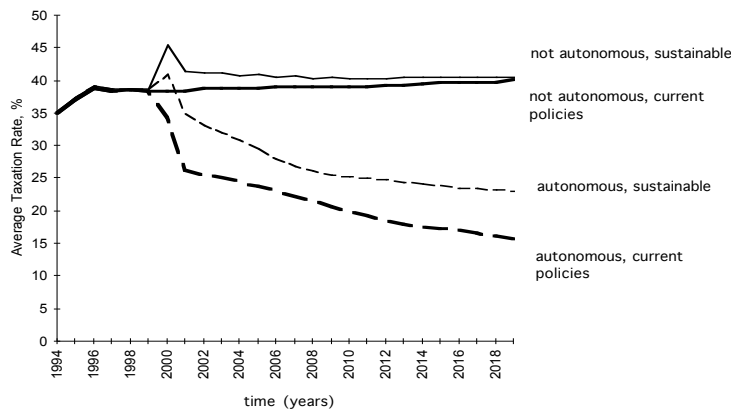
Sulphur Dioxide is implicated in air pollution and acid rain problems across national boundaries. The decrease in this indicator for the 'sustainable' scenarios around 2014 is a result of the completion of the new nuclear power station (see text) and an attendant reduction in coal-fired electricity generation. The lowest solid line shows the emission standards implemented in the sustainable scenarios, with the difference between generation and emission rates being absorbed by flue gas desulphurisation technologies (at an attendant capital cost).

Figure 5
Evolution of Long Term Physical Sustainability Indicator under Scenarios 1 to 4



This indicator reflects the fraction of total Scottish primary energy demand derived from renewable energy resources. Solar energy input to agriculture is included in the figure, as is hydro-electricity (the latter raising the Scottish value considerably above the UK average of about 1%). This indicator declines under the current policies scenarios because the hydro-electric capacity does not increase, while energy demand does. Introduction of small-scale renewables in the 'sustainable' scenarios reverses this trend, but still leaves the economy heavily reliant on non-renewable energy sources.

Figure 6
Evolution of Average Taxation Rate under Scenarios 1 to 4



The average taxation rate is expressed as a percentage of the gross physical wealth creation rate of the economy.

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Despite the very mixed picture presented by these scenarios, we have no doubt that some combination of appropriate taxation measures, cultural change, massive investment in renewable energy systems, and diversion of created wealth to non-wealth-creating activities such as environmental protection and the Arts could produce a sustainable path for both Scotland and the rest of the UK. The measures required for each region might be different, in view of the existing geographical, economic and cultural differences. We hope very much that others, whether from political parties, industry, environmental groups or government, will work with us to elicit these. The work is feasible. The challenge is there.

CONCLUSION

The environmental and social initiatives that we have outlined for Scotland are beneficial in every sense - jobs, environment, potential. Autonomy also offers potential, both directly and by allowing greater freedom in the search for a sustainable path for Scotland. Some will see this alone as a justification for an autonomous Scotland, while others, believing in the benefits of the Union, will prefer to see them implemented in an integrated UK. What is clear is that autonomy by itself offers no solution to the paradoxes of governance for the Scottish economy, and that sustainability as we define it is very hard for any country to achieve.

At least we hope to put to rest the idea that Scotland cannot be a viable economic entity. The major challenge facing Scotland and all developed countries, is not the redressing of internal subsidies and imbalances between developed nations, but rather the redressing of the balance between industrialised humanity and Nature.

APPENDIX: THE ECCO METHODOLOGY

The underlying principles of this novel form of model are outlined briefly below, and are discussed in greater detail in volume 1 of the UK ECCO User's Guide (Slesser et al 1994a). ECCO is not a forecasting model in the traditional sense, but a decision support tool, designed as an interactive component within the policy making process. The user may develop indicators via the model or use other criteria in determining the desirability of scenario outcomes. It is worth noting that the user is not required to

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define future growth rates (as is the case with most econometric models), nor guess at future resource prices.

The structure of the ECCO model is predicated upon the principles of Natural Capital Accounting, which views the world around as consisting of natural capital and human-made capital.

Natural capital may be renewable (like forests), recyclable (like metals) or depletable. Of the latter class, the most important examples are energy resources, the reason being that no transformation of any kind can take place without an exchange of energy in the form of thermodynamic work. In other words, all economic activity is predicated on the exchange and degradation of energy.

The physical contribution of human beings to this thermodynamic work can only be trivial in an industrialised economy. Typically a healthy male can do no more than 0.7kWh of physical work per day, which any electricity company will sell for about 7p (1995 prices). Our economy has been brought to its present state by human thought, knowledge and endeavour coupled to the use of energy to carry out the many, many transformations that occur daily.

There is an additional necessary factor, human-made capital, required to mediate the use of energy, provide infrastructure, handle pollution and extract resources. This is created by the manufacturing economy.

By quantifying the activities of the economy in terms of the natural capital (energy) embodied in creating and operating human-made capital, it is possible to make a model of an economy which rigorously reflects interactions between humans and their environment. Such a model is radically different from an econometric model which can reflect only human-human interactions through its chosen medium of perceived value.

The natural capital accounting approach has been made operational over the last seventeen years through development of the ECCO (Evolution of Capital Creation Options) model, of which there are now several versions including a world model and the UK models presented in this paper. Such models can test the long-term outcomes of any policy, technology or environmental objective that has a resource implication (and there are very few that do not!).

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