The likely regional impacts of an agricultural emissions policy in New Zealand: Preliminary analysis

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Abstract

Hendy and Kerr (2005b) find that an emissions charge on agricultural methane and nitrous oxide of $25 per tonne of carbon dioxide (CO_2) equivalent would be likely to reduce New Zealand's net land-use related emissions for commitment period one in the order of 3%, with full accounting. The costs per farmer and as a percentage of profit would be very high. This paper considers the regional impacts of such a policy in New Zealand by allocating the emission charge across space according to the location of animals. We then combine our emissions charge information with data on the socio-economic characteristics of the affected areas. Obviously rural areas are heavily affected. In many respects, for example median income, ethnic mix, and percentage of working people with a university degree, the rural areas most affected have very similar socio-economic characteristics to other parts of rural New Zealand. Only in two ways do they appear to differ. Our findings indicate that areas with high emission costs tend to have high employment rates, but that they also have a disproportionately high number of unqualified people.

JEL classification
Q25, Q28, R14

Keywords
climate change, land use, social impacts, methane, nitrous oxide, dairy, sheep, beef, distribution of costs, regional

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1 Introduction

In most developed countries, agricultural emissions are a tiny fraction of total greenhouse gas emissions. In New Zealand, however, they are much more significant, constituting approximately half of the country's overall emissions (Brown and Plume, 2004). It therefore seems likely that New Zealand's fight to reduce greenhouse gas emissions will one day come to include agricultural emissions. In fact, the regulation of agricultural emissions has already entered the thoughts of politicians. The New Zealand Government recently proposed a methane research levy aimed at increasing funding for research into reducing ruminant methane emissions. However, this proposal was met by violent opposition on the part of farmers, and became infamously known as the 'fart tax'.[1] Despite all the public debate over the proposed methane levy, we still know very little about what the actual economic and social costs of an agricultural emissions charge would be. This information is necessary for making informed policy decisions.

The policy we consider in this preliminary paper is an emissions charge of $25 per tonne of carbon dioxide (CO_2) equivalent on agricultural methane and nitrous oxide in 2002. In Hendy and Kerr (2005b) we use an integrated model, Land Use in Rural New Zealand: Climate (LURNZv1: Climate), to suggest that such a charge would have reduced net land-use related emissions for commitment period one by 3%, if it had been introduced from 2003. The very small size of this effect may be partly because currently a methane charge would be based on animal numbers and species only, and a nitrous oxide tax would probably be based on these and on fertiliser use only so farmers' ability to reduce taxed emissions is extremely limited. They can only reduce animal numbers and fertiliser use. In our current model, the response is further limited because we allow only the area of each land use to change, and not stocking rates or rates of

[1] In mid-2003 the Government proposed that farm businesses pay an agricultural emissions research levy that would raise NZ$8.4 million to fund research into ways of reducing non-CO_2 emissions from agricultural activities. This proposal was replaced in 2004 by a partnership agreement on voluntary research into agricultural greenhouse gas emissions signed by the Government and agricultural sector groups.

fertiliser application within each land use. Thus our estimate is likely to be low relative to what could be achieved with a more sophisticated policy.

In this paper we consider the regional impacts of a climate change policy that targets agricultural emissions. Agricultural emissions may be targeted through a tax, a credit system (with credits allocated in a range of ways), or a command and control policy. Any emissions charge levied by the Government would probably be accompanied by a reduction in other distortionary taxes, such as labour taxes, so that the policy would be fiscally neutral overall. It is not clear, however, which other taxes the Government would cut. Consequently, we cannot determine the distribution of effects of the tax cut. Thus we make the implicit assumption that the benefits of the tax cut are spread equally across all people and regions in the economy, and focus only on the distributional effects of the methane and nitrous oxide charges. The distributional effects of any specific choice of tax reduction could be analysed separately and added to the effects we find here.

We assume that every hectare with a specific land use is equally affected by the cost of the emissions policy in proportion to regional stocking rates, and that the cost is not shifted out of the geographic area in which the land lies. For example, we assume that impact on dairy land only differs between the Far North and Gore because there are more dairy cows per hectare on a dairy farm in the Far North than on a dairy farm in Gore. We expect that the costs of the charge will mostly be borne by the farmers but that the charge would also have a significant effect on the local economy, in the same way that recent high dairy prices have led to regional economic expansion. Having estimated how the costs of the emissions charge will fall across the country, we combine this information with data on the socio-economic characteristics of areas by linking the Geographic Information System (GIS) datasets of current land use with meshblock level census data. This allows us to assess the characteristics of the areas that are likely to be most affected by the tax.

2 Tax incidence

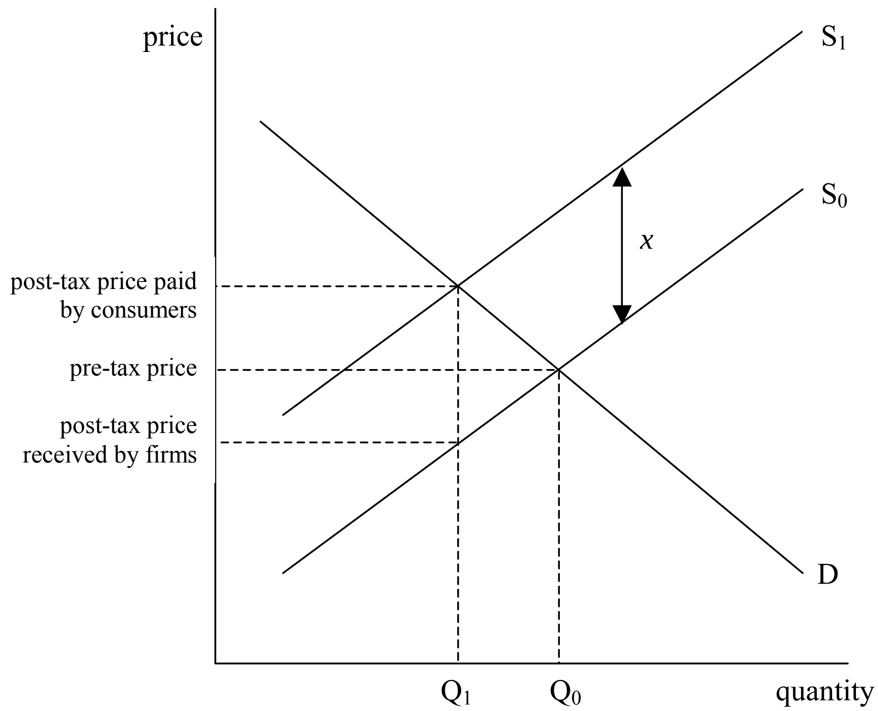
2.1 Theory

Through legislation, taxes are levied on particular groups of agents, such as employers, employees, or the producers of a specific good. These agents face the impact of the tax, or its direct effects, in the absence of any changes to price or economic behaviour. However, the ultimate cost of the tax may be passed on through prices, and thus may end up distributed quite differently across agents. The agents upon whom the tax is levied may in fact bear only a small (or even zero) direct cost. The agents that ultimately bear the cost of tax are said to bear the tax incidence, or indirect effects.[2]

A tax levied on employers, for instance, may be shifted forward to customers through higher output prices, or backward to employees through lower wages. In a competitive market, the degree to which a tax is passed on to customers depends on the relative elasticities of supply and demand for the output. Consider the case of a per unit tax of x dollars on a specific good, levied on firms. Before the tax, supply and demand in the industry are given by S_0 and D in Figure 1. After the tax, the price paid by consumers required for producers to be willing to produce each quantity increases by x. Graphically, this is represented by an upwards shift of the supply curve of x dollars to S_1. However, the final price paid by consumers rises by less than x because quantity adjusts downwards.

[2] This section on tax incidence draws heavily on Stiglitz (1988).

Figure 1: A tax shared between producers and consumers



In this illustrated case, part of the incidence falls upon producers, who receive a lower price, and part upon consumers, who pay a higher price. However, it may be that most or all of the incidence falls on just one type of party. If demand is perfectly elastic (the demand curve is horizontal), or supply is perfectly inelastic (the supply curve is vertical), it is easy to see that the price paid by consumers does not change at all, thus producers bear the entire incidence. Conversely, if demand is perfectly inelastic (vertical) or supply is perfectly elastic (horizontal), then the price paid by consumers rises by *x*, quantity does not change, and consumers bear the entire incidence. These cases suggest a general result for competitive markets: the more elastic is demand or inelastic is supply, the greater is the proportion of the incidence borne by suppliers, and vice versa.

A tax of this type could also cause demand for labour by the producing firms to fall, and thus the wage to decline. If this occurs, the tax incidence is partially or fully shifted backwards to employees. Similarly to the case detailed above, the extent to which the tax incidence is shifted backwards depends on the elasticities of supply and demand for labour. The more elastic is labour demand in the affected industry or inelastic is labour supply, the greater is the proportion of the tax borne by workers, the suppliers of labour.

When an additional tax is levied in an economy, however, the effects tend to spread beyond those directly associated with the party on whom the tax is levied. This occurs because those who bear the tax incidence may alter their other economic behaviour because of the effects of the tax. A workers who have wages reduced may cut back on consumption expenditure, as may a shareholder in a firm that bears some of the tax incidence. The firm itself may reduce investment. The economic agents affected by these secondary effects may also alter their behaviour, and so on.

In this paper, we consider a tax levied at the level of the farmer. New Zealand sheep/beef farmers sell their products in a large international market. Furthermore, the outputs from sheep/beef farms are commodities, and so are undifferentiated from sheep/beef products produced in other countries. Consequently, New Zealand sheep/beef farmers are price takers and are unable to pass any tax burden on to their customers. Thus the only way they are able to shift the tax burden is backwards to their workers.

Dairy farmers, on the other hand, may have a small influence on international dairy prices. Although international demand for New Zealand's dairy exports is still very elastic, dairy exports face one of the least elastic international demands of any of New Zealand's exports.[3] That is, international demand for New Zealand's exports of dairy products falls more slowly as dairy output price rises than do the demands for most of New Zealand's other exports when their prices rise.

The supply of New Zealand farm outputs may be reasonably elastic because if returns to farm labour decrease, farmers may choose to work less on their farms, reduce farm output, and increase their off-farm work. There is

[3] Personal communication with Ralph Lattimore, agricultural economics consultant, 9 June 2005. Also see Finlayson et al (1988).

evidence to suggest that many farmers do some form of additional non-farm work, so they may not have great difficulty increasing the quantity of this.[4] They may also choose to change their land use. However, in this paper we do not consider how supply is likely to change in response to an agricultural emissions charge. We assume perfectly inelastic supply.

In addition to potentially being able to pass a small proportion of the cost of an emissions charge forwards to international consumers, dairy farmers may pass some of the burden to farm workers. The degree to which both dairy and sheep/beef farmers would pass the burden of an agricultural emissions charge on to their workers depends on two major factors. The first is the degree to which they are able to reduce their labour requirements through measures such as substituting unpaid family labour for hired employees, reducing work on farm maintenance, or reducing farm production. If farmers are more able to reduce their demand for labour, they will pass more of the effects of the tax on to farm workers. The second factor is the degree to which farm workers are willing and able to find work in alternative industries. If farm workers have a lot of options for work outside the agricultural industry, farm owners will have difficulty retaining labour if they attempt to reduce the wages of their employees. In this case, farmers will bear more of the tax incidence.

The effects of a methane tax would spread beyond farmers and farm employees. These people, when faced with lower incomes, would most likely curtail their spending in a range of areas, thus adversely affecting businesses that relied on their custom.

We expect that most of the cost would stay with farmers, and perhaps some be passed on to farm employees, who tend to be located where the farms are. Though these people may affect their local communities, by curtailing their spending and thus adversely affecting businesses that relied on their custom, we expect the short run spread of the cost of the emissions charge to mostly be limited to the geographic areas containing farms. Hall and McDermott (2004, Abstract) find “considerable evidence of certain regional cycles being associated

[4] See, for example, Parminter (1997).

with movements in New Zealand's aggregate terms of trade, real prices of milksolids, real dairy land prices and total rural land prices".

In the long run, migration and capital movements will tend to smooth out regional differences. The wider macroeconomic impacts of changes in agricultural returns will be felt all over the country.

2.2 Previous literature on the incidence of environmental taxes

A range of literature explores the incidence of environmental taxes. The simplest consideration that relates to an environmental tax is the question of who legally pays the tax bill.

At the next level of complexity, we can consider who pays the cost of the tax in a partial equilibrium setting. In the context of this paper, this means that we allow for farmers to pass the cost of the tax on to consumers or back to workers, but we assume that farmers do not change the use of their land in response to the tax, nor do other prices or behaviours in the economy change. The majority of environmental policy incidence studies fall into this level of complexity. For instance, Poterba (1990 and 1991) investigates the extent to which gasoline tax is regressive by calculating expenditure on gasoline as a proportion of total expenditure for households with different levels of overall expenditure. It allows the cost of the gasoline tax to be passed on to consumers, but does not consider the extent to which different households are likely to have changed their gasoline purchasing habits in response to the tax. Kerr (2001), a New Zealand paper, uses the same approach to analyse the distributional effects of a tax on petrol in New Zealand. At a slightly higher level of complexity, Creedy and Sleeman (2004), a New Zealand study, uses input–output analysis to explore the impacts of carbon taxes on consumer prices.

The highest level of complexity is general equilibrium. For investigating a methane tax, this would mean allowing for adjustments such as converting some sheep/beef farms (which emit methane) to forestry (which does not), as well as adjustments that would occur throughout other sectors of the economy. The information requirements for general equilibrium analysis are much higher than for partial equilibrium. For instance, to estimate the degree of real adjustment caused by price changes we need to estimate price elasticities, which can be very challenging to do well. Papers such as Jorgenson et al (1992), Bovenberg et al (forthcoming), and Bento et al (forthcoming) use general equilibrium frameworks. The former analyses the distributional effect of a carbon tax set at the level required to stabilise US carbon dioxide emissions at their 1990 levels. Jorgenson chooses this framework because it allows for both energy prices and other prices to change, whereas a partial equilibrium analysis would only permit energy prices to change.

In the case of a New Zealand methane and nitrous oxide tax, most of the incidence of the tax is likely to fall on producers rather than consumers. Thus we are interested in the location of rural landowners, farmers and farm workers, as well as the local economies that are driven by agricultural profitability.

3 Data

This section outlines the data we use in our analysis. Appendix A gives more detailed information on the data.

3.1 Emissions charge impact data[5]

Our emissions charge impact data is derived from Hendy and Kerr (2005b). They calculate the impact of an emissions charge of $25 per tonne of CO_2 equivalent in terms of changes in the price of the farm output.[6] Methane emissions are converted to CO_2 Global Warming Potential (GWP) equivalents using the formula $CO_2(kg) = 1/21 \times CH_4(kg)$; nitrous oxide emissions are converted by $CO_2(kg) = 1/310 \times N_2O(kg)$. This $25 amount is the same as the maximum charge the Government plans to put on fossil fuel emissions from

[5] The derived methane costs presented in this paper are preliminary and subject to inaccuracy. They are most useful to interpret differences in cost impacts between areas. Absolute costs should not be taken seriously, and should not be cited.
[6] Note that a $25 agricultural emissions charge is much higher than the methane research levy the Government proposed in 2003.

2007.[7] These impacts are calculated for the two main rural land uses that produce methane and nitrous oxide emissions: sheep/beef farming (63% of total enteric methane emissions and 70.3% of agricultural direct nitrous oxide emissions), and dairy farming (35% of total enteric methane emissions and 27.3% of direct nitrous oxide emissions).

Dairy cattle produce different emissions to sheep and beef cattle and have outputs of different values. The manner in which Hendy and Kerr (2005b) translate the $25 emissions charge into a cost per kg of output, when combined with data on revenue per kg of output, makes the two impact values comparable.

Emissions per animal are based on the total national emissions for 2002 in Clark et al (2003) and the Statistics New Zealand Agricultural Production Census 2002. The two sections below detail the revenue implications of a charge on dairy and sheep/beef emissions as calculated in Hendy and Kerr (2005b).

3.1.1 Dairy

The cost of a tax of $25 per tonne of CO_2 equivalent emitted is $0.30 per kg of milksolids. Revenue per kg of milksolids in 2002 was $5.31, so this tax equates to a 7% reduction in revenue.

3.1.2 Sheep/beef

To calculate the impact of an emissions charge on sheep/beef land use, Hendy and Kerr (2005b) derive an emissions function based on actual national emissions 2002, with its unit defined in terms of a composite sheep/beef product. The components of this composite product are beef, lamb, mutton, and wool. The cost of a charge of $25 per tonne of CO_2 equivalent emitted is $0.42 per kg of composite product. Revenue per kg of composite product in 2002 was $3.94, so this tax equates to an 11% reduction in revenue.

[7] The Government will introduce an emissions charge of $15 per tonne of carbon dioxide equivalent on fossil fuels and industrial process emissions (i.e. carbon dioxide and fossil methane) from 2007 (New Zealand. Ministry for the Environment, 2005). The charge of $25 that we use approximates the international emissions price.

3.1.3 Spatial allocation

We use the model LURNZv1 from Hendy and Kerr (2005a) to allocate land uses and animal numbers spatially across the country. LURNZ assigns a single land use and a land use intensity to each 25 hectare area using information from the Ministry for the Environment's Landcover Database 2 (LCDB2), which is based on a composite of satellite maps in the summer of 2001/02, territorial authority animal numbers from Statistics New Zealand 2002 Agricultural Production Census, and physical productivity mappings from Landcare Research. For this paper, we aggregate the LURNZv1 results to labour market area (LMA) level, i.e. an area defined so that most people live and work within the same area.[8] Emissions costs are then allocated to LMAs in direct proportion to animal numbers in sheep/beef farming and dairy farming.

Because most people live and work in the same LMA, they operate as self-contained labour markets in the short run so that wage and employment effects from emissions charges borne in these areas will be felt within these areas. Other effects, such as through purchase of inputs and retail shopping, may also tend to occur within the same LMA. Thus LMAs seem the natural geographic units in which the costs of a methane tax are likely to be confined in the short run.

3.2 Socio-economic data

Details of the data used are given in Appendix A. One question that is of particular interest to us is whether emissions charges would primarily affect people who are in a poor position to cope with the costs. The socio-economic characteristics of the people in the most affected areas give us some indication of this. Equity issues arise if the emissions charge disproportionately targets one group. There is also potential for a political backlash, particularly if the charge targets a specific ethnic group.

We use the 2001 Statistics New Zealand meshblock census database, and compile the following variables:

[8] There are 58 LMAs in New Zealand as defined in Newell and Papps (2001). The LMAs are defined so that most people who live in an LMA also work in it, and most people who work in an LMA also live in it.

- Median incomes (of those aged 15 and over)
- Employment rates (as percentages of the population 15 years and over)
- Ethnicity—New Zealand European, Māori, Pacific Islander, Asian (percentages of the total usually resident population who specify these ethnicities as either their ethnicity, or as one of their ethnicities)
- Occupation (percentages of the employed population 15 years and over with each of these occupations: administration, professional, clerical, sales and services, agricultural, and manual)
- Qualifications (percentages of the population aged 15 and over with each of these highest qualification levels: no qualifications, school qualifications, vocational qualifications, and degrees)

Employment rates tell us about the level of activity in the economy and the strength of its labour market. Qualifications give another perspective on the ability of people to adjust to shocks. Those with higher qualifications tend to have more employment options, and are more able to move to other areas of the country for work.

4 The differential regional impact of an agricultural emissions policy

The effects of an emissions charge would touch many people and businesses. We classify the effects of an emissions charge into direct effects and indirect effects. Direct effects are those on the people who actually have to pay the charge. Indirect effects are all the other effects that occur as the effects of the charge feed through the economy.

4.1 Direct effects

At \$25 per tonne of CO_2 equivalent, the total annual revenue from the charge would have been around \$207m from dairy farms and \$363m from sheep and beef farms in 2002, assuming no behavioural response. This corresponds to \$109 per ha per year in dairy and \$42 per ha per year on sheep/beef land, and will probably have corresponding effects on the value of that land. For the average dairy farm this corresponds to a loss of \$15,000 in profit out of average farm net trading profits of \$48,739 in 2002/03 and \$85,029 in 2003/04 (New Zealand.

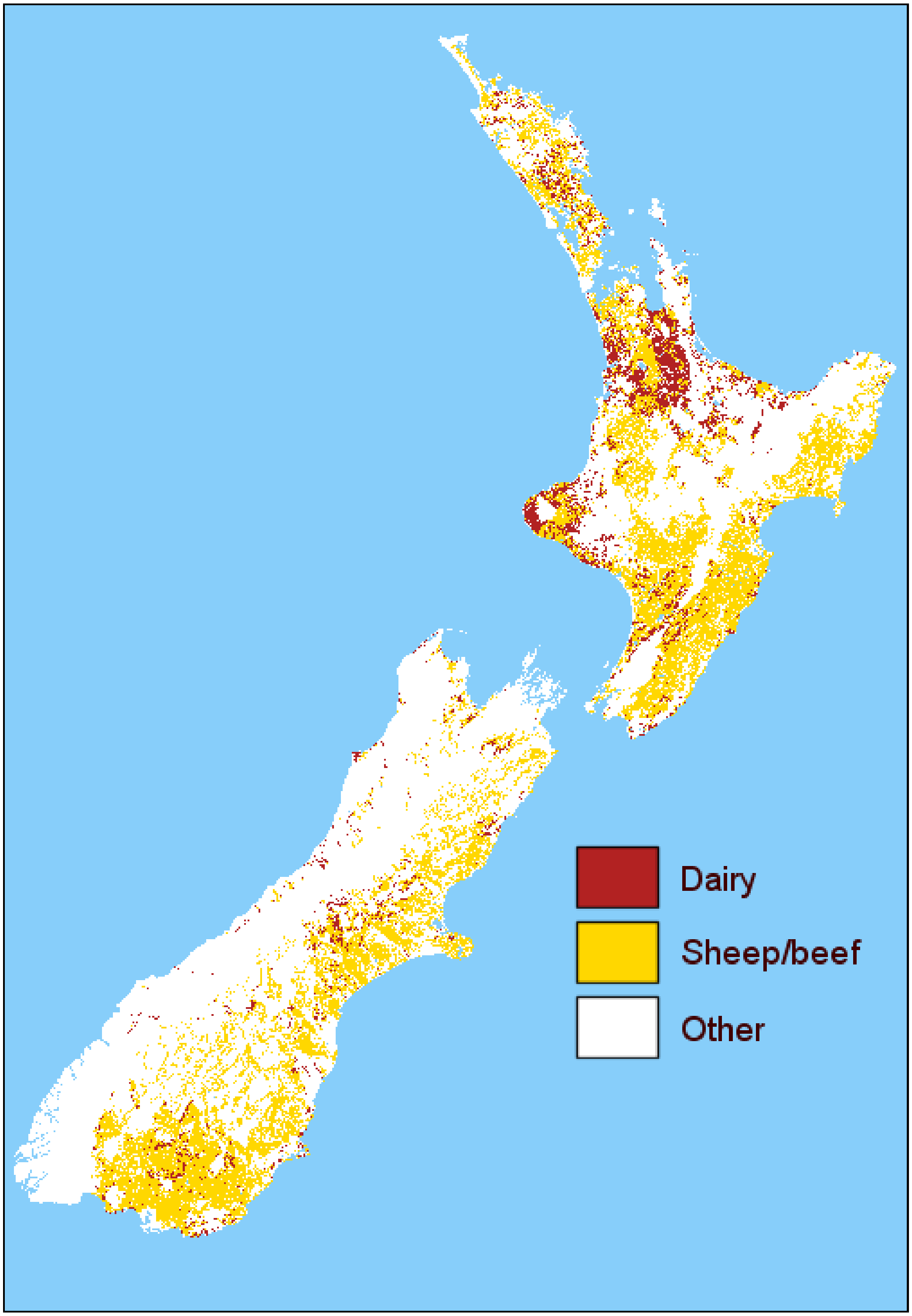
Ministry of Agriculture and Forestry, 2004a). For the average sheep/beef farm it corresponds to a loss of $13,000 out of average farm net trading profits of $86,620in 2002/03 and $40,492 in 2003/04 (New Zealand. Ministry of Agriculture and Forestry, 2004b).

The people directly affected by an emissions charge are dairy farmers and sheep/beef farmers, who actually pay the emissions charge. We can get a fair idea of where these farmers tend to live from the proportions of rural land in the LMAs, specifically the share of sheep/beef land or dairy land. Consequently, direct effects will be concentrated in areas with high proportions of sheep/beef or dairy land.

The parties directly affected by an emissions charge, the owners of dairy and sheep/beef farms, face charges in proportion to their number of stock. Geographically, the distribution of these people is close to the distribution of dairy and sheep/beef farms, which we show in Figure 2. When the owners are not living on the farms, the impact of charges on profit and land values may occur in other regions but the employment impacts will still be co-located with the farms. The distributions of farmland shown here are derived using the model LURNZv1.

With detailed information on the socio-economic characteristics of farm owners, including information on the level of debt farmers bear, we would be able to determine the ability to cope of the people directly affected by the emissions charge. In the absence of this information, we focus for the remainder of this paper on the characteristics of those indirectly affected.

Figure 2: The distribution of land use



4.2 Indirect effects

Indirect effects spread out through the economy from those directly affected. For example, when an emissions charge is introduced dairy farmers will find themselves facing increased costs. They will reduce their spending. Some of these farmers may lay off farm workers or reduce the wages they offer. These adversely affected farm workers may reduce their own expenditure, negatively affecting businesses in their communities. In this manner, the effects of a methane charge would flow on through the community.

We expect indirect effects to be strongest for people geographically close to those directly affected, and thus we make the assumption that indirect effects strike the LMAs in which the direct effects occur. It is important to examine these impacts spatially because the size of the impact depends on the nature of the local economy. For instance, the impact of laying off 50 people in an isolated area will be much greater than laying off 50 people in a dynamic urban area with a strong labour market.

One way that we can gauge the magnitude of the indirect effect in various LMAs is by measuring the per capita cost of an emissions charge by LMA. Alternatives include calculating the proportion of the population of the LMA employed directly by the dairy or sheep/beef industries, and calculating the proportion employed either directly or indirectly by the dairy or sheep/beef industries. Another way of estimating where impacts will be most severe is by looking at the proportion of the total economy that consists of agricultural farming. Where agricultural farming is a large proportion of the overall value of the economy, impacts are likely to be severe. We calculate these alternative measures, and find a high correlation between them and our chosen measure, the per capita annual emissions charge. This measure controls for the population of the area and tells us about how the charge is spread between LMAs.

Figure 3 illustrates the locations of the areas that are most affected by the emissions charge. The black lines are LMA boundaries. The higher is the cost per capita of the charge, the darker is the LMA. The white areas on the map are

Department of Conservation land. The hardest hit areas in the South Island are Gore and MacKenzie, which are sheep/beef farming areas. In the North Island the hardest hit areas are Taihape, Waipukurau, Te Kuiti and Dannevirke, which are mostly sheep/beef farming areas, some with regions of dairy farming. All the areas that are hardest hit by the per capita annual emissions charge have fairly low populations. Each of these districts is predominantly rural and the towns within them are rural centres.

Figure 3: The distribution of a per capita emissions charge over LMAs

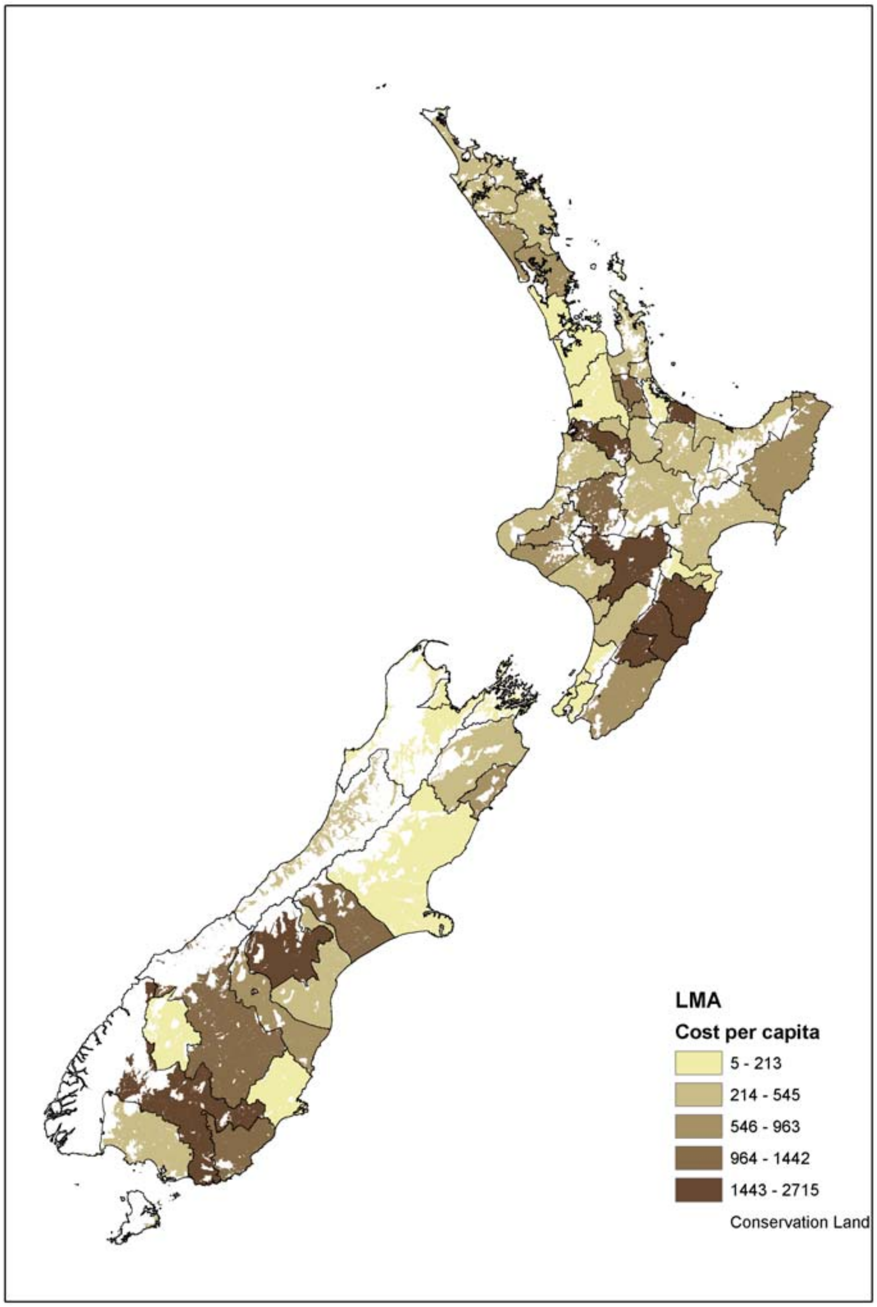
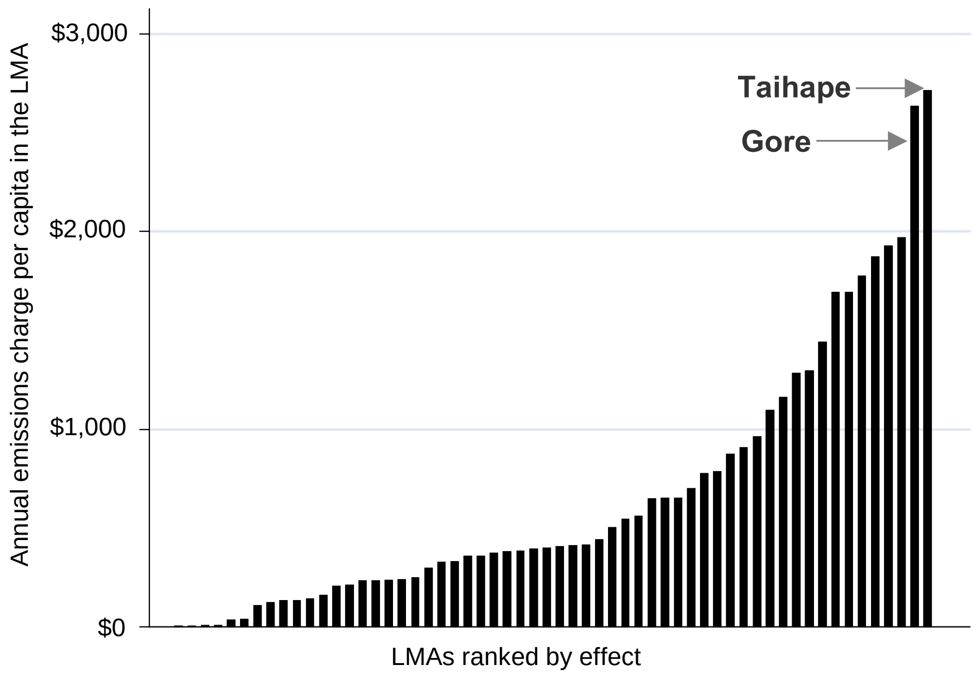


Figure 4 illustrates graphically the spread of per capita costs over LMAs. It is immediately evident that the effects of the emissions charge are spread very unequally across LMAs. A large number of LMAs are hardly affected at all, while a few are very highly affected. The least affected LMAs tend to have large urban populations, and include New Zealand's major cities. Appendix B includes a table of LMAs ranked as in Figure 4.

Figure 4: The distribution of emissions charge effects over LMAs



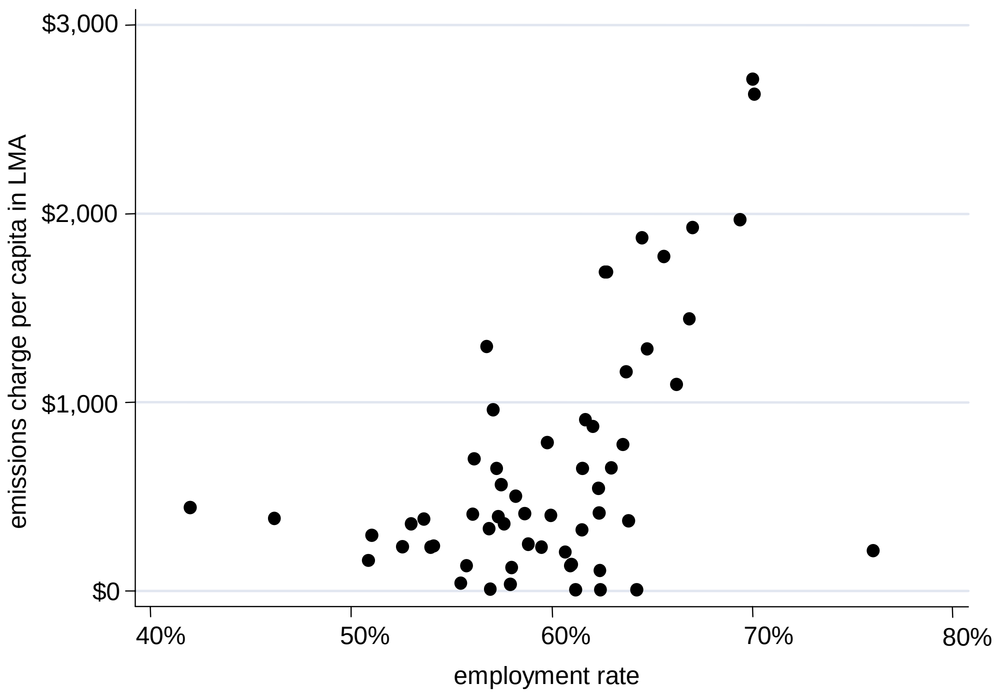
5 Socio-economic characteristics of affected LMAs

In this section of the paper we examine the relationship between the socio-economic characteristics of LMAs and their emissions charge costs, based on current land use. We use the measure "per capita annual emissions charge" throughout this discussion.

5.1 Employment rates

Figure 5 shows the emissions charge effect on LMAs by employment rate. Some relationship between the two variables is evident, with areas with high emissions charge effects also tending to have fairly high employment rates. One result of the emissions charge is likely to be job losses in the hard-hit areas. From the graph it seems that the areas most likely to face job losses have fairly strong labour markets. They may be well placed to absorb the displaced workers back into the workforce. This ignores the uneven distribution of people who are not in the labour force across LMAs. For instance, an LMA with a very large proportion of retired people will have a deceptively low employment rate in this figure.

Figure 5: Emissions charge effects by employment rates

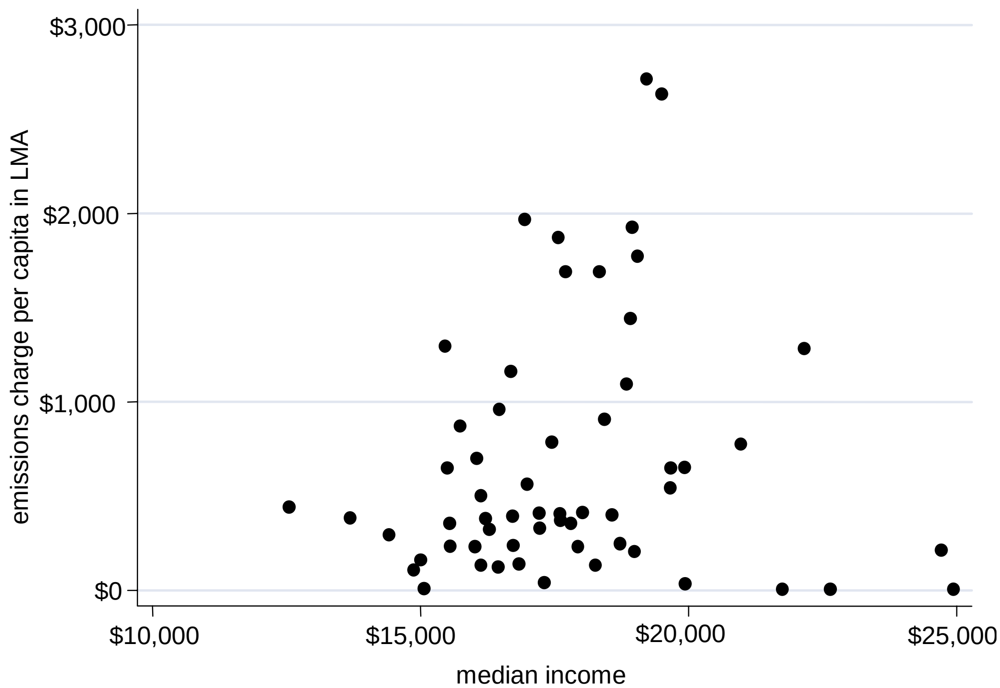


5.2 Median income

An emissions charge would affect the incomes of many people, especially in the harder-hit areas. Median income levels in these areas give one indication of how well those affected would be able to cope with decreases in their incomes. However, we cannot say from this data where in the income distributions of these areas are the people who are most affected.

Figure 6 suggests that areas with the highest emissions charge effects have a variety of median incomes. They are not noticeably different from other areas.

Figure 6: Emissions charge effects by median income



5.3 Ethnicity and occupation

Our findings for ethnicity and occupation are consistent with expectations. For occupation, we find that more agricultural and fishery workers live in areas with higher emissions charge effects, and fewer technicians, trades workers, workers in administration, professional and clerical occupations live in these areas. Other workers are evenly distributed across affected areas. For ethnicity, we do not find any clear relationships between emissions charge effects and the proportions of Europeans or Māori in the area. However, we find that Pacific Islanders and Asians tend not to live in areas with high emissions charges. This may simply be caused by the fact that both Pacific Islanders and Asians tend not to live in rural areas.

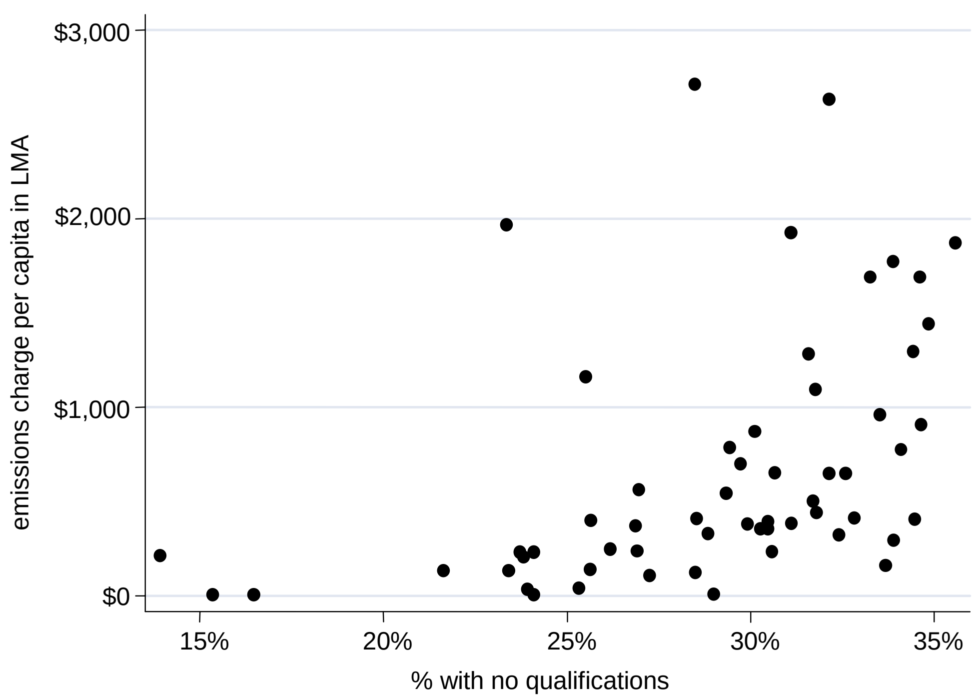
Neither the ethnicity nor the occupation results suggest that an emissions charge would inequitably target any particular socio-economic group.

However, agricultural workers would unavoidably be affected to a greater extent than most other professions.

5.4 Education and formal qualifications

Figure 7 shows the emissions charge effect on LMAs by the proportion of people with no formal qualifications. We can see that most of the observations are grouped in the bottom right, with a just a few areas with high qualification levels and low emissions charge costs, or with low qualification levels and high emissions charge costs. The interesting result here is that the areas with high emissions charge effects tend to also have high proportions of people with no qualifications. Other levels of qualification did not show a clear pattern.

Figure 7: Emissions charge effects by people with no qualifications



The level of formal education that a person has is an imperfect indicator of his or her employability in a wide range of jobs. People with some formal qualifications may be more likely to be able to find alternative work if they are laid off than are people with no qualifications.

Many of the occupations that revolve around dairy and sheep/beef farms, however, tend to involve 'learning by doing' rather than formal qualifications. Thus many people working in these regions who lack formal qualifications may in fact be highly skilled, though the skills may not all be transferrable outside the agricultural sector. Consequently, the data on numbers of people with no formal qualifications are likely to be a little misleading as an indicator of employability.

6 Conclusions

In this paper we have investigated the possible social impacts of an agricultural emissions charge levied on methane and nitrous oxide of $25 per tonne of CO_2 equivalent. For dairy farmers, this equates to a 7% decrease in revenue in the absence of price changes; for sheep/beef farmers, it equates to an 11% decrease. We assume the effects of the charge stay in the labour market areas in which the affected farms are located, and disregard the benefits of the likely accompanying tax decrease on the implicit assumption that they are evenly distributed across the country. Calculated on a labour market area basis, annual emissions charges per capita range from $5 in the Hutt Valley to $2,715 in Taihape.

We examine the socio-economic characteristics of the labour market areas with very high per capita emissions charges. These labour market areas mostly have high employment rates, which suggests people who lose their jobs because of the emissions charge are likely to have decent prospects for finding alternative work. On the other hand, labour market areas that would face high per capita emissions charges tend to have high proportions of people with no qualifications. This may mean that people who are made redundant would tend to have low levels of formal qualifications, and thus may have difficulty finding jobs in alternative industries. On the whole the socio-economic characteristics of high emissions rural areas are very similar to those in rural New Zealand as a whole.

Appendix A: Data

Methane and nitrous oxide emissions data

Table 1 Dairy emissions

Area of pasture (2002)	1,574,510 (hectares)	Kerr and Hendy (2005a)
Total Methane Emissions (2002)	8,272x10^6 (kgs CO_2 equivalent)	Brown and Plume (2004)
Methane Emissions per hectare (2002)	4,356 (kgs CO_2 equivalent per hectare)	–
Total Nitrous oxide Emissions (2002)	5,071 x10^6 (kgs CO_2 equivalent)	Brown and Plume (2004)
Nitrous Oxide Emissions per hectare (2002)	3,221 (kgs CO_2 equivalent per hectare)	–

Table 2 Sheep/beef emissions

Area of pasture (2002)	7,231,133 (hectares)	Kerr and Hendy (2005a)
Total Methane Emissions (2002)	14,512 x10^6 (kgs CO2 equivalent)	Brown and Plume (2004)
Methane Emissions per hectare (2002)	2,007 (kgs CO2 equivalent per hectare)	–
Total Nitrous Oxide Emissions (2002)	6,929 x10^6 (kgs CO2 equivalent)	Brown and Plume (2004)
Nitrous Oxide Emissions per hectare (2002)	958 (kgs CO2 equivalent per hectare)	–

Social characteristics data

All these data were drawn from Statistics New Zealand's 2001 meshblock census data at meshblock level and were aggregated to LMA level.

Median income data are the median income of all people aged 15 years or over who live in the LMA in 2001. Employment rates were calculated as the proportion of the population aged 15 years or over in the LMA who were gainfully employed in 2001. These were calculated from the number of people aged 15 or over who were gainfully employed, and the total number of people aged 15 years or over.

Ethnicity data for 2001 are series giving the percentage of the population claiming each of Māori, European, Pacific Island and Asian ethnicity as either their only ethnicity or one of their ethnicities. These were calculated from the number of people in each LMA claiming each ethnicity, and the total population of the LMA.

Occupation data for 2001 are the percentage of the employed population aged 15 years and over in each of a number of occupations. This is the percentage of the gainfully employed population aged 15 and over in an LMA that are in a particular occupation. The occupations used are:

- agriculture and fishery workers
- legislators, administrators, and managers
- professionals
- technicians and associate professionals
- clerks
- service and sales workers
- trades workers
- plant and machine operators and assemblers.

We also use 'employment by industry' data drawn from the 2001 census at the meshblock level.

Qualification data are the proportion of the population aged 15 years or over in the LMA whose highest qualification fell into one of the categories: 'no qualifications', 'school qualifications', 'vocational qualifications', and 'degree'. These categories exclude those with post-school qualifications such as university diplomas. Except for 'no qualifications', each qualification category is an aggregation of a number of finer categories.

- "School qualifications" contains School Certificate, sixth form qualifications, higher school qualifications, unspecified school qualifications, and overseas school qualifications.

- “Vocational qualifications” contains basic vocational, skilled vocational, intermediate vocational, and advanced vocational qualifications.
- “Degree” contains bachelor degree and higher degree.

Appendix B: Impacts by labour market area (LMA)

per capita annual cost of charge ($)	LMA	median income	employment rate	% European	% Māori	% Pacific Island	% Asian	% with no qualifica-tions	% with school qualifica-tions only	% with post-school qualifica-tions	% with degree
2,715	Taihape	$19,213	70	62	31	1	1	28	35	17	5
2,636	Gore	$19,496	70	88	9	0	1	32	33	17	5
1,970	MacKenzie	$16,946	69	87	5	0	3	23	34	21	6
1,929	Waipukurau	$18,951	67	76	21	1	1	31	33	18	5
1,872	Te Kuiti	$17,561	64	58	37	1	1	36	29	16	4
1,776	Dannevirke	$19,041	66	77	19	1	1	34	31	17	4
1,693	Otorohanga	$18,334	63	66	27	1	1	33	30	15	4
1,692	Eketahuna	$17,708	63	80	16	1	1	35	30	17	4
1,442	Balclutha	$18,912	67	88	8	0	1	35	31	16	4
1,296	Taumaranui	$15,456	57	57	37	1	1	34	27	16	4
1,285	Ngaruawahia	$22,159	65	83	11	1	2	32	34	16	4
1,162	Alexandra	$16,687	64	90	6	0	1	26	33	20	7
1,095	Ashburton	$18,834	66	93	5	0	1	32	34	17	4
963	Dargaville	$16,467	57	69	24	1	1	34	30	15	3
907	Stratford	$18,430	62	85	11	0	1	35	29	16	4
874	Kaikoura	$15,734	62	80	14	0	1	30	32	15	5
787	Masterton	$17,448	60	81	14	2	1	29	31	19	6
776	Hawera	$20,970	64	77	18	0	1	34	30	16	4
700	Gisborne	$16,050	56	49	44	1	1	30	30	17	5
653	Morrinsville	$19,931	63	80	13	1	3	31	33	17	5
651	Matamata	$19,671	62	81	15	0	1	32	33	16	5
650	Oamaru	$15,502	57	92	4	1	1	33	32	16	4
563	Warkworth	$16,986	57	80	12	1	1	27	34	18	5

545	Te Awamutu	$19,657	62	76	19	1	1	29	32	19	5
503	Waimate	$16,121	58	91	5	1	1	32	32	18	5
442	Kaikohe	$12,545	42	28	58	2	0	32	24	13	3
415	Invercargill	$18,014	62	84	12	1	1	33	30	17	5
412	Napier	$17,213	59	71	22	1	2	29	32	18	6
407	Tokoroa	$17,598	56	55	30	9	1	34	29	16	4
401	Taupo	$18,572	60	65	27	2	1	26	33	19	5
395	Bulls	$16,716	57	76	19	1	1	30	32	17	5
385	Kaitaia	$13,681	46	47	40	1	1	31	26	14	3
382	Thames	$16,209	54	79	14	1	1	30	31	17	5
373	Blenheim	$17,605	64	87	9	1	1	27	34	20	6
358	Te Puke	$17,807	58	67	24	1	2	30	31	17	4
357	Wanganui	$15,542	53	72	21	1	1	30	30	18	5
332	New Plymouth	$17,217	57	81	13	1	2	29	30	20	6
326	Greymouth	$16,281	62	86	8	0	1	32	29	17	5
296	Waihi	$14,409	51	76	18	1	1	34	31	16	4
249	Rotorua	$18,724	59	54	35	2	2	26	31	18	7
238	Whangarei	$16,724	54	68	23	1	2	27	31	19	6
237	Whakatane	$15,554	53	50	43	1	1	31	29	18	5
232	Palmerston Nth	$17,934	59	77	13	2	4	24	35	18	11
232	Kerikeri	$16,013	54	60	28	1	1	24	32	18	6
213	Queenstown	$24,714	76	83	6	1	5	14	39	23	11
207	Hamilton	$18,991	61	70	19	2	5	24	35	19	11
161	Levin	$15,002	51	72	20	3	2	34	29	16	5
141	Nelson	$16,832	61	87	7	1	1	26	33	21	7
134	Christchurch	$18,257	61	84	7	2	4	23	36	18	10
133	Dunedin	$16,119	56	86	6	2	4	22	36	17	13
124	Hastings	$16,446	58	65	24	4	2	28	31	17	6
108	Motueka	$14,870	62	82	10	0	1	27	31	17	5

41	Tauranga	$17,310	55	78	15	1	2	25	34	20	6
36	SthAuckland	$19,938	58	47	15	19	12	24	36	15	8
9	Picton	$15,067	57	80	13	1	1	29	30	18	5
8	Auckland	$22,641	61	66	8	7	13	16	38	17	15
6	Wellington	$24,941	64	71	10	7	7	15	35	18	21
5	Hutt Valley	$21,752	62	69	15	7	6	24	35	19	10

Notes:
Median income is calculated for those aged fifteen and over;
Employment rate is calculated as the percentage of the population 15 years and over;
The four ethnicity variables are calculated as percentages of the total usually resident population; individuals can belong to more than one ethnic group;
The four highest qualification variables are calculated as percentages of the population aged 15 years and over.

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