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The Additional Precision Provided by Regional Specific Data: The Identification of Fuel-Use and Pollution Generation Coefficients in the Jersey Economy

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The Additional Precision Provided by Regional-Specific Data: the Identification of Fuel-Use and Pollution Generation Coefficients in the Jersey Economy[1]

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Abstract:
This paper presents findings from the database construction stage of a multi-sectoral economy-environment model of the Jersey economy. The availability of the very rich database used to construct a set of economy-environment accounts and technical coefficients for Jersey provides the opportunity to explore a specific example of what is a widely discussed problem in regional accounting and modelling. This is the appropriateness of region-specific data collection. The work reported here focuses on environmental applications, specifically the problem of regional differences in technology and consumption patterns with respect to energy use and pollution generation. This is an issue attracting considerable current interest and debate in the UK. A significant degree of responsibility for setting and achieving sustainability objectives has been devolved to the Scottish Parliament, National Assembly for Wales and the English Regional Development Agencies, which implies a need to develop economy-environment accounting and modelling frameworks at the regional level. One issue that has been prominent in the move to develop regional empirical frameworks has been the availability of, and investment required to generate appropriate regional economy-environment accounts. The findings reported illustrate the importance of this issue for a small regional economy like Jersey.

Key words: environmental input-output tables, region-specific data

Introduction

A significant degree of responsibility for setting and achieving UK sustainability objectives (Department of the Environment, 1996) has been devolved to the Scottish Parliament and the National Assembly for Wales and delegated to the English Regional Development Agencies (RDAs). Therefore regional policymakers in the UK need to develop an appropriate database and framework for analysis. One active debate amongst the devolved authorities and the UK Environment Agency is the extent to which region-specific environmental and economic data are required to perform this task. The possibility of adjusting more readily available national data is seen as a tempting option. But what is the likely size of the loss in information if such an option is pursued?

The issue of using national data to account for, and model, activity at the regional level is not new. In the context of standard input-output accounting this has been the subject of ongoing debate for a number of years, and Isserman (1980), Round (1983) and Richardson (1985) review of how national technical coefficients have been adjusted to apply at the regional level. In the case of environmental accounting, where region-specific technical coefficients for economy-environment relationships are not available the natural source of proxy coefficients is the national economy, if the polluting technologies and those consumption (mainly fuel use) patterns that determine pollution generation can be expected to be similar.

In this paper an economic-environmental database constructed for Jersey is used to identify and assess the added precision gained from estimating and using Jersey-specific environmental coefficients (physical average energy-use and pollution intensities) as compared to those that can be derived using UK data[2]. This exercise also allows an indirect test of whether the Jersey regional economy is similar to that of the UK in terms of its key

[1] The research reported here was part of a PhD study sponsored by the Policy and Resources Committee of the States of Jersey. I would like to thank staff at the States of Jersey and all the Jersey firms and residents who contributed information that went into the construction of the IO table and environmental accounts used here. I am particularly grateful to Dr David Coley, Centre for Energy and the Environment, Exeter University for his input and advice on estimating pollution generation in Jersey, and my PhD supervisors, Kim Swales and Peter McGregor, at the University of Strathclyde for their ongoing input and advice. I am also indebted to Michael Romeril, Environmental Adviser to the States of Jersey and Rocky Harris, Head of Environmental Accounts Branch at ONS for comments and advice regarding this and related environmental work. An earlier version of this paper was presented at a meeting of the ESRC Urban and Regional Study Group, Strathclyde Business School, Glasgow, UK in January 2002.

[2] Jersey is not in fact a region of the United Kingdom (or any other larger nation), as it is an independent self-governing state. However the Jersey economy is very closely integrated with that of the UK, sharing its language, currency, exchange and interest rates. Moreover, the majority of Jersey's trade flows are with the UK. Therefore, in the absence of Jersey-specific data, the UK would seem to be the natural choice of a proxy national economy from which to draw estimates of parameter values (where appropriate UK data exist).

structural characteristics, and therefore of the value gained from the type of region-specific accounting, modelling and policy analysis currently being undertaken for Jersey[3].

The remainder of the paper is structured as follows. Section 2 gives a brief overview of the method used to construct the economy-environment accounts for Jersey. These accounts are then used to derive a set of Jersey-specific technical coefficients relating the direct emissions intensity of activity in each production and final demand sector. For comparative purposes, in Section 3 a corresponding set of UK pollution coefficients is constructed and adjusted to apply to activity in Jersey. Sections 4 provides an assessment of the degree of added precision gained from estimating and using the Jersey-specific coefficients for environmental accounting purposes relative to what is achieved using the UK-adjusted set. Section examines the factors that are likely to explain the variation in results for Jersey using the region-specific and UK-adjusted pollution coefficients. In Section 6 the wider implications of these results for constructing regional IO tables are considered. Finally, Section 7 contains a summary and conclusions.

2. Construction of a Consistent Set of Economy-Environment Accounts for Jersey

The States of Jersey have made sustainable development a key policy objective. As an independent, self-governing state Jersey has full responsibility for achieving the commitment to sustainable development stated in the States of Jersey's annual policy report in 1995 (States of Jersey, 1995), and the environmental objectives stated in the States' Environmental Charter, endorsed in 1996 (States of Jersey, 1998). Credible devolved decision making on environmental issues, and sustainability in general, requires an appropriate database and framework for analysis. In this context, Jersey's requirements mirror those of the devolved administrations in the UK.

The NAMEA Approach to Economy-Environment Accounting

NAMEA is an acronym for 'National Accounting Matrix including Environmental Accounts'. The concept of a NAMEA database originated in the Netherlands and focuses on the idea of providing an integrated set of economic and environmental accounts. The economic accounts are the national accounts in input-output (IO) matrix format and are presented in monetary units. The environmental accounts are reported in physical units and focus on presenting information on material inputs of natural resources (particularly energy resources) and outputs of residuals (pollution and waste materials) at a level of sectoral detail consistent with the economic accounts.

A key advantage of the NAMEA approach is the mutual consistency between environmental and economic data for analyses such as input-output accounting and modelling of environmental pressures in the economy. One result of the pilot work in the Netherlands is that the statistical office of the European Union (Eurostat) has launched a project to promote the construction of NAMEA accounts in all EU member states (see Haan 2001). This project is still in its infancy; nonetheless, the UK has already adopted the Eurostat guidelines for the development of a trial version of a 76-sector economic-environmental database. Jersey is not a member of the EU. However, the States of Jersey are keen to adopt national accounting practices that are consistent with those used in other European economies. Therefore, a NAMEA-style approach has been adopted to constructing a set of accounts that will form an appropriate database for economic-environmental analyses in Jersey.

The Jersey NAMEA (1998)

In the 1998 environmental accounts for Jersey[4] the standard economic input-output (IO) accounts are augmented with information on the physical use of different types of energy and the direct pollution generation for each of the IO production and final demand sectors.

Because the States of Jersey had stated an interest in both economic and environmental issues from the outset, it was possible from the start to gear the accounting process towards construction of a NAMEA framework. Specifically, particular attention was paid to developing a database that would allow identification of economic activities that are likely to be important in terms of environmental questions. Efforts were also made to ensure that adequate and appropriate data were collected to develop a consistent set of environmental accounts for the same sectoral breakdown as in the economic accounts.

In accounting for pollution generation, information is required on the total flow of emissions (of each pollutant) from each individual sector (and final demand group) of the economy to the environment. However, the flows of pollutants from any one activity over a given time period (e.g. the current base year of 1998) cannot generally be directly observed. This implies a need to make certain assumptions regarding the relationship between economic activity and pollution generation. The key aspect in determining the flow of emissions that

[3] See Learmonth *et al* (2002), McGregor *et al* (2001) and Turner (2002).

[4] Construction of the 1998 environmental accounts for Jersey is described in detail in McGregor *et al* (2001) and Turner (2002).

accompanies economic activity, certainly in the case of Jersey, proves to be the amount of different types of fuel used and the type of technology used to combust it, although non-fuel use sources also need to be identified.

The standard assumption is that emissions are a linear function of the volume of fuel combusted during that activity plus the levels of output from other polluting processes (see for example Beauséjour *et al* (1994), Vaze (1997)). Thus, for each production sector, i, emissions of each pollutant, k, are determined as:

$$(1) \qquad P_{k,i} = m_{k,i}X_i = (\sum_{j,t} (e^k_{ijt}.f_{ijt}) + n^k_i)X_i, \quad \forall\ i = 1,\ldots, I,\ k = 1,\ldots, K,\ j = 1,\ldots J,\ t = 1,\ldots,T$$

where e^k_{ijt} is an emissions factor, identifying the amount of pollutant k that is generated when sector i uses (combusts) one unit of fuel j using technology/process t, f_{ijt} is the amount of fuel j used by sector i using technology t, and n^k_i is an output-pollution coefficient quantifying the non-fuel-combustion-related generation of pollutant k per unit of output in sector i.

Emissions are determined in the same way for each final demand category, z:

$$(2) \qquad P_{k,z} = m_{k,z}C_z = (\sum_{j,t} (e^k_{zjt} \,.\, f_{zjt}) + n^k_z)C_z,\ \forall\ z = 1,\ldots, Z,\ k = 1,\ldots, K,\ j = 1,\ldots J,\ t = 1,\ldots,T$$

where C_z is expenditure by final demand category z.

The economic and environmental data contained in the NAMEA accounts can also be used to derive a set of direct average emissions intensity coefficients that relate the generation of emissions to total output in each sector and expenditure in each final demand category. These take the form introduced by Leontief (1970) for economic-environmental IO analysis (the first empirical application of this system is the US study by Leontief & Ford, 1972) and are represented in (1) and (2) by $m_{k,i}$ and $m_{k,z}$ respectively. Basically a set of Leontief pollution coefficients relate the direct generation of emissions of each pollutant, k, to the gross outputs of each sector, i, and to the total expenditure of each final demand category. In other words, the assumption of a constant linear relationship between the use of inputs and the production of output is carried over from the standard IO framework to the environment. This means that we impose the assumption of a linear relationship between economic activity and pollution generation, where each unit (in monetary terms) of sectoral output is accompanied by a constant amount of each pollutant (in physical terms).

The value of sectoral outputs of Jersey production sectors, the X_i^ϑ, and of expenditure by Jersey final demand sectors, the C_z^ϑ (the superscript ϑ indicates Jersey-specific variables) in equations (1) and (2) are given by the standard IO tables for Jersey (for 1998)[5]. Therefore, the additional data requirements to estimate pollution-by-sector in Jersey (1998) are estimates of the amount of each type of fuel combusted by each sector using different technologies (f_{ijt}^ϑ and f_{zjt}^ϑ) and of the fuel combustion and non-combustion emissions factors ($e^kT_{ijt}^{\vartheta}, e^k_{zjt}{}^{\vartheta}, n^k_i{}^\vartheta$ and $n^k_z{}^\vartheta$).

Table 1. Different Types of Fuels Used In Jersey

Energy/fuel type			Type of use
Electricity			Heating/lighting
Gas, Oil & Fuel Distribution:			
	Coal		Heating
	Gas		Heating
	Oil:		
		Standard grade kerosene	Heating
		Gas oil	Heating/electricity generation
		Light fuel oil	Heating
		Heavy fuel oil	Electricity generation
		Low sulphur kerosene	Greenhouse CO2 enrichment
		Petrol/derv	Automotive

5 The Jersey IO tables for 1998 are available on request from the author at Hkaren.turner@strath.ac.ukH.

In the Jersey IO accounts all energy commodities are imported by the two energy supply/distribution sectors, ‘Electricity’ and ‘Gas, Oil & Fuel Distribution’. Sales of these commodities for use as inputs to production/final consumption in different sectors of the economy are recorded in monetary units (£million) along the ‘Electricity’ and ‘Gas, Oil & Fuel Distribution’ rows of the IO table. However, corresponding data were also collected on the physical use of the eight fuel types supplied by ‘Gas, Oil & Fuel Distribution’ for use by each production sector and final demand category identified in the IO accounts. Table 1 above identifies the nine different energy types and the type of activity they are used for in Jersey.

The second element of the environmental accounts is the physical amount of pollution generated by economic activity in Jersey in 1998. As explained above, this is determined by estimating (1) and (2) for each production sector and final demand category respectively. The Jersey economy has a very small manufacturing sector, with none of the heavy industries where production processes themselves are often pollution intensive (independent of energy use). We would therefore expect emissions from fuel/energy use to be the main source of pollution in Jersey. In other words, we would expect the elements $n^{k}_{i}{}^{\vartheta}$ and $n^{k}_{z}{}^{\vartheta}$ for Jersey in equation (1) and (2) to be equal to zero across most production sectors and final demand categories respectively, meaning that emissions will depend primarily on the type and amount of fuel used and on combustion technology.

For example, emissions from heating-oil-use are a function of both the type of heating oil (kerosene, light fuel oil or gas oil) and on the combustion technology (heating system) used. Emissions are also produced when gas oil is used (along with heavy fuel oil) in the production of electricity, which involves yet another different type of combustion technology. In terms of *motive* fuel use, emissions are a function of the both the type of vehicle used (combustion technology) and what type of fuel the vehicle runs on. Jersey emissions factors, that is the $e^{k}_{ijt}{}^{\vartheta}$ and $e^{k}_{zjt}{}^{\vartheta}$ in equations (1) and (2), for the motive and non-motive fuel types and technologies were identified in an earlier study (Coley, 1994, which adapts IPCC and Warren Springs Laboratory (WSL) emissions factors to reflect polluting technology in Jersey). The Jersey emissions factors are discussed and reported in detail in McGregor *et al*, (2001) and Turner, (2002).

There is another type of motive fuel use in Jersey: aviation fuel is used to operate private and commercial aircraft[6]. Data were available on the total amounts of aviation gas and jet fuel imported and supplied in 1998. However, the amount of aircraft fuel supplied in any one economy is unlikely to correspond to the amount of fuel combusted within that economy’s borders. Therefore we adopt the WSL concept of ‘aircraft movements’, which is consistent with Coley (1994). An aircraft movement is one landing/takeoff cycle of up to 1000 metres and emissions factors are stated in terms of each movement rather than the amount of fuel consumed. Therefore, in estimating emissions from aviation fuel use, the number of aircraft movements (take-off and landing cycles at Jersey airport) in 1998 is taken as a proxy for the $f_{ijt}{}^{\vartheta}$ and the emissions factors, $e^{k}_{ijt}{}^{\vartheta}$ are given for the WSL estimates for a ‘small airport’ (see McGregor *et al*, 2001, and Turner, 2002). All direct emissions generation from aircraft movements is allocated to the ‘Sea & Air Transport and Transport Support’ sector[7].

There are several sources of pollution, summarised in Table 2, in Jersey that are not related to the combustion of fuels. In the sectors and final demand groups where such non-fuel-combustion related emissions are generated, $p_{k,i}{}^{\vartheta}$ and $p_{k,z}{}^{\vartheta}$ are calculated by including the additional non-fuel combustion related element, $n^{k,\vartheta}_{i}.X_i{}^{\vartheta}$ and $n^{k,\vartheta}_{z}.C_z{}^{\vartheta}$, in the estimation of equations (1) and (2). The emissions factors, $n^{k}_{i}{}^{\vartheta}$ and $n^{k}_{z}{}^{\vartheta}$, were identified from the Coley (1994) study.

Adding non-fuel combustion related emissions to total emissions from fuel use for each production sector, i, and each final demand category, z, gives us total emissions of each pollutant by each sector and final demand category.

The NAMEA data on emissions-by-sector can then be used to derive a set of direct average emissions intensity coefficients relating the generation of emissions to total output/expenditure in each production and final demand category. These are the $m_{k,i}{}^{\vartheta}$ and $m_{k,z}{}^{\vartheta}$ parameters needed for equations (1) and (2). Formally, what this gives us is the (kxi) Jersey-specific matrix $\mathbf{M_i}^{\vartheta}$ of output-pollution coefficients for each pollutant, k, and each production sector, i, and the (kxz) Jersey-specific matrix $\mathbf{M_z}^{\vartheta}$ of final demand expenditure-pollution

[6] Another type of motive fuel combustion that is not covered in the present study, but which leads to emissions generation, is shipping activities. Coley (1994) did not make any attempt to identify fuel used in shipping activities either, due to problems of data availability. A previous study of energy supply and use in Jersey (Burek, 1988) had found that shipping represents a relatively small proportion of fuel use in the economy. Moreover, as with the case of air transport, there are problems in determining how much of the fuel supplied to marine users can actually be classified as being combusted within the economy’s borders. However, at such a time as appropriate data do become available, emissions from shipping and marine fuel use should be separately identified and accounted for in Jersey.

[7] This allocation may not be entirely satisfactory: Jersey Aero Club (part of the ‘Total Recreation, Culture & Sport’ (TRCS) sector) and private flyers (both local and non-local) also purchase aviation gas and fly in and out of Jersey Airport. Therefore some aircraft movements should really be allocated to TRCS, Jersey households and tourists. However, no information is available on how many aircraft movements these groups account for, and, due to the problem discussed above, it is not possible to make an allocation based on shares in fuel purchases. This is a problem that should be rectified if and when better data become available

coefficients. These matrices are represented (in transpose form) in Table 3 below. Note that $\mathbf{M_z}^9$ is effectively an 8 by 6 matrix showing direct emissions of each pollutant by the six final demand categories – five household groups (income quintiles) and tourists – that are responsible direct emissions generation in Jersey.

Table 2. Non-fuel-combustion sources of emissions

Sector	Process	Pollutants
Public Services	Waste incineration	Carbon dioxide (CO2) Methane (CH4) Nitrous oxides (NOX) Non-methane volatile organic compounds (NMVOC) Carbon monoxide (CO)
Manufacturing Other Service Activities	Solvent use	Non-methane volatile organic compounds (NMVOC)
Agriculture & Fishing Households Tourists	Biological	Methane (CH4)

3. UK-Adjusted Environmental Coefficients for Jersey

However, it may be the case that region-specific data on the variables required to construct these matrices of environmental coefficients are not readily available. That is to say, region-specific environmental data on the sectoral physical fuel intensities (fuel use per unit of total output/expenditure), f_{ijt}, f_{zjt}, and/or the emissions factors, e_{ijt}, e_{zjt}, $n^k{}_i$, $n^k{}_z$, may not be available to calculate equations (1) – (2) above[8]. In the absence of region-specific data on one or more of these variables, an alternative course of action would be to use data from a comparable regional economy or national data as a proxy. In the case of Jersey, a comparable regional economy may be one of the other Channel Islands (e.g. Guernsey) or a selected English region. However, at this time, emissions factor data do not exist for any comparable region. Indeed the availability of environmental data in a format that is consistent with sectoral economic accounts at the regional level in the UK is a problem attracting a significant level of consultation and debate (see Turner, 2003). In the absence of a comparable regional data, the most appropriate proxy would seem to be national, UK, data. Thus, if data are unavailable on the Jersey-specific fuel-combustion-related emissions factors, $e_{ijt}{}^9$ and $e_{zjt}{}^9$, an alternative may be to apply UK national emissions factors to the Jersey-specific fuel-intensities ($f_{ijt}{}^9$ and $f_{zjt}{}^9$) in estimating sectoral emissions and the direct average emissions intensity coefficients. This would mean making the assumption that fuel-combustion-related polluting technology does not vary across space in the UK and Jersey.

The UK (trial) NAMEA accounts report total emissions of K=18 individual pollutants and J=8 types of fuel for I=76 production sectors and Z=1 final demand sector (aggregate households) – i.e. $P_{k,i}{}^{UK}$, $P_{k,z}{}^{UK}$, $f_{ij}{}^{UK}$ and $f_{zj}{}^{UK}$ - along with data on total output/expenditure - $X_i{}^{UK}$ and $C_z{}^{UK}$ - in each of these sectors. However, no information is given on the polluting technology that relates these variables to one another. While staff at the Environmental Accounts Branch of the ONS confirm that in principle the UK method of estimating sectoral emissions is consistent with equations (1) and (2) above, they acknowledge that in practice a number of adjustments are made. However these are not specified and a full account of the method used to estimate the sectoral emissions levels reported in the UK NAMEA accounts is not supplied. In particular, while the UK NAMEA accounts do report the total amount of each type of fuel used by each production sector and final demand category, these are not disaggregated by combustion technology to give the $f_{ijt}{}^{UK}$ and $f_{zjt}{}^{UK}$ required for estimating (1) and (2). Moreover, no information is given on the emissions factors, $e^k{}_{ijt}{}^{UK}$, $e^k{}_{zjt}{}^{UK}$, $n^k{}_i{}^{UK}$ and $n^k{}_z{}^{UK}$.

[8] Indeed, it is commonly the case in the UK that regional *economic* data, in the form of region-specific IO tables, will not be available from which to draw information on sectoral gross outputs/expenditures, i.e. the X_i and C_z used in the estimation of equations (1) - (4). I return to this issue in Section 5.

Table 3 Jersey-Specific Sectoral Emission Intensities - kg/£1mill. Output/Expenditure

Pollutant Sector	CO_2 as carbon	CH_4	SO_2	NO_X	NMOVOC	CO	N_2O	Black smoke
Production Sectors:								
Agriculture & Fishing	262119	14010.89	5419.75	2244.17	265.85	1158.91	1.41	0.00
Quarrying & Construction	30841	1.17	14.03	102.77	45.22	125.01	0.69	0.00
Manufacturing	58068	3.33	662.05	339.26	122.70	664.80	0.50	0.00
Electricity	1310790	3.65	9500.40	17312.43	237.17	938.18	0.18	1153.55
Water	12864	2.56	0.00	62.76	93.03	547.54	0.26	0.00
Gas, oil & fuel distribution	61380	9.43	0.00	450.46	333.29	1809.99	1.34	0.00
Jersey Telecommunications	5372	0.55	0.67	17.07	20.59	107.04	0.12	0.00
Wholesale & Retail Trade	24447	4.72	12.64	166.76	168.95	992.62	0.43	0.00
Hotels, Restaurants & Catering	43706	1.98	134.56	212.42	76.12	428.97	0.15	0.00
Land Transport	62988	12.21	16.89	392.77	439.21	2569.73	1.20	0.00
Sea & Air Transport & Trans. Supp.	278158	20.52	260.83	5105.39	1432.35	4211.77	0.21	279.53
Post	13973	0.34	23.91	48.68	13.82	35.04	0.23	0.00
Banks & Building Societies	80	0.00	0.31	0.40	0.10	0.62	0.00	0.00
Insurance Companies	2732	1.19	0.00	14.63	43.29	277.79	0.03	0.00
Investment Trusts & Fund Managers	3734	1.28	3.13	19.52	46.57	298.30	0.04	0.00
Computer Services	14153	5.33	0.84	70.00	194.46	1236.98	0.20	0.00
Legal Activities	3241	0.69	0.00	12.02	25.26	152.82	0.06	0.00
Accountancy	633	0.28	0.00	3.39	10.04	64.40	0.01	0.00
Other Business Activities	10652	2.00	0.00	38.39	73.53	433.55	0.22	0.00
Other Services Activities	74193	11.26	722.10	339.17	415.86	2452.31	1.22	0.00
Recreation, Culture & Sport	37432	1.47	68.45	142.68	58.56	300.66	0.20	0.00
Education	20468	0.13	45.43	79.05	7.55	12.22	0.05	0.00
Health, Social Work & Housing	23733	0.14	35.54	83.68	9.31	12.96	0.04	0.00
Public Services	568032	128.27	29.49	3572.08	10396.98	41820.54	0.03	0.00
Public Adminstration & Defence	6200	0.04	2.21	18.54	2.69	2.99	0.00	0.00
Final Demand Categories								
Household Income Group 1	112639	270.68	206.57	464.29	1389.40	8117.86	0.93	0.00
Household Income Group 2	142900	192.07	139.49	633.20	2008.86	11854.93	1.40	0.00
Household Income Group 3	123173	149.61	194.58	549.74	1797.62	10562.63	1.23	0.00
Household Income Group 4	115040	118.83	105.55	512.29	1626.96	9602.24	1.14	0.00
Household Income Group 5	110763	89.84	43.93	464.59	1343.32	7957.27	0.96	0.00
Tourists	38028	56.50	0.00	189.90	663.54	3949.68	0.48	0.00

Thus, given the lack of information on the emissions factors used to estimate $\mathbf{P_{k,i}^{UK}}$ and $\mathbf{P_{k,z}^{UK}}$, it is not possible to quantify sectoral emissions and direct average emissions intensities in the manner shown in equations (1) and (2) using UK data. Instead, given the data available at this time, the best that can be done is to construct an 18x76 matrix, $\mathbf{M_i^{UK}}$, of fixed output-pollution coefficients and an 18x1 vector (household) fixed final demand expenditure-pollution coefficients, $\mathbf{m_h^{UK}}$, for the UK using the sectoral emissions and output/expenditure data – i.e. the $\mathbf{P_{k,i}^{UK}}$, $\mathbf{P_{k,z}^{UK}}$, $\mathbf{X_i^{UK}}$ and $\mathbf{C_z^{UK}}$ – from the 1998 UK (trial) NAMEA tables. In applying these to the case of Jersey, this means making the assumptions that:

- *The fuel intensity of production and consumption does not vary between the UK and Jersey economies.* That is to say, the elements f_{ijt} and f_{zjt} on the right-hand side of equations (1) and (2) respectively do not vary between the UK and Jersey economies.
- *Polluting technology does not vary between the UK and Jersey economies.* That is to say, the emissions factors, e^k_{ijt} and e^k_{zjt} and n^k_i and n^k_z are the same in the UK and Jersey.

The matrix $\mathbf{M_i^{UK}}$ must be aggregated to make it consistent with the sectoral breakdown of the Jersey accounting system. This involves the following steps:

1. A weight of zero is attached to the column vector of output-pollution coefficients for all sectors that are present in the UK economy but not in the Jersey economy.

Table 4 UK-Adjusted Sectoral Emission Intensities for Jersey - kg/£1mill. Output/Expenditure

Pollutant / Sector	CO_2 as carbon	CH_4	SO_2	NO_X	NMOVOC	CO	N_2O
Production Sectors:							
Agriculture & Fishing	81554	45639.38	461.23	2535.91	798.97	3633.16	4430.08
Quarrying & Construction	17696	10.04	45.15	577.39	661.96	2831.31	16.26
Manufacturing	34122	7.95	179.10	315.55	1535.91	174.18	2.27
Electricity	1477975	677.47	38787.26	13239.63	277.69	2987.62	235.55
Water	38454	10.19	46.51	611.91	710.35	2492.16	14.72
Gas, oil & fuel distribution	22635	9698.62	7.63	263.61	2302.70	921.68	2.98
Jersey Telecommunications	11231	4.21	7.87	169.20	83.28	530.92	1.89
Wholesale & Retail Trade	17627	6.82	11.32	337.05	147.84	862.98	3.33
Hotels, Restaurants & Catering	12767	4.34	3.25	106.86	60.95	461.01	1.43
Land Transport	247043	69.61	206.22	6969.05	1527.27	5310.51	33.34
Sea & Air Transport & Trans. Supp.	293542	140.94	5142.68	10293.17	1719.14	4028.01	47.13
Post	11231	4.21	7.87	169.20	83.28	530.92	1.89
Banks & Building Societies	8638	3.31	5.39	93.26	62.66	492.91	1.48
Insurance Companies	8694	3.49	4.71	101.04	69.93	551.90	1.64
Investment Trusts & Fund Managers	8174	3.03	5.37	83.21	54.56	428.09	1.29
Computer Services	13079	5.96	10.79	196.87	220.67	1139.36	3.39
Legal Activities	8422	2.98	7.09	81.08	51.28	399.88	1.22
Accountancy	8422	2.98	7.09	81.08	51.28	399.88	1.22
Other Business Activities	9214	3.72	7.16	122.81	78.97	596.99	1.85
Other Services Activities	16856	6.43	13.84	248.56	761.15	908.26	3.09
Recreation, Culture & Sport	11683	3.03	48.14	82.74	35.68	261.92	1.10
Education	29057	6.62	85.31	165.14	66.32	502.90	2.04
Health, Social Work & Housing	13297	2.77	116.87	65.96	31.49	93.62	0.55
Public Services	30634	110683.65	53.66	1250.81	1324.95	723.43	76.85
Public Adminstration & Defence	35633	6.32	213.64	580.11	34.33	187.55	2.73
Final Demand Categories	0						
Households	74265	91.37	116.45	900.20	1049.63	5500.41	18.21

2. The remaining sectors that are present in both economies are aggregated to the sectoral breakdown identified in the Jersey IO tables[9] For example, the column vectors of coefficients for the UK NAMEA sectors 7 and 50 ('Other mining and quarrying' and 'Construction') are brought together in the Jersey NAMEA sector 2 ('Quarrying & Construction')[10].
3. For each Jersey NAMEA sector, the column vectors from matrix $\mathbf{M_i^{UK}}$ are then weighted according to the contribution of each component activity to the total output of the Jersey sector. For example the UK coefficients for 'Construction' activities (NAMEA code 50) is given a weight 0.945 corresponding to the fact that 'Construction' activities account for 94.5% of the output of the 'Quarrying & Construction' sector identified in the Jersey IO table for 1998. The vector of UK 'Other mining and quarrying' coefficients is given a weight of 0.055 because 'Quarrying' activities account for the other 5.5% of the Jersey 'Quarrying & Construction' sector. The two weighted vectors are then summed to give the UK-adjusted vector of pollution coefficients for the Jersey 'Quarrying & Construction' sector.

This allows the derivation of a KxI (18x25) matrix, $\mathbf{M_i^{UK(9)}}$ of UK-adjusted output-pollution coefficients for Jersey (1998). Part of this matrix is shown (in transpose form) in Table 4 above, for the 7 pollutants that are common to the Jersey-specific and UK-adjusted sets of output-pollution coefficients for Jersey.

[9] Details on the composition of each of the production sectors identified here (according to 1992 SIC classification) are available on request from the author at karen.turner@strath.ac.uk.
[10] Note that it has been necessary to aggregate the 'Other mining and quarrying' and 'Construction' activities in Jersey for reasons of confidentiality (there are very few individual firms operating in each of these sectors).

As noted above, it is only possible to derive a single column vector of final demand expenditure-pollution coefficients, the vector $\mathbf{m_h^{UK}}$ of (aggregate) household coefficients. This enters the UK-adjusted matrix $\mathbf{M_z^{UK(9)}}$ unweighted; all other elements of $\mathbf{M_z^{UK(9)}}$ are equal to zero because the UK does report direct emissions by any other final demand sector.

4. The Added Precision from Estimating and Using Jersey-Specific Environmental Coefficients

In this section I attempt to assess the added precision that is gained from estimating and using Jersey-specific environmental coefficients by comparing the region-specific and adjusted national coefficients for Jersey both in terms of their coverage and the differences in relative and absolute values.

Coverage

If we compare the UK-adjusted coefficients in Table 4 with the Jersey-specific ones in Table 3, it is clear that in general the two sets differ quite significantly. The two sets have seven individual pollutants in common and the present discussion is limited to comparison of these across the two sets (coverage in both cases was determined by data availability, rather than a decision as to what pollutants are appropriate for inclusion).

One thing that is immediately clear is that in the UK-adjusted set there are no coefficients for the tourist final demand category or for households disaggregated by income. This is due to data availability. As we saw in Section 2, the Jersey-specific data separately identifies the key source of direct emissions generation by tourists during their stay on the Island. This facilitates the derivation of a separate vector of pollution coefficients for tourists in the Jersey-specific matrix, $\mathbf{M_z^9}$. On the other hand, the UK sectoral emissions data used to generate the UK-adjusted coefficients does not separately identify pollution directly generated by tourists (nor do the UK energy use data include automotive fuel use by tourists). It is likely that any emissions by tourists in the UK dataset are included in the figures given for domestic (UK household) pollution generation. However there is no documentation to support this supposition so I take the omission of tourist expenditure as a polluting activity in the UK database to mean that no direct emissions by tourists are accounted for. Of course, if the household emissions figures do include emissions by tourists, this will upwardly bias the UK-adjusted household direct emissions coefficients. Therefore, the absence of direct emissions coefficients for tourist expenditure in the UK-adjusted set would be expected to result in an omission and/or misallocation of some direct emissions generation (given that we know that the average tourist to Jersey does combust automotive fuels during his/her visit). In contrast, the Jersey 1998 tourist expenditure survey allowed directly polluting activities (mainly automotive fuel use) to be specifically and separately identified.

The availability of data for identification of direct energy use and emissions generation by tourists in the Jersey-specific case is illustrative of one of the main advantages of region-specific data collection – the ability to focus on region-specific needs. In an economy like Jersey, where industrial processes are a less significant source of emissions, the environmental impact of activities such as tourism will be of greater concern.

The Jersey-specific data also provide information on household energy use and other polluting activities disaggregated by income, which facilitates the derivation of five separate vectors of household emissions coefficients in matrix $\mathbf{M_z^9}$. The absence of UK-adjusted versions of these coefficients would limit the scope of future analyses. In the Jersey-specific set of coefficients in Table 3, it is clear that emissions intensities vary with household income, which suggests a potential need for distributional analysis of any related policy change or other disturbance. However, the presence of a vector of pollution coefficients for aggregate households does mean that, in contrast to the case of tourists, it would be possible to account for direct emissions generation in household consumption using the UK-adjusted coefficients. Nonetheless, as noted above, if emissions by tourists are included in the household data, direct emissions generation by households will be over-estimated.

Therefore, the first conclusion we can draw is that in the case of Jersey fuller data are available at the regional level. It might be expected that, in general, more accurate data will be available at the national level due to economies of scale in data collection. However, the converse appears to be true in the comparison of Jersey and the UK, where the national data appears to be *inferior* in terms of scope. The UK (trial) NAMEA accounts are also less transparent in that there is virtually no explanation or information as to *how* the sectoral emissions levels reported in the UK NAMEA are actually generated.

Relative and Absolute Values

The composition of the 25 production sectors is equivalent across both the region-specific and adjusted-national sets of coefficients in Tables 3 and 4. This means that we can directly compare the emissions intensities shown for each sector and aggregate households in these tables. For the pollutants that are common to both sets, two crucial observations can be made:

1. The Jersey-specific and UK-adjusted coefficients for any one sector differ significantly in terms of the *absolute pollution intensities* of production/consumption (i.e. the level of emissions per unit of output/expenditure).
2. Overall, the sets of Jersey-specific and UK-adjusted coefficients differ significantly in terms of the *relative pollution intensities* of the different activities in the Jersey economy.

Both of these factors are crucial. If the absolute intensities are over- or under-stated this will lead to errors in estimating total pollution in the Jersey economy. If the relative intensities are incorrect this will lead to errors in determining the direct (*and* indirect[11]) contributions of different production sectors and consumption activities to the pollution problem. This could lead to errors in terms of prioritising activities in determining policy to reduce pollution. As well as affecting the accuracy of the base-year environmental accounts, both these factors would also be expected to impact on the accuracy of any economic-environmental *model* for Jersey based on these data.

We can determine the magnitude of the first problem (the differences in the absolute level of the pollution intensities across all sectors) by looking at the total pollution estimates that the two sets of coefficients would provide for the Jersey economy. The (Kx1) vector, $\mathbf{P}^{\vartheta}$, of pollution generated in Jersey is estimated as[12]

$$\text{(3)} \qquad \mathbf{P}^{\vartheta} = \mathbf{P_i}^{\vartheta} + \mathbf{P_z}^{\vartheta} = \mathbf{M_i}^{\vartheta}.\mathbf{X_i}^{\vartheta} + \mathbf{M_z}^{\vartheta}.\mathbf{C_z}^{\vartheta T}$$

(Where superscript 'T' on the vector of total final demand expenditure indicates that this is the transpose of the row vector of total final demand expenditure by Jersey households and tourists, given in the IO tables.)

Table 5. Environmental IO accounting: Total emissions (kg) of 7 air pollutants generated in Jersey 1998

	Estimates based on:	
POLLUTANTS:	**Jersey-specific output- and expenditure-pollution coefficients**	**UK -adjusted output- and expenditure-pollution coefficients**
CO_2 as carbon	**291,065,182**	**215,481,253**
CH_4	**961,262**	**5,826,417**
SO_2	**1,024,795**	**2,403,697**
NO_X	**2,205,893**	**3,127,692**
NMVOC	**2,403,511**	**1,874,431**
CO	**13,277,245**	**8,439,382**
N_20	**1,933**	**295,809**

We can also estimate a vector of total emissions in Jersey, $\mathbf{P}^{(UK)\vartheta}$, using the UK-adjusted matrices $\mathbf{M_i}^{UK(\vartheta)}$ and $\mathbf{M_z}^{UK(\vartheta)}$ of pollution coefficients in place of the Jersey-specific matrices $\mathbf{M_i}^{\vartheta}$ and $\mathbf{M_z}^{\vartheta}$ (noting that in the latter the column entries for z = tourists are all zeros due to the absence of UK-adjusted pollution coefficients for tourists):

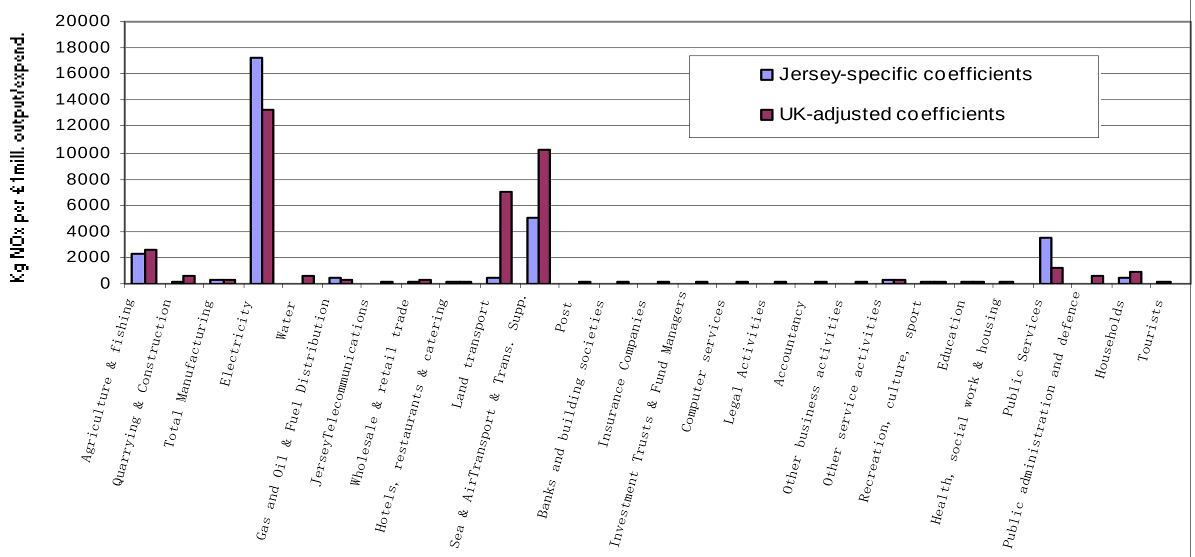
$$\text{(4)} \qquad \mathbf{P}^{(UK)\vartheta} = \mathbf{P_i}^{(UK)\vartheta} + \mathbf{P_z}^{(UK)\vartheta} = \mathbf{M_i}^{UK(\vartheta)}.\mathbf{X_i}^{\vartheta} + \mathbf{M_z}^{UK(\vartheta)}.\mathbf{C_z}^{\vartheta T}$$

[11] See the attribution analyses for pollution generation in Jersey reported in McGregor *et al* (2001).

[12] Note that with the Jersey-specific pollution coefficient matrices, $\mathbf{M_i}^{\vartheta}$ and $\mathbf{M_z}^{\vartheta}$ (the 9x2 version with aggregate households), (3) is an identity. That is to say, we simply recreating the base-year vector of total emissions, $\mathbf{p}^{\vartheta}$, estimated in (1) and (2) using the 1998 fuel use and emissions factor data.

The results of calculating (3) and (4) are given in Table 5 above. Note that there are indeed huge differences between the total emissions estimates derived using the set of Jersey-specific coefficients and those estimated using the UK-adjusted set. In the case of five out of seven of the pollutants, the UK-adjusted coefficients give estimates that are much larger those found using the Jersey-specific coefficients. The largest difference is in the case of N_2O, with the estimate of total emissions using the UK-adjusted coefficients being more than 153 times the size of the estimate based on the Jersey-specific fuel-use figures and emissions factors. This is an extreme result: the next biggest difference is found in the case of methane, where the UK-adjusted estimate is 506% higher than the Jersey-specific one (followed by 35% for SO_2 and 42% for NO_X). In the case of the three remaining pollutants, CO_2, NMVOC and carbon monoxide (CO), the Jersey-specific estimates of total emissions are higher than the UK-adjusted ones (the UK-adjusted estimates being respectively 26%, 22% and 36% less than the Jersey-specific ones).

Figure 1 Direct NOx Intensity of Production/Final Consumption - Comparison of Jersey-Specific and UK-Adjusted Direct Emissions Coefficients

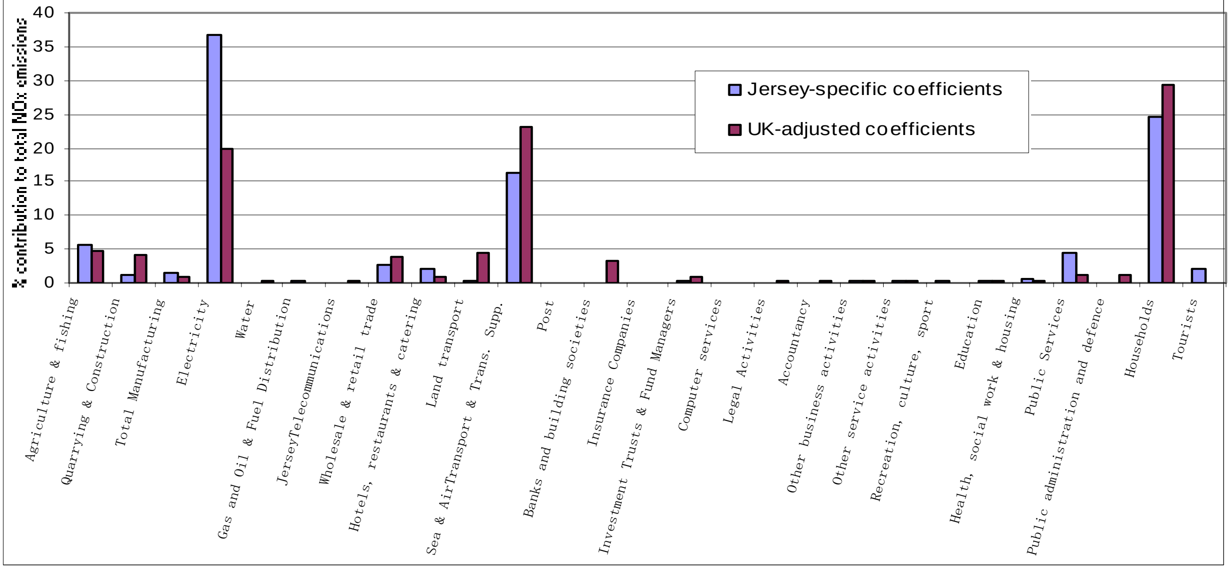


The second problem is the fact that the relative pollution intensities of sectors differ across the two sets of coefficients in Tables 3 and 4. In accounting terms, the main impact of differing relative pollution intensities will be on the contribution of individual production and final demand sectors to total emissions in the base year. Figures 1 and 2 illustrate this point for the individual pollutant NO_X. Figure 1 graphs the Jersey-specific and UK-adjusted NO_X coefficients for each production sector and final demand category as reported in the fourth column of Tables 3 and 4. Figure 2 (below) then shows the (direct) sectoral contributions to total emissions of NO_X in the Jersey economy that are calculated using the Jersey-specific and UK-adjusted NO_X coefficients respectively.

The direct contribution of each production sector, i, and final demand category, z, to total emissions of any one pollutant, k, is determined by the emissions intensity of the activity in question and by the scale of activity. The scale of activity in each production sector, $\mathbf{X_i}^{\mathbf{9}}$, and final demand sector, $\mathbf{C_z}^{\mathbf{9}}$, is common to both calculations. Therefore the differences between the two sets of results shown in Figure 2 are entirely due to the differences in relative pollution intensities (including the zero intensity for all pollutants in the tourist final demand category in the UK-adjusted set).

For example, according to the UK-adjusted coefficients, 'Land Transport' is the third most NO_X-intensive production sector in the Jersey economy. However, under the Jersey-specific measures it is only the sixth most NO_X-intensive, with an output-NO_X coefficient that is much smaller in relative terms. In the Jersey-specific set of pollution coefficients (Table 3) the 'Land Transport' direct NO_X-intensity coefficient is only 2.3% of the size of the coefficient for the most NO_X-intensive sector, 'Electricity', while this figure is almost 53% in the UK-adjusted case. In terms of contribution to total NO_X emissions, we can see from Figure 2 that 'Land Transport' is attributed with the fourth highest contribution of all the production sectors under the UK-adjusted measure, accounting for 4.53% of total emissions. However, under the Jersey-specific measure this share is smaller both in absolute and relative terms: with a 0.36% share of total NO_X emissions, it has only the eleventh highest contribution of all the production sectors.

Figure 2 Direct Contribution of Sectors to Total NOx Emissions in Jersey (1998) - Comparison of Estimates Using Jersey-Specific and UK-Adjusted Direct Emissions Coefficients



Conversely, Figure 1 reveals that 'Public Services' has a higher NO_X-intensity both in absolute and relative terms under the Jersey-specific measure, being the third most NO_X-intensive production sector, compared with fifth in the UK-adjusted set. Figure 2 shows that if we rely on the UK-adjusted set of coefficients, 'Public Services' is attributed with only 1.06% of direct NO_X generation, the eighth highest contribution of all twenty-five production sectors; however the Jersey-specific measures show its contribution to be much higher, 4.03%, the fourth highest contribution.

5. Factors Underlying the Variation in the Region-Specific and UK-Adjusted Estimates of Economy-Environment Relationships in Jersey

Two main factors can be identified that may contribute to the differences in direct emissions intensities shown for equivalent sectors in the Jersey-specific and UK-adjusted sets of coefficients in Tables 3 and 4:

1. Accuracy of data collection in Jersey and the UK levels.
2. Regional variation in fuel use (types and intensity) and polluting technology in Jersey and the UK.

The first issue has already been discussed above. Due to the size of the Jersey economy, its island status, the structure of the energy supply industry and the availability of earlier studies such as Coley (1994) it has been possible to construct a highly detailed and accurate database on fuel use and polluting technology. In the case of an economy the size of the UK, it is unlikely that it would be possible to construct such a database. Even if a high level of resources were available for environmental accounting, it is unlikely that such detailed records of fuel supply and use would or could be kept for the UK. One important factor would be that patterns of fuel use are much more complex in the UK than in Jersey, where limited technology and competition among fuel and heating system suppliers constrains the choices available to producers and consumers.

Moreover, in this paper I argue that the reporting of how the environmental accounts for Jersey (1998) have been constructed is characterised by a much greater degree of transparency than the UK NAMEA accounts. For example, as noted in Section 3, the UK reporting does not include any information on what is assumed about polluting technology in order to generate sectoral emissions estimates. The Environmental Accounts Branch of the ONS does acknowledge making adjustments that reflect problems in allocating fuel use and emissions from transport activities. However, these are unspecified. On the other hand, in the Jersey-specific case it has been possible to clearly identify and state where accounting problems have arisen. This will allow rectification of these problems when and if improved data permit. Conversely, in the case of the UK NAMEA tables it is not possible to identify the nature of any accounting problems, in particular, what impact these may have on any accounting work for Jersey based on UK-adjusted coefficients.

The second factor that will contribute to the differences in the UK-adjusted and Jersey-specific estimates is variations in fuel use (types of fuel and amounts used) and polluting technology in Jersey and the UK. Region-specific pollution coefficients reflect the *actual* average emissions intensities (for each pollutant) of each production and final consumption activity that takes place in the regional economy. Adjusted national coefficients reflect the average emissions intensities for equivalent activities, *independent of the location of activity*. Thus, by adopting adjusted national coefficients (in the manner described here[13]) to apply at the regional level involves adopting the two crucial assumptions identified in Section 3 above: that fuel use (type and intensity) and polluting technology at the regional level corresponds to the averages observed for the national economy. If this is not the case, i.e. if one or more of the elements on the right-hand side of equations (1) and (2) differ significantly across space in the UK national and Jersey regional economies, the UK-adjusted coefficients will mis-represent absolute and relative pollution intensities in the Jersey economy. This will in turn lead to errors in estimating total pollution generation in the economy and the contribution of individual activities to this total (even if the assumptions are not violated for all production and final demand sectors). Thus, even if the first factor, accuracy of data collection, is not a problem, if fuel use and technology are significantly different for equivalent activities in the UK and Jersey this will be sufficient to render use of pollution coefficients based on average UK technical relationships inappropriate.

Differences in Fuel Use and Polluting Technology in Jersey and the UK

The main motivation for investing resources in constructing a set of Jersey-specific base-year environmental accounts and pollution coefficients was that important differences are known to exist with respect to the technology used in certain activities in Jersey relative to the UK. For example, all electricity produced in Jersey is generated using oil-powered technology while in the UK a combination of gas-, hydro-, nuclear- and oil-powered techniques is used to generate the total electricity requirement. Waste disposal is another example: in the UK there will be emissions from landfill, while in Jersey all waste is disposed of by incineration or composting. Thirdly, the composition of technologies used for commercial and domestic heating activities in Jersey is known to be different to that found in the UK. With no infrastructure for natural gas to be piped to Jersey it is necessary to import and bottle a combination of propane or butane. As a result, gas-heating systems are expensive relative to other forms of heating and a larger proportion of households and businesses therefore rely on oil-powered heating systems than is the case in the UK.

As explained above, information is not available on the precise mix of polluting technologies used in the UK; in particular the UK trial NAMEA tables do not include emissions factors for comparison with the ones used for Jersey. However, the UK trial NAMEA table does include fuel use by sector that allows a direct comparison of the physical fuel use intensities of equivalent activities in the UK and Jersey (but only for some of the fuel types used in Jersey). If fuel-use in equivalent sectors differs sufficiently between Jersey and the UK, this alone would cast serious doubt on the validity of using UK-adjusted pollution coefficients to estimate and model pollution generation in the Jersey economy.

Average energy/fuel use intensities for each production and final demand sector are calculated as total use of each type of fuel, j, (aggregated across all combustion technologies) in 1998 divided by total sectoral output/expenditure. For the UK an equivalent set of energy/fuel use intensities can be derived using the 76-sector fuel-use, sectoral output and final demand expenditure figures in the UK 1998 trial NAMEA table. These are then adapted to the Jersey case in the same manner explained for derivation of the UK-adjusted pollution coefficients (using weights that reflect the composition of output at the aggregate and sectoral levels in the Jersey economy). Note that, as with the UK-adjusted pollution coefficients, the absence of data on direct fuel use by tourists means that it is not possible to include a vector of fuel intensities for z = tourists.

First, look at the individual heating fuel, gas oil[14]. Given what has been explained above about the lack of infrastructure for piping natural gas to Jersey and the consequent reliance on oil-powered heating systems, we would expect to find higher heating oil use intensities in Jersey than in the UK. Figure 3 reveals that this is indeed the case across most production sectors for gas oil use. Note that Figure 3 also reflects another peculiarity of fuel consumption and supply patterns in Jersey: while oil-powered heating systems are generally more prevalent in Jersey than any other type of heating system, gas oil is only used in the commercial sector. Domestic heating systems in Jersey run exclusively on kerosene (and the private household sector is the sole user of kerosene as a heating fuel). Therefore, while the aggregate UK household sector shows a positive, but relatively low, use of gas oil, the Jersey household sector has zero intensity for this fuel. This distinction

[13] As explained in Section 3, if fuller data are available at the national level – for example, on polluting technology (represented by the emissions factors, e^k_{ijt}, e^k_{zjt}, n^k_i and n^k_z) it would be possible to derive adjusted national coefficients that rely on a weaker set of assumptions.

[14] Gas oil is technically the same fuel as the diesel used for automotive purposes; however it is standard practice to define and record supply of gas oil used for automotive purposes separately as 'diesel' (or 'derv').

between different types of fuel (e.g. kerosene or gas oil) used for the same purpose (e.g. running oil-powered domestic heating systems) is crucially important because the pollution properties of different *types* of fuel can vary significantly. In the current example, the combustion of one kilogram of kerosene using the type of technology identified for heating systems in Jersey generates significantly smaller amounts of SO_2, NO_X and carbon monoxide than would result from the combustion of one kilogram of gas oil (see McGregor *et al*, 2001, and Turner, 2002).

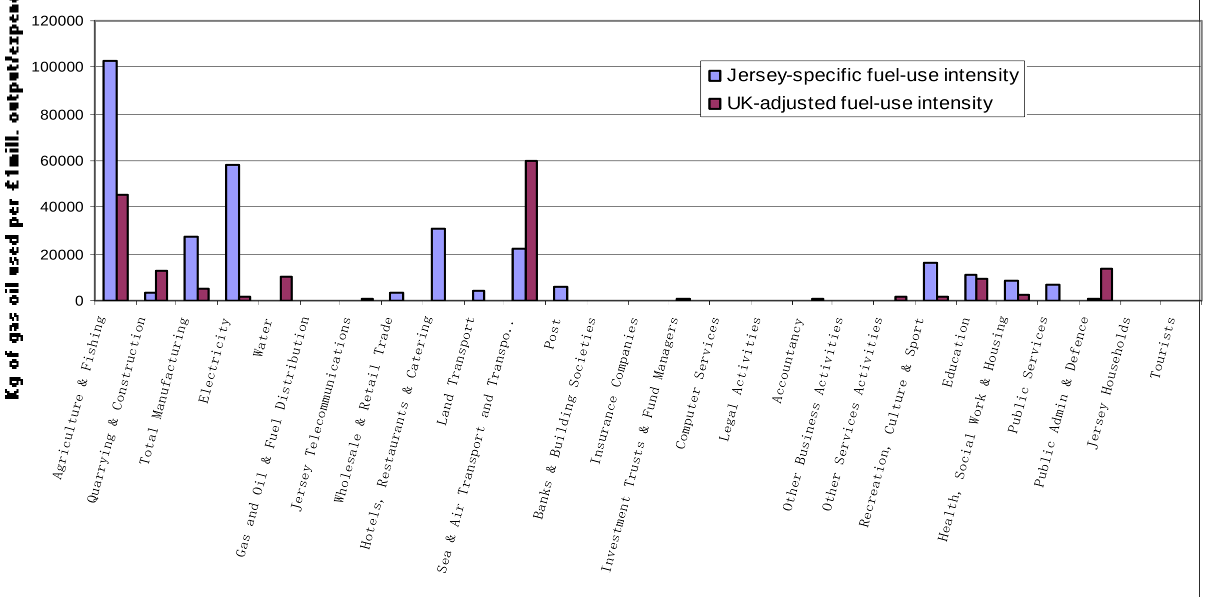


Figure 3 Direct Gas Oil Intensity of Production/Final Consumption - Comparison of Jersey-Specific and UK-Adjusted Fuel Use Coefficients

Therefore, if we were to assume that gas oil intensities are the same across equivalent sectors in the UK and Jersey, the result would be significant errors in estimating the amount of gas oil used at both the aggregate and sectoral levels. In terms of total fuel use in the economy, actual total gas oil use in Jersey in 1998 was almost twice as high as would be estimated using the 1998 UK-adjusted gas oil intensities. This is consistent with the greater reliance in Jersey on oil-powered heating systems noted above. However, more important in the present context is fuel use at the sectoral level. The fuel-intensities shown in Figure 3 demonstrate that assuming identical gas oil use for equivalent sectors in Jersey and the UK would lead to drastically misleading results, both in terms of the amount of gas oil used and the amount of emissions generated from this type of fuel use. This would be the case even if the technology used to combust this type of fuel were identical in the UK and Jersey.

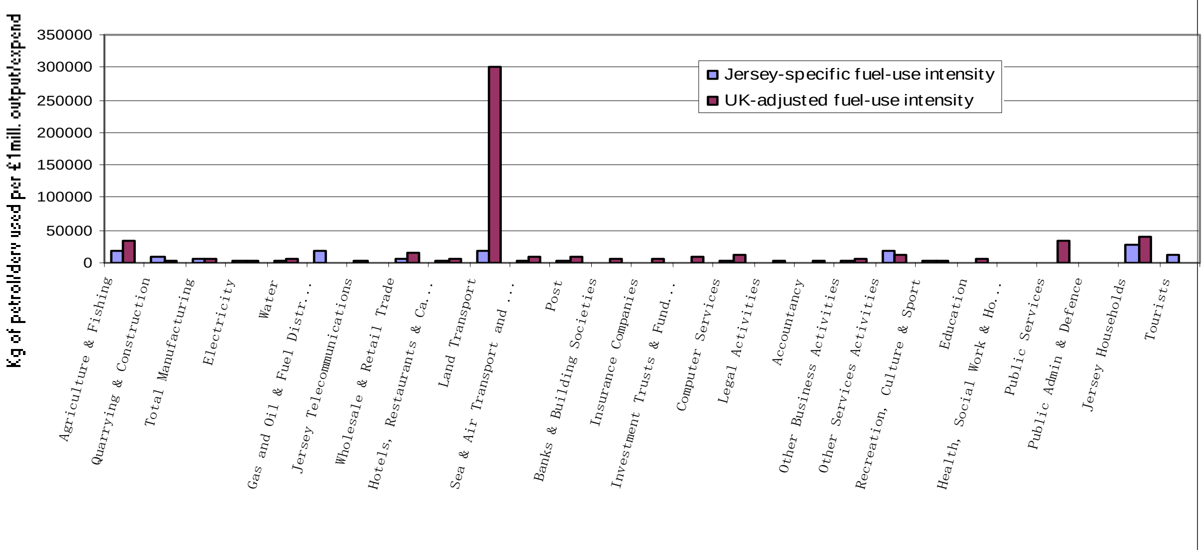
However, it is also the case that automotive fuel use intensities differ across equivalent sectors in Jersey and the UK, even though there are not the same restrictions on combustion technology - i.e. there is no restriction on the type of vehicles that can be used on the Island. Figure 4 (below) shows that twenty out of the twenty-five production sectors are significantly less automotive fuel intensive than equivalent sectors in the UK would be. In particular, 'Land Transport' is far less fuel intensive than its UK counterpart, the value of its petrol/derv-output intensity being only 6.2% of the value of the UK-adjusted intensity. The other five production sectors – 'Quarrying and Construction', 'Total Manufacturing', 'Electricity', 'Gas and Oil & Fuel Distribution' and 'Telecommunications' - are significantly more automotive fuel intensive than equivalent sectors operating in the UK would be.

In terms of final demand categories, note again that the UK figures do not separately identify fuel use by tourists, so it is not possible to determine the extent of any variation in automotive fuel use by visitors to Jersey compared to destinations in the UK. However total final consumption by Jersey households is significantly less automotive fuel intensive, despite the high level of private car ownership on the Island (of course this may be expected given the limited road space available to drive on).

So, just as is found in the case of stationary fuel use, it is clearly the case that automotive fuel-use patterns in Jersey are quite distinct from those that underlie the combustion-related element of the UK-adjusted pollution coefficients. Some of the differences in emissions intensities can be related to differences in the types of fuel use associated with their generation. For example, in McGregor *et al* (2001) we found that the main source of SO_2

combustion-related emissions from production activities that take place in the Jersey economy is stationary fuel use (automotive fuel use, other than aircraft movements, does not generate SO_2 emissions). Here, I have explained that the main type of fuel involved in stationary combustion in the production sector of the Jersey economy is gas oil. Examination of the output-SO_2 coefficients in Tables 3 and 4 and the gas oil intensities in Figure 3 show that it is the case that the Jersey-specific output-SO_2 coefficients do tend to be higher (lower) than the UK-adjusted ones where gas oil intensities are higher (lower).

Figure 4 Direct Petrol/Derv Intensity of Production/Final Consumption - Comparison of Jersey-Specific and UK-Adjusted Fuel Use Coefficients



However, in general, the observed differences in the Jersey-specific and UK-adjusted pollution coefficients, and in the estimates of total emissions in Table 5, cannot be explained simply by looking at the differences in fuel intensities. As noted above, no information is available about the emissions factors used to estimate the sectoral pollution levels reported in the UK trial NAMEA accounts. Without this it is difficult to determine whether violation of one or both of the assumptions required for adoption of the UK-adjusted coefficients alone can explain all the observed variation in results. It may be the case that the other potential explanatory factor suggested above, accuracy of data collection, is also important. Nonetheless, the crucial point is that, independent of all other possible explanatory factors, the observed differences in fuel intensities across the board in Jersey (1998) from what would be expected in their UK counterparts are *sufficient* to render use of pollution coefficients based on UK technical relationships inappropriate.

6. Further Implications

The findings reported above have a significance that applies more generally than simply to the appropriate choice of pollution coefficients for economy-environment accounting and modelling. Here I have examined the consequences of adopting national rather than region-specific energy-use and pollution coefficients to construct the environmental component of a regional IO system, the economic component of which has been generated using region-specific data. However, I note in the introduction to this paper that it is sometimes the case that national data will be used to generate the basic IO tables describing the structure of the regional economy. This is generally due to the resource costs involved in constructing regional economic accounts in the form of IO tables using primary region-specific data.

There have been a number of developments in terms of how national coefficients can be adjusted to reflect the difference in level and composition of activity in the regional economy. Isserman (1980), Round (1983) and Richardson (1985) provide surveys of the basic methodologies adopted for this purpose. The most common approach appears to be some variant on the use of location quotients (LQs), which basically reflect differences in such factors as the level of employment, the export base, import requirements and/or specialisation at the regional and national levels.

However a critical observation is made by Round (1983). He notes that in some early developments of the methodology for deriving regional tables from national data there was confusion in relation to the distinction between differences in *trade* and differences in *technology*. While concluding that this confusion seemed to have been resolved, Round (1983) goes on to observe that developments tended to have been "geared towards the estimation of trade coefficients rather than technical coefficients" (p193). There have been some studies investigating the information loss from estimating regional IO tables using national coefficients as compared to using region-specific data collection such as Harrigan *et al* (1980a, b). However, it seems that differences in trade at the national and regional levels have continued to be the main focus of research. See, for example, reviews and discussion by Flegg *et al* (1995) and McCann & Dewhurst (1998)).

There is no disputing the importance of differences in import requirements at the national and regional levels, or the resource costs involved in constructing region-specific technical coefficients. However, the findings reported here imply that potential differences in technology may be of crucial importance. The fuel-use data for the UK and Jersey that were used to construct the region-specific and UK-adjusted fuel intensity coefficients for Jersey tell us the absolute physical amount of fuel used in each activity, regardless of whether these fuels are imported or purchased locally. The crucial finding of this paper is that differences in the energy (fuel) requirements of equivalent sectors at the national (UK) and regional (Jersey) levels mean that the assumption of identical technical coefficients for this input-output relationship would result in extremely inaccurate and misleading results. In general, examination of the 1998 Jersey IO table, which was constructed using region-specific industrial, public sector, household and tourist survey data relating to that year, shows that use of UK-adjusted technical coefficients for *any* input-output relationship would result in inaccurate and misleading results.

It would be incorrect to generalise this result as applying to all input-output relationships and all national/regional economies. In particular, it is important to emphasise the fact that Jersey is a very *small* and quite idiosyncratic economy. However, it would seem indicative that if such extreme results are observed in one case, investigation of potential differences in technology merits as much priority as factors like differences in trade. The types of region-specific data collection processes that have been carried out for Jersey *are* a costly investment. However, adapting UK national data to the Jersey case generates such misleading results that it would be of no use whatsoever.

7. Conclusions

The economic-environmental accounting and modelling work being done for Jersey is in response to policy commitment to environmental and wider sustainability objectives. There is currently similar policy interest in accounting for and modelling economy-environment interaction at the national and regional level in the UK. Specifically this is due to the varying but generally significant degree of responsibility for meeting sustainability objectives that has been devolved to the Scottish Parliament, the National Assembly for Wales and the English regional authorities. One active debate amongst the devolved authorities and the UK Environment Agency is the extent to which region-specific environmental and economic data are required to construct a framework for analysing economy-environment interaction at the regional level within this policy context.

The present study of the Jersey economy indicates that a considerable degree of added precision is gained from using region-specific information on polluting activities. This is primarily a result of differences in technology between Jersey and the UK. Whilst it is understood that Jersey has a rather unique regional economy, these findings add weight to the arguments that regional input-output tables and environmental accounts should be informed by locally acquired data.

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