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Carbon Policy Design and Distributional Impacts: What does the research tell us?

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Disclaimer

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These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD) which are carefully managed by Stats NZ. For more information about the IDI and LBD please visit https://www.stats.govt.nz/integrated-data/.

The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes and is not related to the data's ability to support Inland Revenue's core operational requirements.

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Abstract

There are two main veins of literature examining the distributional effects of carbon policy: the effects on households and the effects on production sectors (i.e., employment). These literatures have generally arisen from two common arguments against carbon policies – that these polices disproportionately affect lower income households and that the overall effect on jobs and businesses will be negative. However, existing research finds that well-designed carbon policies are consistent with growth, development, and poverty reduction, and both literatures provide guidance for policy design in this regard. This paper brings together the guidance from both literatures.

JEL codes

J01, Q52, R11

Keywords

Environmental Economics, Climate Change Mitigation, Distributional Impacts of Carbon Policies

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1 Introduction

There are two main veins of literature examining the distributional effects of carbon policy: the effects on households and the effects on production sectors (i.e., employment). Of course, the two are inextricably linked. Moreover, both literatures provide some guidance for the design of carbon policies, and this paper brings the guidance from both literatures together.

Two common arguments against carbon policies are that these polices will 1) disproportionately affect lower income households and 2) negatively impact jobs, businesses, and economic growth. While it is true that research has found that carbon taxes can be regressive (i.e., lower income households are disproportionately burdened by the tax), this is not always the case. Moreover, policy packages can be designed to offset any regressive effects while still effectively reducing greenhouse gas (GHG) emissions. For example, revenue recycling is one policy option that has been found to offset the regressive effects of taxes. Moreover, the study design used to evaluate the policy itself can affect whether a policy is determined to be regressive or progressive. The literature relating to the distributional effects on employment of these policies has generally found long-term effects in the overall economy to be relatively small; however, some industries are disproportionately impacted. Yet, again, research in this area has shown that policy design can help to reduce the negative impacts on employment and result in an overall net positive effect. In fact, well-designed climate policies "are consistent with growth, development, and poverty reduction". (High-Level Commission on Carbon Prices 2017, 8)

Understanding the potential distributional effects of policies has important ramifications for their successful implementation. The yellow-vest protests in France are a recent, though not unique, example of resistance to carbon taxes. These protests began in 2018 over increasing fuel prices – in particular an additional fee on diesel[1] – as well as a reduction in the speed limit for country roads.[2] The protests were disproportionately by rural and peri-urban residents who felt targeted by both the diesel fee and the speed limit changes as these groups rely heavily on private vehicles[3] for transport. (Hamdaoui 2021; Mehleb, Kallis, and Zografos 2021) After the yellow vest protests, the French fuel tax was initially suspended but then dropped all together, and it has not as yet been reinstituted.

In New Zealand, protests were staged in 2021 by farmers which had echoes of the yellow-vest protests – with farmers objecting to the burdens imposed by a number of different government policies, some of which were environmental. One particular policy was the Clean Car Package, which

[1] Diesel vehicles were viewed as being more prevalent in lower income households, so the diesel fees were viewed as targeting these groups.
[2] The speed limit reduction was to increase road safety and was not related to carbon policy, but was it viewed as another tax imposed via citations on rural populations who rely heavily on their vehicles.
[3] One survey of demonstrators found that 85% reported owning a car. (Bedock et al. 2018)

became known colloquially as the “Ute Tax” since rebates to purchase low-emission vehicles were funded by charges on high emitting vehicles (i.e., utility vehicles or “utes”[4] as they are commonly known). Farmers felt particularly burdened by these charges since low-emissions vehicles were not seen as feasible options for them.[5]

As fuel prices and inflation worldwide have increased sharply in 2022, a number of governments, including New Zealand’s,[6] are implementing tax holidays, often for fuel taxes, to reduce the impact of these shocks on households (Sharafedin, Kelly, and Rua 2022). Reinstating these taxes in the future – as well as additional efforts to fight climate change – may again require voters’ support.

2 Distributional Impacts on Households

Much of the literature about the distributional impacts of carbon pricing on households examines the expected effects of fuel price changes on household expenditures for household fuels (i.e., energy used in homes) and for transportation (e.g., petrol, diesel, public transportation prices). Since this research tends to focus on determining if carbon policies are likely to be regressive, proportional, or progressive, these analyses generally examine the effects of increased fuel prices (through the imposition of a fuel tax or through the removal of a fuel subsidy[7]) on households across different income groups.[8]

A review of this literature indicates that studies of developed countries find an overall tendency for regressive impacts of carbon taxes but that the results for developing countries are inconsistent. However, while the carbon tax burden from domestic energy consumption tends to be regressive, the burden from transport fuels tends to be weakly progressive or proportional even in developed countries[9]. (Flues and Thomas 2015; Wang et al. 2016; Alvarez 2019; Ohlendorf et al. 2021) Flues and Thomas (2015) delved into this further using 21 OECD countries and found that taxes on electricity are more regressive, on average, than taxes on heating fuels and that transport fuel taxes are not regressive when averaging across all countries. However, their results varied by country. For example, they found more progressive effects in lower GDP-per-capita countries and more proportional or regressive effects in higher GDP-per-capita countries.

[4] Utes generally refer to pickup trucks.
[5] See the organisers’ position statement for more information.
[6] Starting in March 2022, the Government reduced fuel excise duties and road user charges for 3 months. The price of public transport was also halved. See the announcement.
[7] These policy changes may or may not be related to carbon policy. Ohlendorf et al. (2021) also find that the results from studies of subsidy outcomes were no different than those of cap and trade systems or taxation policies.
[8] For example, Flues and Thomas (2015) examine socio-demographic characteristics including household size (number of adults and number of children) and location as well as education level, gender, age, and labour force activity.
[9] Sterner (2012) attributes the regressivity argument related to transport fuel taxation to early studies in the US.

In developed countries, the reason for the differing results between domestic energy consumption and transport are varied. Flues and Thomas (2015) point out that low-income households tend to have more substitution options for transport and heating fuels than they do for electricity consumption as some electricity is fixed for households (e.g., water heating, refrigeration). Approximately 27% of electricity usage for the typical household in New Zealand in 2018 was for water heating, 17% for refrigeration, 15% for space heating, 13% for lighting, and 5% for cooking.[10] (Electricity Authority 2018) For water heating or for refrigeration (which is almost half of NZ households' electricity consumption), reducing electricity consumption will generally require the household to replace the current appliances with more energy efficient options. However, lower income households tend to have less capital to purchase new appliances, and when they do buy new, they may be less able to afford higher-priced, more efficient models that could lower their electricity bills. Moreover, renters, who are often more likely to be lower income,[11] are also more restricted than homeowners in their ability to make changes to the dwelling itself or to the appliances. (Barton 2014; Petrov and Ryan 2021) Hence, lower income households have greater difficulty reducing electricity consumption. On the other hand, households can reduce their heating needs, for example, by living in smaller dwellings or by spot heating despite living in less energy-efficient dwellings.[12]

After conducting an extensive literature review, Wang et al. (2016) highlight that policy design can affect both the effectiveness of carbon pricing (in terms of emissions reductions) and its distributional effects. Wang et al. (2016) classify policy measures to reduce adverse effects of these policies as either ex-ante (e.g., lower tax rates or exemptions for the most affected groups[13]) or ex-post (e.g., compensation after the fact as with revenue recycling policies). They state that it is better (i.e., more efficient and more effective) to incentivise innovation and replacement of emissions-intensive technologies using carbon taxes combined with ex-post measures rather than ex-ante measures to reduce adverse effects of taxes. García-Muros et al. (2022), on the other hand, investigate combining less efficient but more equitable revenue recycling schemes (e.g., direct rebates to households) with more efficient but less equitable schemes (e.g., reduction in payroll

[10] These percentages have not changed much over the last two decades. Using data collected between 1999-2005, approximately 34% of household electricity use was from hot water, 15% for refrigeration, 12% for heating, 12% for lighting, and 7% for cooking. (Isaacs et al. 2010)

[11] According to the 2018 Census, approximately 35% of NZ households rented their dwellings, but for households with incomes below $20,000, 58% rented their homes. Of households with incomes greater than $150,000, about 20% were renters.

[12] This may be less true in New Zealand where heat pumps and electric heaters are the dominant forms of heating. Just over half of homeowners reported using heat pumps as a main type of heating and about 40% reported using an electric heater. For renters, these percentages were just under 40% for heat pumps and about 45% for electric heaters. The next most prevalent heating type reported was a wood burner – reported by almost 40% of owners and just over 20% of renters. Fixed gas and portable gas heaters were also reported. For renters, the percentages of each are about the same (between 5-10%), whereas homeowners were much more likely to report fixed gas heaters (about 12% compared to about 5%). (Stats NZ 2020)

[13] In their review, Wang et al. (2016) find that ex-ante measures often include exemptions for energy-intensive industries due to concerns about GDP and labour effects, but this reduces the effectiveness of the tax in terms of emissions reductions.

taxes) and find that doing so creates synergies which result in greater efficiency gains and more progressive outcomes.

This approach of combining policies that complement carbon pricing is also highlighted in the *Report of the High-Level Commission on Carbon Prices*.[14] (High-Level Commission on Carbon Prices 2017) While the report recognizes that carbon prices are an "indispensable" component of strategies to reduce emissions efficiently, the report also states that carbon pricing alone may be insufficient for meeting the Paris Agreement targets and that a combination of policies may be more efficient.

Recommendations to use pricing and non-pricing interventions is something of a departure from standard economic policy, and one of the central reasons for this is due to the distributional impacts[15] of pricing interventions and the potentially large costs of undoing them. (Stiglitz 2019) If non-pricing interventions can help to lower the carbon price, then the distributional effects of pricing interventions should be reduced, and hence, should be optimal compared to using pricing interventions alone. Moreover, simple regulations may be able to induce a shift to preferred technologies faster, more efficiently, with less uncertainty, and fewer distributional effects than carbon pricing. (Stiglitz 2019) In fact, regulations can be more effective than carbon pricing when pricing responses are muted due to market failures or behavioural issues (e.g., economies of scale, uncertainty).[16] (High-Level Commission on Carbon Prices 2017; Stiglitz 2019)

Throughout the literature, revenue recycling is recognised as a key policy component that can reduce the regressive effects of carbon policies and make the overall policy progressive. (Wang et al. 2016; Alvarez 2019; Ohlendorf et al. 2021) Moreover, policies which include a revenue component and a spending component are more likely to succeed than those that only have a revenue component. (High-Level Commission on Carbon Prices 2017) The High-Level Commission report suggests a number of ways that revenues could be used: in-kind or in-cash transfers; social safety nets, education, and health; wage subsidies in growth sectors to help absorb workers from declining sectors; re-employment services for displaced workers; R&D and innovation to negatively impacted sectors[17] and regions[18]; and infrastructure investments to accelerate economic growth.

[14] This report is also known as the Stern-Stiglitz report as Nobel Laureate Joseph Stiglitz and Lord Nicholas Stern were co-chairs of the Commission. The Commission's purpose was to investigate carbon-pricing options that could both deliver on the Paris Agreement and foster economic growth and development.

[15] Stiglitz (2019) notes uncertainty from pricing interventions can be welfare reducing and that certain regulations may be preferred due to lower uncertainty and fewer distributional effects.

[16] The Commission Report (2017) cites the banning of incandescent light bulbs and of lead in gasoline as two successful government interventions. Stiglitz (2019) adds policies for single-use plastic bags to the list of successful government interventions that changed behaviours and norms quickly.

[17] This may seem counter-intuitive, but it could help businesses transform their production processes. For example, during the COVID-19 Pandemic, a number of businesses transformed their processes to make needed items like hand sanitiser or masks and a number of other businesses invested in technologies to reduce in-person interactions (e.g., on-line ordering systems, contactless delivery, contactless payments).

[18] One suggestion in the report is funding pilot projects for green technologies in regions negatively impacted by climate policy.

Using a survey representative of Norwegian voters, Sælen and Kallbekken (2011) found that earmarking revenues for environmental measures increased support for a fuel tax because people then expected to personally benefit from the tax revenues' use and because people did not believe that the tax itself would improve environmental quality.[19] This contrasts with the *Report of the High-Level Commission on Carbon Prices* which recommends caution in earmarking revenues because matching revenues with spending needs is not straightforward and because the funds could be subject to capture by interest groups. (High-Level Commission on Carbon Prices 2017)

In the French yellow-vest protests, there was no clear earmarking of the tax revenues for recycling, and many believed that the revenues would instead be used to offset tax cuts that primarily benefited the wealthy which had been instituted around the same time. (Mehleb, Kallis, and Zografos 2021; Stiglitz 2019) Mehleb et al. (2021) used systematic discourse analysis to assess the viewpoints of active participants in the yellow-vest protests and found common themes of an unfair policy that placed more burden on the unprivileged and did not address inequalities. Moreover, there was no evidence of climate denialism or scepticism despite portrayals of the movement as anti-green. Hence, the yellow-vest movement highlights the importance of not only considering the distributional effects of carbon policies but also of clearly communicating the components of the policy designed to offset them.

It is also important to note that poorly designed recycling policies may not achieve their intended effects. For example, Alvarez (2019) finds that revenue recycling significantly increased the likelihood of progressive outcomes if done as a lump-sum transfer, flat tax discount or food subsidy.[20] However, revenue recycling done as a corporate or income-based tax discount did not affect the progressive or regressive nature of the policy. Stiglitz (2019) notes that the more nuanced policy approach recommended by the High-Level Commission requires a better understanding of the economy and the distributional effects of policies than relying on carbon pricing alone.

One example of the importance of this understanding is highlighted by the study of fuel economy standards,[21] which are often viewed as less regressive than fuel taxes. While most of the previous literature focuses on pricing interventions, Davis & Knittel (2016) assess the distributional impacts of these standards in the US. They find that these standards create an implicit subsidy for fuel-efficient vehicles and an implicit tax on fuel-inefficient vehicles which are mildly progressive if

[19] Their results also indicated that there was no linkage between increased support via earmarking and distrust of government. Moreover, the researchers did not find the same increased support for an income tax with earmarking for environmental measures.

[20] In thinking about this type of revenue recycling, policy makers should also consider timing issues with the implementation of the tax and the reimbursement. Just as some households may not have the upfront capital to afford more energy-efficient appliances even when the appliance could pay for itself over time via reduced energy bills, some households may be adversely affected in the short-term by price increases despite reimbursement in a later time period. In NZ, 18% of households in 2015/16 and 20% in 2018/19 reported not being able to pay an unexpected $500 expense within a month without borrowing. (Hyslop, Riggs, and Maré Forthcoming)

[21] In the literature, these are often referred to as Corporate Average Fuel Economy (CAFE) standards.

only new vehicles are considered; however, the standards are regressive when used vehicles were included in the analysis, more so than a gasoline tax with lump-sum revenue recycling. Hence, these results indicate that an appropriately designed tax policy can be more progressive and more efficient than other measures that have been implemented.

These results also reflect the importance of study design in the analysis. Two meta-analyses examine the effects of the study design itself on the policy outcome (i.e., regressive, proportional, or progressive): Alvarez (2019) and Ohlendorf et al. (2021).[22] Both differentiate studies using general equilibrium modelling from other types of analyses and find no effect on the results. However, Ohlendorf et al. (2021) find that studies which included direct and indirect effects and studies which included demand-side effects were both more likely to find progressive outcomes (general equilibrium models generally include these types of effects). These meta-analyses as well as a number of other studies find that progressive outcomes are more likely and regressive outcomes weaker when studies use a measure of lifetime income (i.e., total expenditure) as opposed to annual income. (Sterner 2012; Flues and Thomas 2015; West et al. 2017; Alvarez 2019; Ohlendorf et al. 2021) Sterner (2012) notes that studies using annual disposable income tend to make regressive taxes more regressive and progressive taxes more progressive and that total expenditure is considered a better proxy for lifetime income.[23]

Mitigation can have co-benefits that are typically not included in the distributional impacts analysis which can change the result of the study. (Wang et al. 2016; High-Level Commission on Carbon Prices 2017) For example, mitigation could also reduce pollution, which tends to disproportionately affect lower income households and workers, but the health benefits from reducing pollutants are often not included in distributional studies. One study, Knittel & Sandler (2011), does examine the health co-benefits of carbon pricing and finds that incorporating these benefits resulted in a net benefit (as opposed to a net cost) from U.S. fuel taxes between 1998 and 2003 and in a lower net cost between 2004 and 2010. This finding was driven by the fact that increased fuel prices not only reduced the distance households drove but also resulted in households driving newer, cleaner, more efficient vehicles when they did drive.

3 Distributional Impacts on Production Sectors

Wang et al. (2016) note that there are fewer studies of the distributional impacts on production sectors compared to those studying households. From the studies which have been done in this

[22] These meta-analyses tended to confirm the findings of previous literature reviews such as Wang et al. (2016).
[23] The rationale is that consumption (i.e., expenditure) is smoother than income over an individual's lifetime and hence a more reliable approximation of family welfare. (Flues and Thomas 2015; Alvarez 2019) Sterner (2012) uses both annual disposable income and total expenditure and finds that the results are more regressive when disposable income is used compared to when total expenditure is used as the income measure.

area, Hafstead and Williams (2020) conclude that existing research has generally shown that environmental policy has little effect on overall employment – particularly in the long run – and that policy design can be used to reduce adverse effects (typically found in the short run). Existing research indicates that changes in jobs due to environmental policies are primarily reallocations across industries as opposed to substantial aggregate effects such as large net job gains or net job losses (i.e., the net policy effects are small). Moreover, most of this reallocation occurs via less hiring rather than through separations.[24] The researchers find that both results hold even for large, economy-wide policies.

Policy design (scale, scope, and implementation speed) has been found to effect short-term employment outcomes. For example, pre-announcements and phasing-in policies have been found to counter some of the short-term negative effects for workers by providing more time for firms to adjust their employment with less hiring as opposed to separations or layoffs. (Hafstead and Williams III 2019) In terms of scale and scope, economy-wide policies compared to targeted (i.e., sector-specific) policies tend to reduce adverse outcomes for workers because more reallocation provides more opportunities for workers to move as demonstrated in Hafstead and Williams (2019). In fact, they conclude that the short-run[25] policy effects on unemployment rates largely depend on two things: the ease with which workers could change industries and the magnitude of reallocation across industries caused by the policy.[26] This was particularly true for workers in mining and utilities[27]. Moreover, in their model, some high-turnover sectors like coal mining, which had high unemployment rates even without the policy, had lower unemployment rates in the medium-term under the policy as it accelerated workers' movements into lower-turnover sectors.

These results suggest that policies designed to improve worker mobility across industries could reduce the negative distributional effects of carbon prices alone and is perhaps an area for using carbon-pricing revenues to smooth the transition. The High-Level Commission Report (2017) provides some suggestions for policies in this area, such as wage subsidies in growth sectors to help absorb workers from declining sectors, unemployment insurance for negatively affected workers, and re-employment services for displaced workers. In fact, all of these were used in the US to help industries and workers affected by trade liberalisation. Research also

[24] However, the authors note that this may be less true for already declining industries – these industries may have already reduced hiring substantially and hence increased job separations may be the only viable option remaining.
[25] In their model, the short run is less than 18 months.
[26] They looked at unemployment in terms of both magnitude and duration.
[27] Castellanos & Heutel (2019) found similar results using a static model to compare results when assuming perfect mobility between jobs to those assuming perfect immobility. They found little overall effect on the aggregate unemployment rate but more substantial differences for unemployment of workers in the oil and gas extraction sector and in the coal mining sector (more negatively affected under perfect immobility). They also found that policy design could be used to mitigate these effects.

indicates that skill shortages may slow the transition to a low-emissions economy and that the reallocation process can be aided by supporting policies for education, migration, and trade. (High-Level Commission on Carbon Prices 2017)

Using a simulation model, Riggs and Mitchell (2021) find that very few groups of workers in New Zealand were expected to be negatively affected, in terms of the number of jobs, by different carbon policy mix options required to meet emissions targets, especially over the long term. This indicates that the netting of policy effects could occur within these groups (e.g., for every job negatively affected by the policy that was typically held by a woman, there was at least one job positively affected by the policy that was also typically held by a woman); however, this requires that workers can transition away from negatively affected sectors to positively affected sectors.

Despite a net positive effect for most groups of workers over the long term, there were also some groups that were expected to be negatively impacted (in terms of number of jobs). For example, Figure 1 shows that workers in three sectors – Mining, Manufacturing, and Utilities[28] – were predicted to have fewer jobs available to them over the forecast period due to the implementation of the policies, and manufacturing more so than the other two industries. In terms of geography, Figure 2 shows that workers in Taranaki and the West Coast were predicted to be negatively affected by the policies; however, this is largely due to the concentration of the negatively affected industries in these regions. Given that the negative employment effects are expected to outweigh the positive employment effects in these regions, these workers may have reduced mobility and more difficulty during the transition. One recommendation in the High-Level Commission Report (2017) seems particularly relevant here —funding pilot projects for green technologies in regions negatively impacted by climate policy.

Riggs and Mitchell (2021) also showed that while some groups were expected to be positively affected (in terms of the number of jobs) by the different policy options overall, they were also expected to experience a disproportionate share of the churn (i.e., both more gains and more losses due to these policies relative to their share of worker-jobs). For example, Figure 3 shows that workers with no educational qualifications were expected to be positively affected by each policy mix option in terms of the number of worker-jobs over the long run (ranging from 2% to 20% of the net change in worker-jobs); however, they were also substantially more likely to be in industries that were expected to experience greater decline due to the policies as shown in Figure 4[29]. Older workers were also substantially more likely to be in industries that were

[28] The specific industry is Electricity, Gas, Water and Waste Services, but the term 'Utilities' is used here as shorthand.
[29] Workers with no educational qualifications held 12% of all worker-jobs, but they held 26% of worker-jobs expected to lose more jobs due to the policies than without the policies as shown by the 'Loss, More Loss' category.

expected to experience greater decline due to the policies. Given that Poot (1987) finds lower geographic mobility among older people, which tends to narrow older workers' job opportunities, older workers may have more limitations on their ability to transition into new opportunities. For this reason, targeting resources to help these groups transition could be a cost-effective strategy to reduce adverse outcomes for these groups.

Existing research such as that found in Poot (1987) can also improve policy makers understanding of worker mobility, as there are several literatures related to worker mobility which touch on many aspects of the determinants of labour supply and labour demand. One relevant area of research relates to the nature of employment and the quality of that employment from the worker's perspective. Another is the mobility of workers in relation to their human capital, their geographic mobility, and even their social networks. Finally, there is also a large body of research related to the process of workers matching up to appropriate jobs which is often referred to as sorting. (Krueger and Schkade 2007)

Combining the existing literature on worker mobility with an examination of the characteristics of jobs and workers in declining and growing industries can shed light on the nature of employment in these industries as well as on the likelihood that workers moving from one industry into another may have to adjust to different working environments or face other frictions that may make it difficult for them to move easily between industries. For example, research on the concentration of workers in some occupations and industries by race or ethnicity provides evidence that labour market networks play an important role in hiring and in better worker-to-job matches[30] for these groups, over and above the influence of residence-based networks. (Hellerstein, Kutzbach, and Neumark 2013) These networks appear to be more important for less-skilled workers and for workers who are not as well-integrated into the labour market (e.g., younger workers, immigrants). (Hellerstein, Kutzbach, and Neumark 2013) It also important to note that for those workers who rely heavily on their networks for employment opportunities, a disruption in the network could markedly reduce workers' ability to transition.

There are a number of other worker characteristics that have been associated with worker mobility. In New Zealand, for example, Sin and Stillman (2015) show that while Māori were on average more geographically mobile than similar Europeans, Māori living in areas where their iwi had a strong network were less mobile than Europeans and much less responsive to local labour market shocks (i.e., much less likely to migrate to find employment). Hence, concentrations of workers in some occupations and industries by race or ethnicity may indicate structural frictions

[30] Kerr and Mandorff (2015) find similar results for the relationship between social networks and entrepreneurial concentration for small and socially isolated ethnic groups in the US.

that could limit their mobility to move into other jobs or industries, whether this is due to geographical constraints or to breakdowns in their networks. Poot (1987) also finds lower geographic mobility of agricultural workers, which is particularly relevant for carbon policy employment effects in New Zealand.

4 Concluding Discussion

As policy makers face increasing pressure from many directions on climate change and carbon pricing policies, it is important that they have information at their disposal that is based on current research in order to devise “well-designed policies” which can support growth, development, and poverty reduction as suggested by the High-Level Commission Report (2017). A significant aspect of well-designed policies appears to entail consideration of the distributional impacts to help smooth the transition for households, workers, and businesses. Doing so is important both for garnering political support for these policies but also for delivering on the potential for sustainable growth. Hence, this paper brings together multiple literatures in order to provide policy makers with a better understanding of current recommendations for designing carbon policies as well as other considerations that may need to be considered as policies are being developed.

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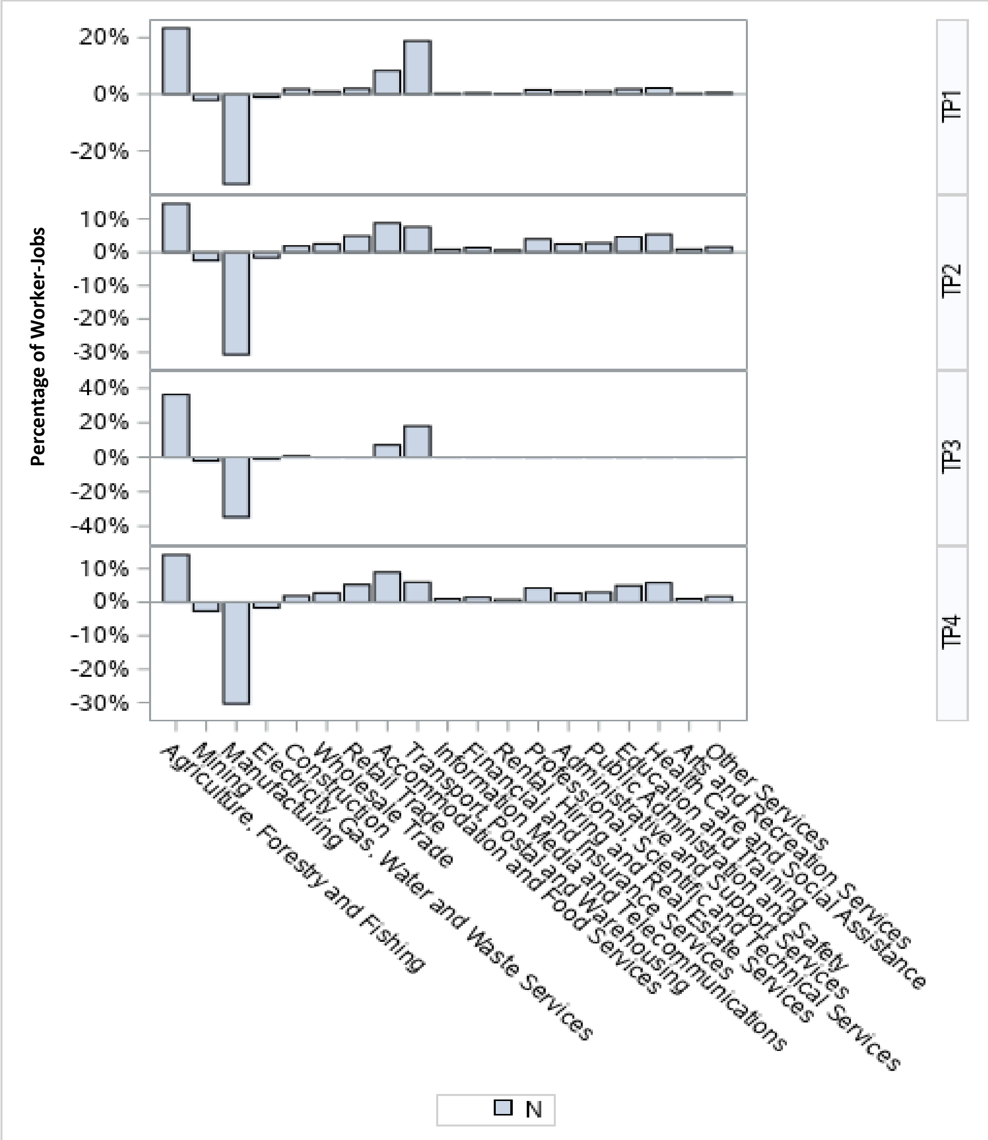
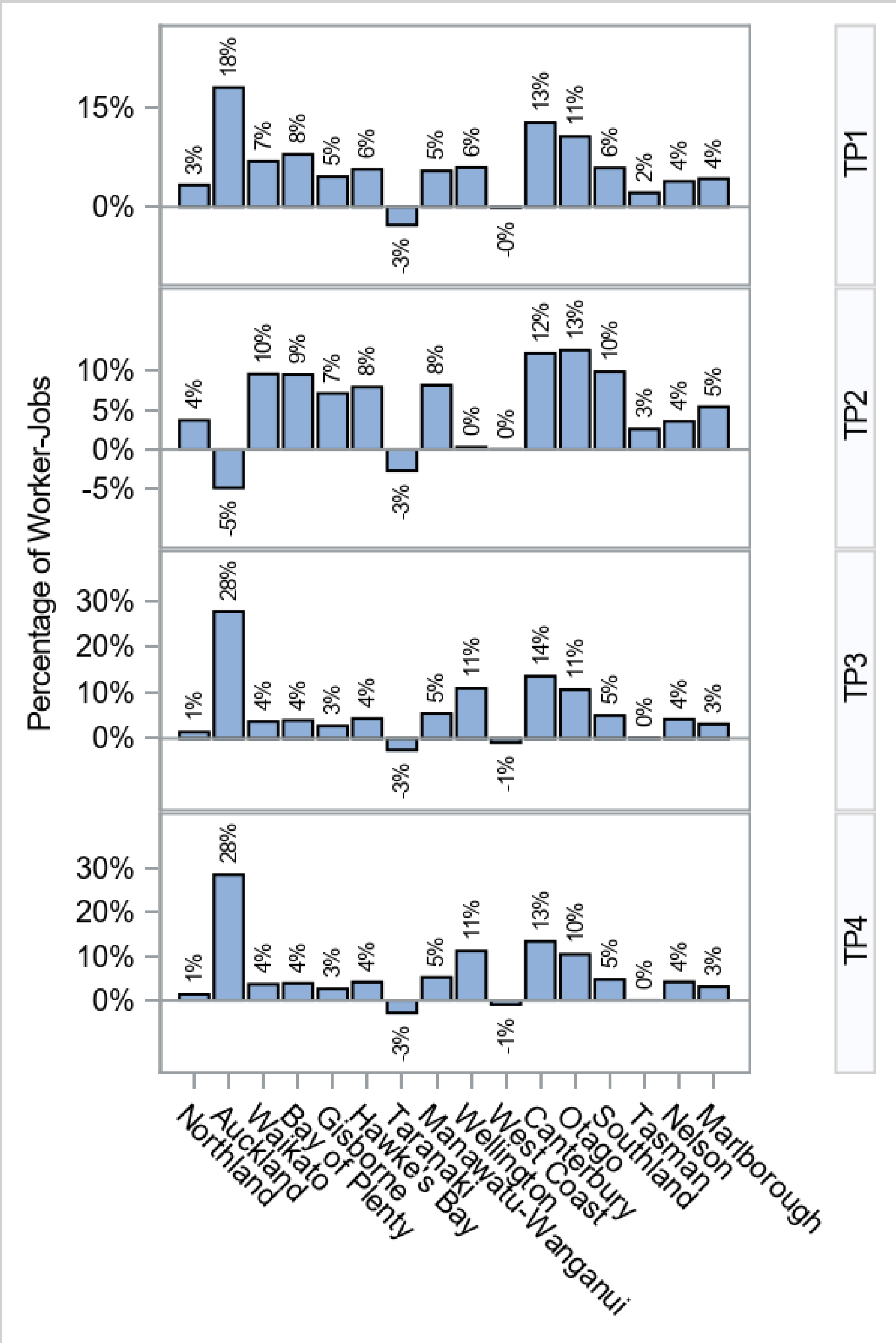
Figure 1. Cumulative Net Policy Effects 1-digit Industry for Different Policy Mix Options, 2022-2050



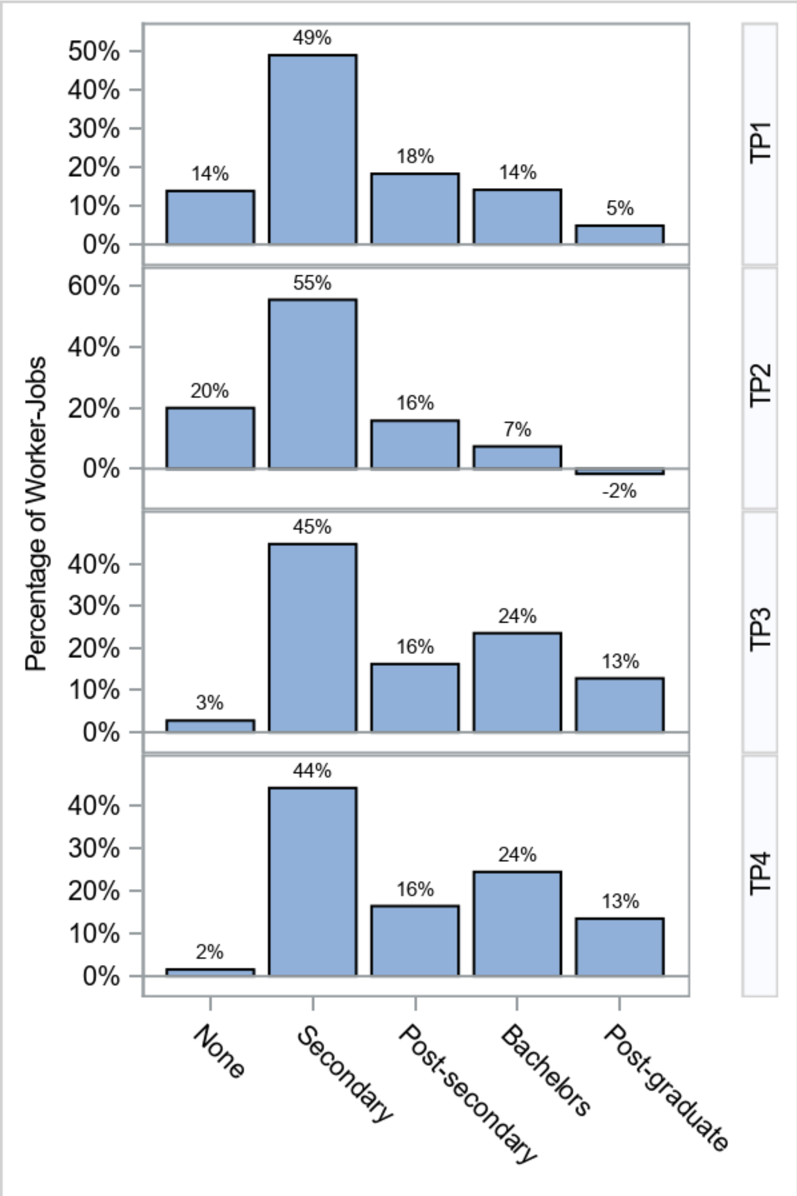
Notes: This figure is based on the research that was described in Riggs and Mitchell (2021). Each panel in the figure shows the simulation results from four different policy mix options (TP1-TP4). These results are based on employment results from the C-PLAN model as described in Winchester and White (2021). Under all four policy mix options, three industries are negatively affected by the policies: Mining; Manufacturing; and Electricity, Gas, Water, and Waste Services.

Figure 2. Cumulative Net Policy Effects by Region for Different Policy Mix Options, 2022-2050



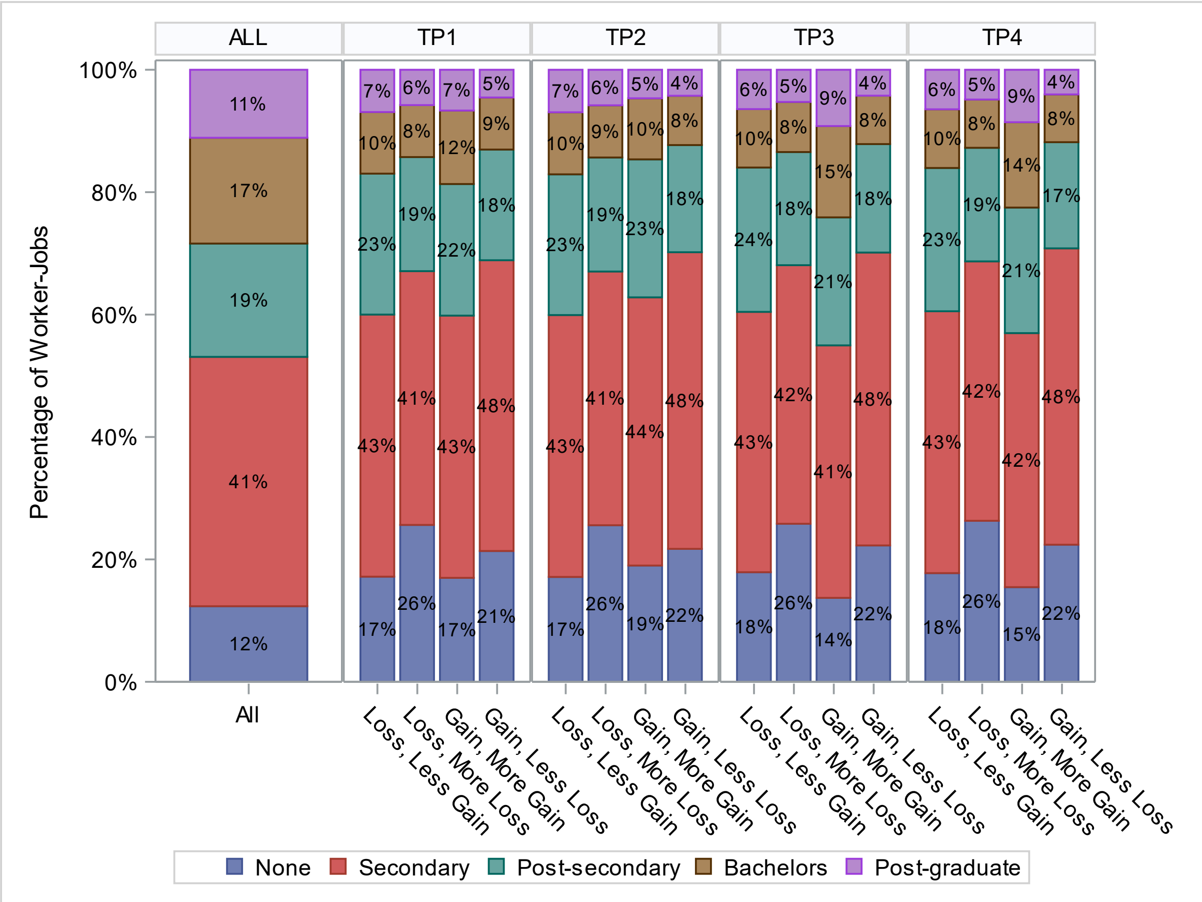
Notes: This figure is based on the research that was described in Riggs and Mitchell (2021). Each panel in the figure shows the simulation results from four different policy mix options (TP1-TP4). These results are based on employment results from the C-PLAN model as described in Winchester and White (2021). Under all four policy-mix options, the policy has net negative effects for worker-jobs in Taranaki and the West Coast Regions. Moreover, while Auckland is receiving a large share of the positive effects in three of the four scenarios, 35% of all worker-jobs were located there.

Figure 3. Cumulative Net Policy Effects by Highest Educational Qualification for Different Policy Mix Options, 2022-2050



Notes: This figure is based on the research that was described in Riggs and Mitchell (2021). Each panel in the figure shows the simulation results from four different policy mix options (TP1-TP4). These results are based on employment results from the C-PLAN model as described in Winchester and White (2021).

Figure 4. Breakdown of Cumulative Net Policy Effects by Highest Educational Qualification for Different Policy Mix Options, 2022-2050



Notes: This figure is based on the research that was described in Riggs and Mitchell (2021). Each panel in the figure shows the simulation results from four different policy mix options (TP1-TP4). These results are based on employment results from the C-PLAN model as described in Winchester and White (2021). The "Loss, More Loss" (LML) category indicates negative job effects from the policy mix option that was due to more job losses in contracting industries with the policy than without it. Similarly, the "Gain, More Gain" category indicates positive job effects from the policy mix option that was due to more job gains in growing industries with the policy than without it. Workers with no educational qualifications were disproportionately represented in the LML category (26%) relative to their share of all worker jobs (12%) under all four policy mix options.