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GREEN SKILLS AND CLIMATE POLICY:

Evidence From British Columbia's Carbon Tax

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Green Skills and Climate Policy: Evidence from British Columbia's Carbon Tax

Hossein Jebeli* and Geoffrey R. McCarney†

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Abstract

The impact of environmental policies on labour markets is a highly contested topic. This paper uses individual-level occupation data and greenness measures of the tasks and skills assigned to each occupation to estimate the demand for occupations with higher green skill requirements following the introduction of a carbon tax in British Columbia (BC), Canada, in 2008. The results show that BC's carbon tax did not deferentially impact either the hours worked or labour force participation rates for jobs with higher green skill requirements. However, we find that the policy did significantly reduce the unemployment rate in jobs with higher green skill requirements by 2 percentage points, and that when layoffs occur in jobs requiring green skills, the probability that those layoffs are classified as temporary instead of permanent increases for green skill versus non-green skill jobs. Counter-intuitively, we also find that this impact is more pronounced in emission-intensive (or 'brown') industries, suggesting significant changes in the demand for green skills in these sectors. We also investigate the heterogeneous effects of the BC carbon tax across types of workers in the labour market, finding that the impacts of the policy on unemployment rates were more pronounced for male green-skilled workers who are low and medium-educated.

JEL Classification: E24, H23, J2, Q52

Keywords: Environmental policies, Labor market consequences, Distributional effects

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1 Introduction

Carbon taxes have emerged as a key policy instrument that countries are adopting to meet their emissions targets (Ghazouani et al. 2020 , Zhao et al. 2019). While the environmental benefits of carbon taxes on reducing greenhouse gas emissions have been well documented (Best et al. 2020, Andersson 2019), there is a growing research interest in assessing their labour market and skills impacts (Borissov et al. 2019, Marin & Vona 2019).

Carbon taxes may impact human capital accumulation (Spinesi 2022), and influence the relative demand of "green skills" in industries (Vona et al. 2018). Supporting the development of green skills is integral for countries to meet their climate targets (Atiq et al. 2022). A lack of investment in green skills could have real consequences such as project delays, cost overruns, or reduced appetite for private investment, thereby hindering countries' Net-Zero ambitions (Augustine et al. 2023). It accordingly remains important to understand linkages between climate policies and green skills. The overarching goal of this paper is to measure the effects of British Columbia (BC), Canada's carbon tax on demand for green skills, which was the first carbon tax policy to be introduced in North America.

The overall employment effects of climate policies have been frequently investigated in previous studies. Some studies find negative effects on overall employment and an employment shift from manufacturing to other sectors (Greenstone 2002, Walker 2011, Curtis 2014, Kahn & Mansur 2013). On the other hand, Bovenberg & Goulder (2001) argue that environmental tax reform, such as recycling the revenue from an environmental tax to reduce the rates of other distortionary taxes, can increase employment. For instance, Brown et al. (2020) estimate that carbon taxes could result in 511,000 additional jobs by 2030 in the US, while Berman & Bui (2001) provide empirical evidence that local air pollution regulation on the manufacturing sector in Los Angeles (LA) resulted in small increase (2600 to 5400) in employment over the 1979–1991 period. Overall the impact of climate policies on employment remains contested, with studies showing heterogeneous impacts when investigating the overall labor-market effects of climate policies. Given these different findings, current thinking suggests that that actual impacts of climate policies on labour markets may be more nuanced (Keese & Marcolin 2023).

British Columbia's carbon tax was announced on February 19, 2008 and implemented on July 1, 2008. The tax was applied to the consumption of fossil fuels in BC (households and industries). The carbon tax rate was initially \$10 per tonne of carbon dioxide equivalent (CDE) emissions in 2008, increased by \$5 per tonne annually until reaching \$30 per tonne of CDE on July 1, 2012, and stayed at \$30 from that time until April 2019 when it began increasing annually in line with Canada's federal carbon pricing regulation (the Pan-Canadian Framework on Clean Growth and Climate Chanage). As of April 2024, the BC carbon tax stands at \$80 per tonne of CDE. With a revenue-neutral nature, all carbon tax revenues in BC are returned to residents and firms by the reductions in corporate taxes, personal income taxes, and lump-sum transfers. To date, several studies have looked at the effectiveness of the carbon tax in reducing emissions. Rivers & Schaufele (2015) find that the tax reduced carbon dioxide emissions from gasoline consumption by 2.4 million tonnes during the 2008-2012 period, and Ahmadi et al. (2022) find that the BC carbon tax lowered emissions from the manufacturing sector in the province by 4 percent. However, while Pretis 2022 similarly find that the tax has reduced transport emissions, they also conclude it has not significantly impacted aggregate carbon emissions in the province.

Labour market impacts of the BC carbon tax have also previously been studied, with conflicting results. In an initial study, Murray & Rivers (2015), find that the BC carbon tax did not impact employment outcomes in the province in the years following its implementation. Two subsequent studies find differing results. Using industry-level employment data, Yamazaki (2017) finds that the BC carbon tax generated, on average, a small but statistically significant 0.74 percent annual increase in employment over the 2007-2013 period. Alternatively, Yip (2018) use individual-level data from the Canadian Labor Force Survey and find that the BC carbon tax raised the overall unemployment rate by 1.3 percentage points with more negative effects on employment outcomes for less-educated workers.

While the overall labour market impacts therefore remain inconclusive, the literature so far has looked specifically at overall labour market outcomes. There is little empirical research to date that attempts to specifically quantify the effects of climate policies on demand for occupations with higher "green" skill requirements, as opposed to impacts on the labour market in general. Given that one might expect a disparate impact of climate policies on occupations that may or may not be aligned with a low carbon economy, this study evaluates these effects by focusing specifically on green/brown skills in the context of British Columbia's carbon tax. To do so, we build off of a recent methodology developed in the US for classifying green versus non-green skill requirements by occupation, and merge this with Canadian specific individual-level labour market data to build a unique dataset to identify how the BC carbon tax has changed employment outcomes in occupations with specific green skill requirements.

2 Data

2.1 Identifying green skills

Following the methodology introduced by Vona et al. (2018), we use the O*NET dataset to construct a Green Skills Importance Index for Canadian occupations. The O*NET is a comprehensive database developed by the United States Department of Labor, Employment and Training Administration. It consists of a comprehensive list of occupations across all sectors and industries and their definitions. For each occupation, it also includes detailed information on its associated attributes, including the skills, abilities, and knowledge and training required to undertake that role. Based on these attributes, for a subset of occupations (138 occupations out of 1087 in the dataset) tasks have been categorized into three groups related to their overall 'greenness': non-green task, existing green task, new green task. Table 1 shows two occupations from the dataset with different numbers of green tasks as an example.

Table 1: Types of green tasks

Occupation	Type of green task	Total	Example
Civil Engineers	Non-Green Task	9	Compute load and grade requirements, water flow rates
	Existing Green Task	2	Conduct studies of traffic patterns or environmental conditions
	New Green Task	6	Design energy efficient or environmentally sound civil structures
Agricultural Technicians	Non-Green Task	23	Collect animals or crop samples
	Existing Green Task	0	Analyze geospatial data to determine agricultural implications of soil quality
	New Green Task	3	Assess comparative soil erosion from various planting

Using the number of green tasks for each occupation, similar to Vona et al. (2018), we define greenness of an occupation k as the ratio between the number of green specific tasks (those categorized as either an 'existing green task' or a 'new green task' in O*NET) and the total number of specific tasks performed in occupation k:

$$Greenness_k = \frac{\#green\ specific\ tasks_k}{\#total\ specific\ tasks_k} \tag{1}$$

After calculating this Greenness index for each occupation, Vona et al. (2018) define Green General Skills (GGS) as a set of workplace skills that are used more intensively in greener occupations. To do this, Vona et al. (2018) use OLS estimation leveraging information in O*NET on both tasks (i.e., what workers are expected to do at the workplace—the demand side) and skills (i.e., the abilities and competencies that workers should possess to perform work tasks—the supply side). Tasks are further divided into "general" tasks, which are common to all occupations, and "specific" tasks that are unique to each occupation. Using the same methodology as Vona et al. (2018), we use the updated version of the O*NET dataset (version 28.0) to find which skills can be categorized as Green General Skills and update the GGS definition.

To then understand how important these Green General Skills are in each occupation, we use the importance measures provided in the O*NET dataset for each occupation (by Standard Occupation Codes, SOC). These measures are scaled to vary between 0 (low importance) and 1 (high importance). In addition to the importance of the different skills in each occupation, the O*NET dataset specifies the level of each skill as well. The level measures are scaled to vary between 0 and 7. The importance and level of skills are different. A skill may be equally important for a variety of occupations but the level of that skill needed may differ between occupations. For example, "speaking" is equally important for a lawyer and paralegal. However, the lawyer (who frequently argues cases in court) requires a higher "speaking" skill level than a paralegal. While we focus on the importance measures for GGS in this study, we also tested our approach and analysis using the O*NET measures of skill levels and found similar results.

Finally, to match the information on the importance of skills from the SOC classification to the Canadian National Occupational Classification (NOC), we leveraged the concordance developed jointly by the Labour Market Information Council (LMIC), Employment and Social Development Canada (ESDC), and Statistics Canada (Labour Market Information Council (LMIC) 2020). Using this crosswalk, the standardized scores for "importance" are extracted for each Canadian NOC occupation. Then, the information on the importance of green skills in each Canadian occupation was merged to the Canadian Labor Force Survey (LFS).

2.2 Labour Force Survey (LFS)

We use individual-level data from the Canadian Labour Force Survey (LFS). The Canadian LFS is a monthly household survey which includes approximately 100,000 individuals. Similar to the United States Current Population Survey, the Canadian LFS provides a number of different statistics across the Canadian labour market. To assign a GGS importance index to every respondent in the LFS, the standardized scores for "importance" of green skills for each NOC occupation (explained in section 2.1) were merged to the LFS according to the respondent's occupation.

To give a flavour of the resulting dataset, Table 2 provides summary statistics of the resulting GGS importance index and other key labour market variables (weekly working hours, unemployment rates, and labour force participation rates) for both BC and the rest of Canada. These variables are further delineated by separating them into pre- and post-policy periods, around the introduction of the BC carbon tax in 2008. The first panel in the table shows statistics for GGS importance variable itself. As shown in table, a simple difference-in-difference analysis finds that the effect of the policy on the average GGS importance score is zero (and insignificant). In this study we are interested in the interaction of the GGS variable with the other three labour market variables included in the table.

Table 2: Summary statistics

	BC	Rest of Canada	Difference-in-Difference
A. Green General Skills (GGS) Importance Index			
July 2005–June 2008	0.2017	0.2072	
July 2008–June 2015	0.1968	0.2023	
Difference	0.0048	0.0048	0.0000
B. Weekly Working Hours			
July 2005–June 2008	35.98	36.08	
July 2008–June 2015	35.41	36.35	
Difference	-0.57	-0.45	-0.12
C. Unemployment Rates (in %)			
July 2005–June 2008	4.89	6.81	
July 2008–June 2015	7.07	7.81	
Difference	2.18	1.00	1.18
D. Labour Force Participation (LFP) Rates (in %)			
July 2005–June 2008	65.04	65.74	
July 2008–June 2015	63.98	64.93	
Difference	-1.06	-0.81	-0.25

Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. Samples are restricted to the employed in Panel A, labor force participants in Panel B, and all respondents in Panel C. The rest of Canada, excluding MB, is the control group. Data come from the Canadian LFS for July 2005-June 2015.

2.3 Green General Skill Categories

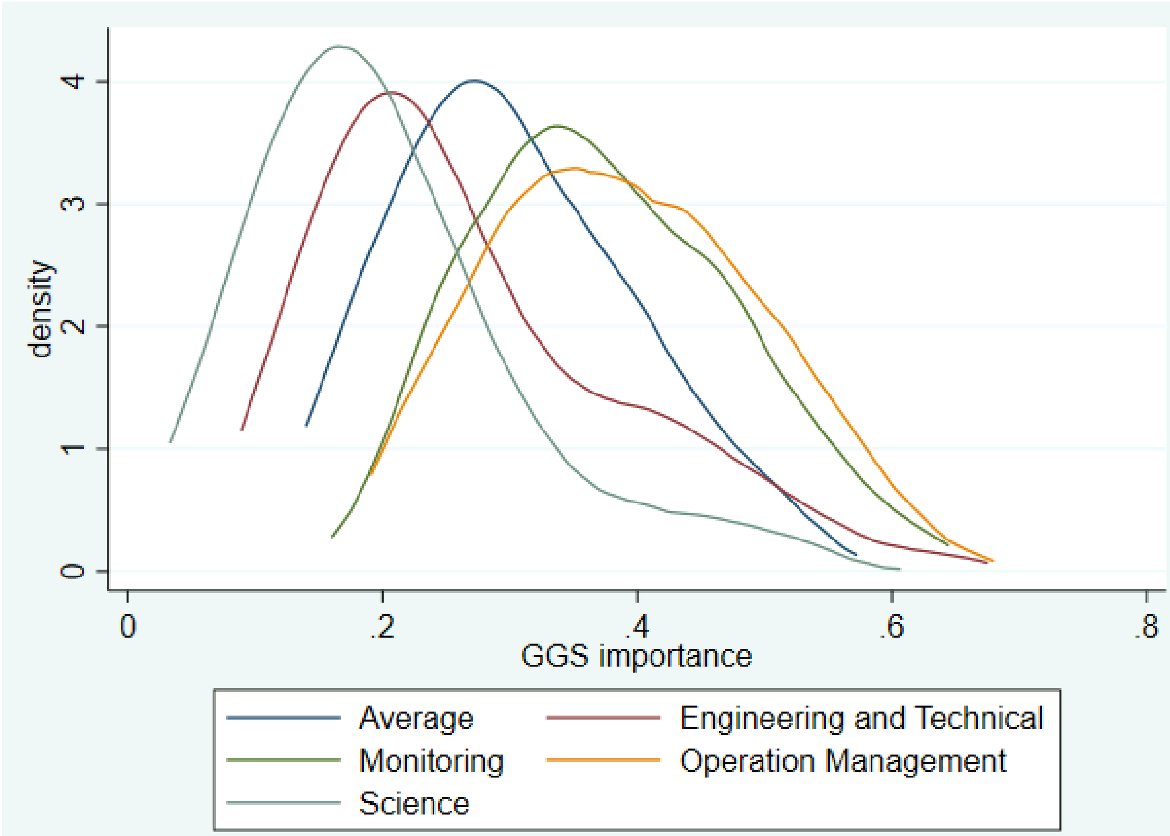
To simply interpretation of the findings across occupations, we finally again follow Vona et al. (2018) in categorizing our Green General Skills (GGS) importance index into four groups, classified by their Green General Skill requirements: Engineering and technical, Monitoring, Operation management, and Science. Table 3 breaks down the resulting GGS categories by their component skills.

Table 3: Green General Skills Categories

Green General Skills Categories	Green General Skills
Engineering and technical:	
	Engineering and technology
	Design
	Mechanical
	Drafting, laying out, and specifying technical device, parts, and equipment
	Estimating the quantifiable characteristics of products, events, or information
	Programming
	Technology Design
	Computers and Electronics
Operation management:	
	Systems analysis
	Systems evaluation
	Operation and Control
Monitoring:	
	Equipment Maintenance
	Installation
	Quality Control Analysis
	Repairing
	Repairing and Maintaining Electronic Equipment
	Repairing and Maintaining Mechanical Equipment
	Inspecting Equipment, Structures, or Material
	Monitor Processes, Materials, or Surroundings
	Monitoring and Controlling Resources
	Production and Processing
	Analyzing Data or Information
	Troubleshooting
	Operation Monitoring
Science:	
	Physics
	Chemistry
	Science
	Mathematics

Finally, Figure 1 shows the distribution of the GGS importance index values that are obtained for all categories presented in Table 3, with the addition of an overall average value for the resulting Canadian dataset. Overall these densities show a somewhat symmetric distribution of GGS by occupational category, with the exception of a relatively persistent fatter tail on the higher GGS index side, suggesting some degree of specialization in high GGS importance occupations in the Canadian labour market,

Figure 1: Distribution of GGS index in the sample



3 Methodology

We use triple-difference to capture the causal effect of the carbon tax policy on changes in employment outcomes for occupations according to their green skill importance score. Since the policy was implemented in BC, we define the treatment group as survey respondents in BC. Their counterparts in other provinces (except Manitoba - see justification below) serve as a control group. Using the DID approach, the causal effect of the policy is estimated by a regression model as follows:

$$\begin{aligned} y_{ijt} =& \beta_1(Post_t \times BC_j \times GGS_i) + \beta_2(BC_j \times Post_t) \\ &+ \beta_3(GGS_i \times Post_t) + \beta_4(BC_j \times GGS_i) \\ &+ \beta_5(GGS_i) + \beta_6(BC_j) + \beta_7(Post_t) + X^T_{ijt}\gamma + \eta_j + \delta_t + \epsilon_{ijt} \end{aligned} \tag{2}$$

where y_{ijt} is the labour market variable (i.e., hours worked, unemployment, and labour force participation) for respondent i, in province j, and month t. X^T_{ijpt} is a vector of individual characteristics, including dummies for gender, age group, the highest qualification attained, and marital status. These regressors control for variations in sample composition. BC_j equals one if a respondent lives in BC, and zero otherwise. $Post_t$ equals one in July 2008 (i.e., the time of policy implementation) or later, and zero otherwise. Therefore, the term $BC_j \times Post_t$ equals one if a respondent lives in BC after the policy, and zero otherwise. η_j, δ_t capture province and time fixed effects.

Finally, GGS_i captures the relative Green General Skills (GGS) importance level for each respondent i, and equals one if the GGS importance index of the respondent's occupation is higher than the average value for its category in table 3, and zero otherwise. While the choice of the average GGS index value for the cut off is arbitrary, we find it a reasonable choice to give an indication of the labour market outcomes of relatively higher versus lower GGS occupations, and note that the average GGS importance index score for each category rests above the median, given the shape of the distributions in Figure 1. The key estimate of interest in this setup is therefore β_1, which shows the difference in labour market outcome y_{ijt} for above versus below average GGS respondents by occupation category, between BC and control provinces, and after the policy relative to the before policy. In other words, β_1 captures the effect of the BC carbon tax on the labour markets outcomes for occupations requiring higher green skills by comparing labour market outcomes in BC to those in other provinces without the carbon tax.

In the analysis presented below we also make several core assumptions. First, we limit our period of analysis to the 2005-2015 timeframe, capturing the period immediately preceding and immediately following implementation of the carbon tax in BC. We do this for several reasons. It allows us to directly compare our findings to Yip (2018) who study general labour market impacts of policy over the same time period, using the same Canadian LFS data. Restricting the pre-policy analysis phase to the 2005-2008 period is also important for maintaining the common trend assumption requirement. As shown by Yip (2018), while labour market trends between BC and the rest of Canada are parallel from 2005 until the carbon tax is introduced in 2008, they diverge prior to 2005 so that the common trend assumption in DID analysis would not hold.[1] We further limit our post-policy analysis to the 2008-2015 period because the Canadian Federal Government published the Pan-Canadian Framework for Clean Growth and Climate Change in 2016, which included a national carbon pricing strategy. As a result of the publication and later adoption of the Pan-Canadian Framework, our exclusion restriction would no longer hold as other provinces were required to either implement their own carbon pricing strategy, or otherwise adopt a Federal backstop carbon pricing plan, with common annual increases in pricing stringency starting in April 2019.

Finally, in assembling our control group of other Canadian provinces, we exclude the province of Manitoba. We do this to follow Yip (2018) who demonstrate that Manitoba experiences a sharp, exogenous increase in employment during the post-2008 period. We do, however, include the provinces of Alberta and Quebec in our control group despite the adoption of variations of carbon pricing systems in both provinces starting in 2007. Alberta adopted a a carbon pricing system applicable only to heavy industry in that year, while Quebec implemented a carbon levy that later became a cap-and-trade system in 2013. Both of these polices would be expected to reduce any estimated effects of the BC carbon tax identified in this study.

4 Results

Table 4 presents the effects of the policy from the estimation of Equation 2. In this table in panel A the dependent variable is weekly working hours, in panel B it is unemployment and in panel C

[1] For further discussion on choosing the appropriate pre-policy period and a comparison with Yamazaki (2017) results see Yip (2018) Appendix A.

it is labour force participation. Each column shows estimates from a different model specification. Columns 2 to 5 each use one of the GGS categories specified in Table 3 as a measure for the GGS variable in Equation 2, while column 1 uses the average of these four categories as an overall measure. The second part of each panel shows the results when $Post_t \times BC_j$ and $Post_t \times BC_j \times GGS_i$ are replaced with $Tax_t \times BC_j$ and $Tax_t \times BC_j \times GGS_i$ where Tax_t equals 0, 0.1, 0.15, 0.2, 0.25, and 0.3 if it is observed during July 2005-June 2008, July 2008-June 2009, July 2009-June 2010, July 2010-June 2011, July 2011-June 2012, and July 2012-June 2015, respectively – capturing the actual rate of the BC carbon tax applied in each period in CAD/tonne divided by 100.

A number of points emerge from the table. The results in Panel A suggest that the effect of the policy on the intensive margin of employment with green skills is weak. The estimates in columns 1 to 5 indicate that BC's number of weekly working hours in occupations with higher GGS, on average, increased by 0.8 percent subsequent to the policy. However all of these estimates are statistically insignificant at the 10 percent level except for the operation management and science categories. The results in the second part of panel A indicate that each Canadian dollar of the BC carbon tax is associated with a 0.024 percent increase in the number of weekly working hours for the average GGS. However, these estimates are statistically insignificant as well.[2]

As shown in panel B of Table 4, the policy decreases the unemployment rate for jobs with higher green skills on average by 2.3 percentage points relative to the jobs with lower green skills. This effect is robust across occupational categories, with estimates of 1, 3.3, 1.5 and 0.8 percentage points for engineering and technical, monitoring, operation management, and science occupational categories, respectively. In addition, each Canadian dollar increase in the BC carbon tax reduces the unemployment rate by 0.11 percentage points for average GGS and these estimates are statistically significant at the one percent level for all categories except operation management, which is significant at the five percent level. Although the previous literature is mixed on the overall employment impact of the BC Carbon tax, the closest study to ours (Yip (2018)) found that the BC carbon tax increased the overall unemployment rate by 1.2–1.3 percentage points, and each Canadian dollar increase in the carbon tax raised the unemployment rate by 0.043–0.046 percentage points. Our results here suggest that the employment impact of the policy differed significantly for occupations with more green skills.

Lastly, the results in Panel C in Table 4 suggest that the policy has not impacted the labour force participation rate for jobs with more green skills.

[2]Since the Tax variable is the annual carbon tax divided by 100, the coefficient relevant to tax should be divided by 100 to give us the impact of $1 change in carbon tax.

Table 4: Effects of BC Carbon Tax on Green General Skill Index

Difference-in-Differences Models

	(1)Overall	**(2)Engineering and Technical**	**(3)Monitoring**	**(4)Operation Management**	**(5)Science**
A. Dependent Variable: ln(Weekly Working Hours)					
BC × Post × GGS	0.008 (0.007)	0.002 (0.006)	0.002 (0.006)	0.013* (0.007)	0.012* (0.007)
BC × Tax × GGS	0.024 (0.027)	0.027 (0.027)	0.025 (0.025)	0.030 (0.030)	0.029 (0.029)
B. Dependent Variable: Unemployment					
BC × Post × GGS	−0.023*** (0.007)	−0.010** (0.004)	−0.033*** (0.010)	−0.015* (0.009)	−0.008** (0.004)
BC × Tax × GGS	−0.112*** (0.028)	−0.057*** (0.018)	−0.145*** (0.039)	−0.086** (0.037)	−0.053*** (0.015)
C. Dependent Variable: LFP					
BC × Post × GGS	0.000 (0.004)	−0.001 (0.004)	0.002 (0.004)	0.005 (0.004)	0.001 (0.004)
BC × Tax × GGS	−0.015 (0.018)	−0.017 (0.019)	−0.008 (0.017)	0.005 (0.018)	−0.006 (0.019)

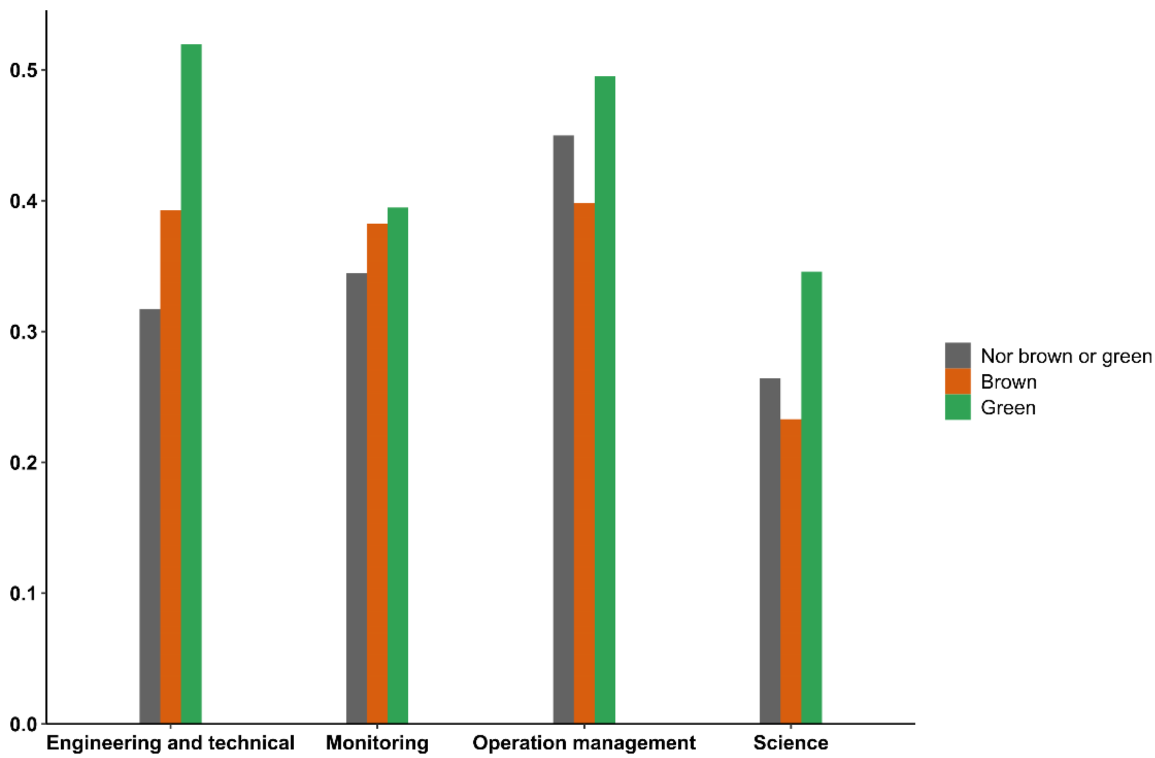
Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. All specifications include province and year × month fixed effects. Specifications also include dummies for gender, age, educational level, and marital status in columns (2) and (4). Samples are restricted to the employed in Panel A, labor force participants in Panel B, and all respondents in Panel C. The rest of Canada, excluding MB, is the control group. Data come from the Canadian LFS for July 2005-June 2015. The post-policy period is defined as July 2008-June 2015. The numbers of observations are 6,913,550, 7,459,073, and 11,446,313 in Panel A, B, and C, respectively. Adjusted R^2s are 0.23, 0.1, 0.65 in Panel A, B, and C, respectively. Adjusted R^2s are identical across columns within each panel. Robust standard errors are clustered at the level of province, gender, educational level, and marital status and t-statistics are reported in parentheses. Significance levels: '***' 0.01 '**' 0.05 '*' 0.1.

4.1 The impacts across brown versus green occupations

To measure the skill distance between occupations that may benefit and those that instead may be harmed by new environmental regulations we need to identify a set of brown occupations that are more common in highly polluting industries. Similar to Vona (2018), we identify pollution-intensive industries as those three-digit North American Industry Classification System (NAICS) industries in the 95th percentile of pollution intensity (measured in terms of emissions per worker) for at least three pollutants (CO2 and emissions that contribute to criteria pollutants: CO, VOC, NOx, SO2, PM10, and PM2.5). This definition yields a set of 27 brown industries (at 3-digit NAICS) listed in Table 9 in the Appendix. We use reported emissions by Environment and Climate Change Canada (Statistics Canada 2024*a*) for GHG intensity by industry and from the National pollution report inventory (Treasury Board of Canada Secretariat 2024) for other pollutants.

Next, using LFS data and the list of brown industries we identify brown occupations that are most prevalent in these industries by selecting those jobs with a probability of working in polluting industries seven times higher than in any other job. We end up with 58 9-digit NOC occupations as brown jobs (see Table 10 in the Appendix). We also define green occupations as those with a Greenness index (see Equation 1) greater than 0.1.[3] Using this definitions, we classified all occupations in the LFS to three categories: brown, green and neither brown nor green. Figure 2 then shows the average GGS importance index for each of our four GGS categories (listed in Table 3) separated according to this brown versus green classification. As shown in the figure, the average GGS importance index for the brown occupations is not much lower than the average of green occupations, indicating that green general skills play important role in many brown industries as well.

Figure 2: Average green general skills (GGS) across industries



To compare the effects of BC carbon tax on brown and green occupations, we estimate the same model specified in equation 2 for only brown occupations. The results are presented in Tables 5. As shown in Table 5, the effect of the policy on the intensive margin of employment with green skills is generally insignificant in brown occupations, with the exception of occupations in the monitoring category. Our results show a significant reduction in hours worked for monitoring-related brown occupations with higher green skills following introduction of the policy. This result is interesting in that it runs counter to the general direction of our other findings and likely merits further study.

Table 5 also shows that we find the policy decreased the unemployment rate for brown occupations with higher green skills on average by 3.6 percentage points. This estimate is 1.9, 7.6, 1.8 and 1.3 percentage points for engineering and technical, monitoring, operation management, and science skills, respectively. In addition, each Canadian dollar increase in the carbon tax reduces the unemployment

[3] We have followed Vona et al. (2018) in selected the thresholds for defining both brown and green occupations.

rate by 0.1 percentage points for brown occupations with higher green skills and these estimates are statistically significant at one percent level for all occupational categories except science. Overall, the unemployment effects of the policy on jobs with more green skills in brown industries is higher than the average effects shown for all industries in Table 4. This supports the observation from Figure 2 that green skills play important role in many brown industries.

Table 5: Effects of BC carbon tax on green general skill index for brown occupations

Difference-in-Differences Models

	(1)Overall	**(2)Engineering and Technical**	**(3)Monitoring**	**(4)Operation Management**	**(5)Science**
A. Dependent Variable: ln(Weekly Working Hours)					
BC × Post × GGS	−0.005	0.007	−0.045***	0.014	0.005
	(0.014)	(0.014)	(0.017)	(0.014)	(0.013)
BC × Tax × GGS	−0.010	−0.030	−0.135*	0.012	0.026
	(0.058)	(0.050)	(0.072)	(0.047)	(0.047)
B. Dependent Variable: Unemployment					
BC × Post × GGS	−0.036***	−0.019***	−0.076***	−0.018***	−0.013**
	(0.011)	(0.007)	(0.019)	(0.007)	(0.006)
BC × Tax × GGS	−0.108***	−0.057**	−0.295***	−0.061***	−0.006
	(0.036)	(0.025)	(0.069)	(0.024)	(0.024)
C. Dependent Variable: LFP					
BC × Post × GGS	0.004	−0.004	0.001	−0.003	0.000
	(0.011)	(0.008)	(0.013)	(0.008)	(0.009)
BC × Tax × GGS	0.015	−0.007	0.051	−0.005	−0.022
	(0.041)	(0.035)	(0.047)	(0.037)	(0.032)

Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. All specifications include province and year × month fixed effects. Specifications also include dummies for gender, age, educational level, and marital status in columns (2) and (4). Samples are restricted to the employed in Panel A, labor force participants in Panel B, and all respondents in Panel C. The rest of Canada, excluding MB, is the control group. Data come from the Canadian LFS for July 2005-June 2015. The post-policy period is defined as July 2008-June 2015. The numbers of observations are 548,388, 588,225, and 638,267 in Panel A, B, and C, respectively. Adjusted R^2s are 0.16, 0.06, 0.13 in Panel A, B, and C, respectively. Adjusted R^2s are identical across columns within each panel. Robust standard errors are clustered at the level of province, gender, educational level, and marital status and t-statistics are reported in parentheses. Significance levels: '***' 0.01 '**' 0.05 '*' 0.1.

4.2 The distributional impacts across gender and educational categories

This subsection investigates the heterogeneous policy effects on employment of higher green-skilled jobs across gender and educational categories. Table 6 presents the effects of the policy from the estimation of equation 2 for different educational levels and by gender. For this estimation only the average effect across all GGS categories is used as the independent variable in equation 2. Similar to Table 4, in panel A the dependent variable is weekly working hours, in panel B it is unemployment and in panel C it is labour force participation. Male (Female) samples are examined in columns of odd (even) numbers. Samples of high-, medium-, and low-educated workers are examined. All specifications include province and year × month fixed effects and dummies for age and marital status.

First, the results in panel A of Table 6 suggest that the policy does not change the number of working hours of jobs with more green skills regardless of gender or educational level. The estimates of $Post_t \times BC_j \times GGS_i$ and $Tax_t \times BC_j \times GGS_i$ are all materially and statistically insignificant in panel A. Also, the estimates in panel C indicate that the effects on the LFP rate are economically and statistically insignificant as well at any conventional level across educational and gender groups.

However, the results in panel B of Table 6 suggest that unemployment rates in green-skilled jobs decrease except for higher-educated male and lower-educated female workers, for whom results are insignificant. Among significant effects, the unemployment rates decrease between 1.7 to 6 percentage points. We note particularly that at the high end of this range, the impact on low-educated males with higher green skills is substantial: we find the carbon tax decreases their unemployment rate by 6 percentage points relative to non-green skilled workers. The results also indicate that each Canadian dollar increase in the carbon tax is associated with a 0.08 to 0.27 percentage point decrease in the unemployment rates across education and gender categories, again excluding low-income females.

In summary, this subsection suggests that the impacts of the BC carbon tax are not uniform across the labour market. Table 6 shows that the policy decreased unemployment across most education levels for green skill workers, but that the effect is stronger for medium- and low-educated males relative the other categories. We note this result is consistent with the findings in Section 4.1. As shown in Section 4.1, the effect of the carbon tax in reducing unemployment in brown occupations with green skills is particularly strong. Energy and manufacturing sectors tend to disproportionately employ male workers and, as shown by Yip (2018), medium- and lower-educated workers tend to engage in manufacturing industries that are more energy-intensive than those in which the higher-educated engage.

More generally, our results here again add important context to the broader literature on the overall employment impacts of the carbon tax. Yip (2018) found that the policy disproportionately increased overall unemployment among medium- and lower-educated males (whose experienced overall unemployment increases of 1.4 and 2.4 percentage points, respectively). Our findings more than counteract these impacts for medium and low-education occupations with higher green skills, again suggesting that the employment impact of the carbon tax differed significantly for occupations with more green skills.

Table 6: The heterogeneous effects on the number of working hours, the unemployment rate, and the LFP rate.

Difference-in-Differences Models	High-educated		Medium-educated		Low-educated	
	M	**F**	**M**	**F**	**M**	**F**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
A. Dependent Variable: ln(Weekly Working Hours)						
BC × Post × GGS	−0.014	0.084	0.084	0.073	0.100	−0.017
	(0.047)	(0.051)	(0.060)	(0.074)	(0.087)	(0.124)
BC × Tax × GGS	0.048	0.184	0.191	0.275	0.451	0.089
	(0.209)	(0.199)	(0.200)	(0.304)	(0.348)	(0.474)
B. Dependent Variable: Unemployment						
BC × Post × GGS	−0.025	−0.023**	−0.045**	−0.017**	−0.060***	−0.005
	(0.022)	(0.011)	(0.020)	(0.007)	(0.016)	(0.010)
BC × Tax × GGS	−0.214**	−0.079*	−0.194***	−0.089***	−0.269***	−0.027
	(0.091)	(0.045)	(0.071)	(0.028)	(0.060)	(0.040)
C. Dependent Variable: LFP						
BC × Post × GGS	−0.006	0.000	0.012	−0.022	0.013	0.043
	(0.038)	(0.036)	(0.020)	(0.032)	(0.032)	(0.044)
BC × Tax × GGS	−0.023	0.083	0.020	−0.099	0.074	0.253
	(0.139)	(0.134)	(0.058)	(0.116)	(0.088)	(0.156)

Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. All specifications include province and year × month fixed effects and dummies for age and marital status. M and F denote male and female samples. BC is the treatment group. The rest of Canada, excluding MB, is the control group. Data come from the Canadian LFS for July 2005–June 2015. The post-policy period is defined as July 2008–June 2015. The numbers of observations are about 1.9 million, 4.5 million, and 4.9 million for the samples of high-, medium, and low-educated, respectively. Robust standard errors in parentheses are clustered at the level of province, age, and marital status, providing us with 216 clusters. Significance levels: '***' 0.01 '**' 0.05 '*' 0.1.

4.3 The impacts on the natures of layoffs

Digging deeper into the unemployment impacts, in this subsection we explore the effects of the policy on the natures of layoffs for jobs with higher green skills. There are three types of unemployed workers in the data: job losers, job leavers, and others. Others include new entrants and re-entrants. Similar to Yip (2018), we consider job losers and job leavers as involuntary and voluntary unemployment, respectively.

Table 7 reports the impact of the BC carbon tax on the nature of layoffs from the estimation of equation 2. In Panel A of Table 7 the dependent variable is a dummy variable for job losers and the sample includes only unemployed workers. In Panel B, we exclude job losers from the sample and estimate the impact on the proportion of job leavers. Layoffs are either temporary or permanent. Then in Panel C, we construct a dummy variable for temporary layoffs to estimate the effects on this variable, and report the corresponding estimates. All specifications include province and year × month fixed effects and dummies for age and marital status.

The results in Panel A suggest that the incidence of involuntary unemployment (job losers) decreased for green-skilled workers after the policy. However, the estimates are only significant for operation management and science, suggesting that the policy decreased the proportions of job losers by 0.25 and 0.32 percentage points for these two categories. This is consistent with increasing demand for green-skilled workers due to the carbon tax, which would reduce the likelihood of involuntary unemployment for some of these occupations.

Panel B presents the effect on the likelihood of voluntary unemployment (i.e. being a job leaver) for workers with higher green skills. The results suggest that the likelihood of voluntary unemployment of more green-skilled jobs increased after the policy. The estimates are all positive and statistically significant at 10% level except for monitoring, and we note that the effect isn't strong enough to carry through to the overall result across all job categories. Nevertheless, these results suggest that in some GGS categories (especially operation management) workers in occupations requiring higher green skills may have become more confident to leave their position after the introduction of the carbon tax. Overall, the picture that emerges in one where layoffs of workers with more green skills have become less involuntary and more voluntary after the policy relative to the non-green skilled workers.

Panel C digs further into heterogeneity in the nature of layoffs. The estimates suggest that because of the policy, the proportion of temporary relative to permanent layoffs among green-skilled jobs increases by 4.6 percentage points on average. This suggests that for workers in occupations with higher green skills, should they become unemployed following the introduction of the carbon tax, the likelihood that their unemployment would be classified as only temporary, versus permanent, increases versus non-green skilled workers subsequent to the policy. This is again consistent with higher demand for green skills following the policy, and would support the conjecture that workers with higher green skills were relatively more confident in their employment prospects following the introduction of the carbon tax.

Table 7: The heterogeneous effects on unemployed workers

Difference-in-Differences Models

	(1)Overall	(2)Engineering and Technical	(3)Monitoring	(4)Operation Management	(5)Science
A. Job losers					
BC × Post × GGS	-0.003 (0.013)	0.000 (0.012)	-0.007 (0.014)	-0.025^{**} (0.011)	-0.032^{***} (0.012)
B. Job leavers					
BC × Post × GGS	0.018 (0.015)	0.025^{*} (0.014)	0.017 (0.016)	0.034^{**} (0.014)	0.023^{*} (0.014)
C. Temporary Layoffs					
BC × Post × GGS	0.046^{***} (0.016)	0.040^{**} (0.016)	0.031^{**} (0.015)	0.024 (0.015)	0.007 (0.017)

Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. All specifications include province and year × month fixed effects. Specifications also include dummies for gender, age, educational level, and marital status in columns (2) and (4). Samples are restricted to the employed in Panel A, labor force participants in Panel B, and all respondents in Panel C. The rest of Canada, excluding MB, is the control group. Data come from the Canadian LFS for July 2005-June 2015. The post-policy period is defined as July 2008-June 2015. The numbers of observations are 545,523, 339,854, and 205,669 in Panel A, B, and C, respectively. Adjusted R^2s are 0.33, 0.1, 0.04 in Panel A, B, and C, respectively. Adjusted R^2s are identical across columns within each panel. Robust standard errors are clustered at the level of province, gender, educational level, and marital status and t-statistics are reported in parentheses. Significance levels: '***' 0.01 '**' 0.05 '*' 0.1.

4.4 The dynamics of the effects of carbon taxes

To explore the dynamic effects of the BC carbon tax following its introduction, the $Post_t$ term in equation 2 is replaced with a full set of year indicators (d_t) as follows:

$$\begin{aligned} y_{ijt} =& \sum_t \beta_{1t}(d_t \times BC_j \times GGS_i) + \sum_t \beta_{2t}(BC_j \times d_t) \\ &+ \sum_t \beta_{3t}(GGS_i \times d_t) + \beta_4(BC_j \times GGS_i) \\ &+ \beta_5(GGS_i) + \beta_6(BC_j) + \sum_t \beta_{7t}(d_t) + X_{ijt}^T\gamma + \eta_j + \delta_t + \epsilon_{ijt} \end{aligned} \tag{3}$$

where d_t equals one between July in year t and June in year $t+1$ for all years between 2005 and 2014 except 2007-2008, and zero otherwise. July 2007-June 2008 is excluded because it serves as a reference year. Similar to the previous models, y_{ijt} is the labour market variable (i.e., hours worked, unemployment, and labour force participation) for household i, in province j, and month t. X_{ijt}^T is a vector of individual characteristics, including dummies for gender, age group, the highest qualification attained, and marital status. The estimates of interest are β_{1t} which show the difference in a dependent variable between BC and control provinces during July in year t through June in year t + 1, relative to the reference year (e.g. June 2007-July 2008).

Figures 3 - 5 show the coefficient β_{1t} from estimating equation 3 while the dependent variable is one of the labour market variables of interest. Each figure again shows the results for each GGS occupation category in Table 3 (i.e., engineering and technical, operation management, monitoring, and science) and the average of all GGS categories taken together. As shown in Figures 3 and 5 the effect of the policy on the hours of employment and labour force participation rate are statistically insignificant over time. However, as shown in Figure 4, the effect of the policy on the unemployment rate remains statistically significant and relatively persistent over time. These results confirm the main effects of the policy that were found in Section 4 (i.e., the larger and significant impact of the policy on the unemployment rate).

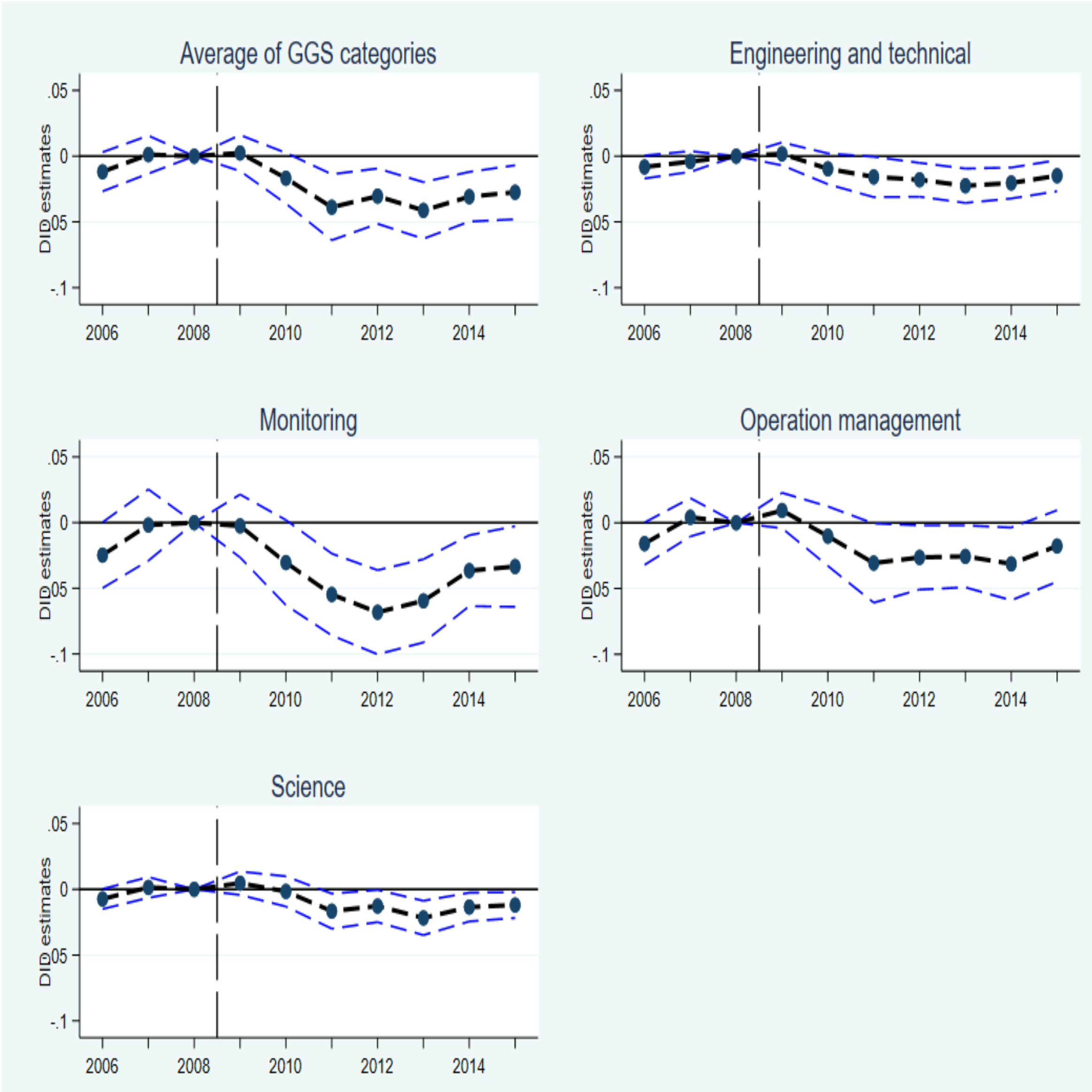
Among the three labour market variables in this study, only the effects on the unemployment rate are found to be statistically significant over time (at least until 2015), with slightly lower impacts in the later years of the study period. This later decline may be related to a change in the Canadian Federal Government in 2015 and the reasonable ability to foresee a national carbon price from this point, indicating that our identification strategy weakens at this juncture. As previously described, this national policy was introduced in 2016. We will investigate it's impacts further in section 5.3 below.

The results shown in Figures 3 - 5 also provide further evidence that the common trend assumption holds. Even though it is generally agreed that the announcement of the BC carbon tax was unexpected, it nevertheless may have been possible for the labour market to respond to the possibility of the policy prior to it's implementation. This would violate our common trend assumption, which requires that the difference in the dependent variables between BC and the rest of Canada prior to the reference year is close to the difference in the reference year. That is, the trends between the treatment and the control group are close prior to the treatment period. Examining the possibility of anticipatory responses in the data, we find in Figures 3 - 5 that all estimated coefficients prior to the reference year are statistically not different from zero.

Figure 3: The effect of carbon tax on hours of employment for average GGS and sub-categories

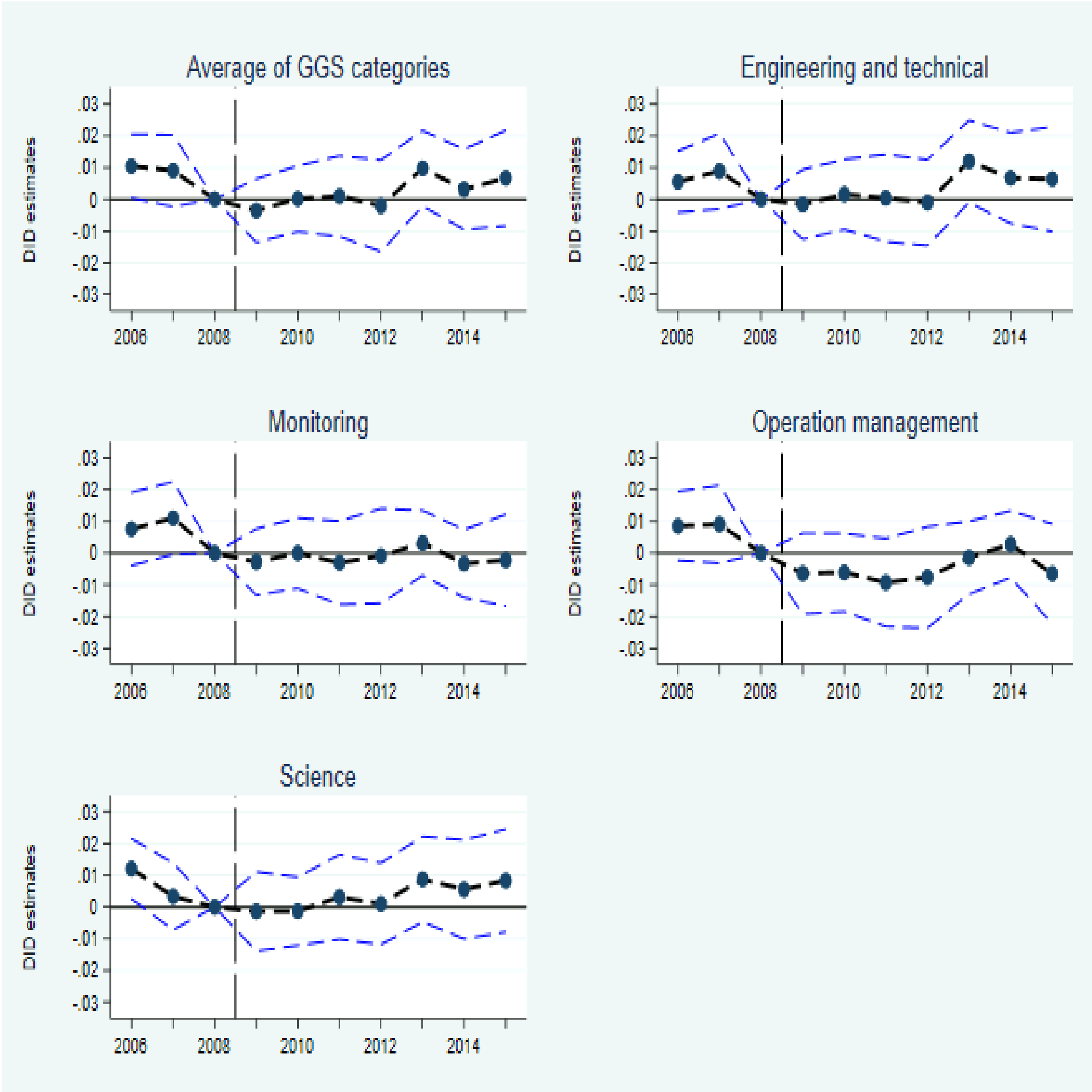
Note: The figures show the dynamic effects on the hours worked. The dependent variable is ln(weekly working hours) and each dot represents the main triple-D estimate from equation 3 in the corresponding year. For example, the first dot represents the main triple-D estimate of the period July 2005-June 2006. The reference period is July 2007-June 2008. Data are from the Canadian LFS for July 2005-June 2015. BC is the treatment province.

Figure 4: The effect of carbon tax on unemployment rate for average GGS and sub-categories



Note: The figures show the dynamic effects on the unemployment rates. The dependent variable is unemployment rate and each dot represents the main triple-D estimate from equation 3 in the corresponding year. For example, the first dot represents the main triple-D estimate of the period July 2005-June 2006. The reference period is July 2007-June 2008. Data are from the Canadian LFS for July 2005-June 2015. BC is the treatment province.

Figure 5: The effect of carbon tax onlabour force participation for average GGS and sub-categories



Note: The figures show the dynamic effects on the labour force participation rate. The dependent variable is labour force participation rate and each dot represents the main triple-D estimate from equation 3 in the corresponding year. For example, the first dot represents the main triple-D estimate of the period July 2005-June 2006. The reference period is July 2007-June 2008. Data are from the Canadian LFS for July 2005-June 2015. BC is the treatment province.

5 Robustness Checks

5.1 Stable Unit Treatment Value Assumption (SUTVA)

One of the threats to identification in this paper is spillover effects. The carbon tax in BC may affect the demand for green skilled workers in other provinces through inter-provincial migration. If so, this migration would violate the stable unit treatment value assumption (SUTVA), which requires that the control group not be affected by the policy.[4] The magnitude of the potential effects of the BC carbon tax on labour demand in other provinces depends on the degree of bilateral inter-provincial migration.

To test this, we performed a robustness check by using only provinces that have very low inter-provincial migration flows to BC.[5] Based on inter-provincial migration data from Statistics Canada (2024*b*), these provinces are Newfoundland and Labrador, New Brunswick, Nunavut, Prince Edward Island, Nova Scotia, Quebec, and the Northwest Territories. The results of this check are presented in Table 8 and they are similar to the main results shown in Table 4. This provide some evidence that the unemployment effects presented under the main specification in the paper are not driven by spillover effects.

Table 8: Different control groups: Provinces with limited migration flow with BC

Difference-in-Differences Models

	(1)Overall	**(2)Engineering and Technical**	**(3)Monitoring**	**(4)Operation Management**	**(5)Science**
A. Dependent Variable: ln(Weekly Working Hours)					
BC × Post × GGS	0.012*	0.006	0.005	0.018	0.021***
	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
B. Dependent Variable: Unemployment					
BC × Post × GGS	−0.056***	−0.024***	−0.076***	−0.034***	−0.020***
	(0.011)	(0.005)	(0.012)	(0.009)	(0.004)
C. Dependent Variable: LFP					
BC × Post × GGS	−0.004	−0.007	−0.004	0.002	−0.001
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)

Note: Unemployed equals one if a respondent is unemployed, and zero otherwise. LFP equals one if a respondent participates in the labor market, and zero otherwise. All specifications include province and year × month fixed effects. Specifications also include the dummies for gender, age, educational level, and marital status in columns (2) and (4). Samples are restricted to the employed in Panel A, labor force participants in Panel B, and all respondents in Panel C. The control group includes Newfoundland and Labrador, New Brunswick, Nunavut, Prince Edward Island, Nova Scotia, Quebec, and Northwest Territories. Data come from the Canadian LFS for July 2005-June 2015. The post-policy period is defined as July 2008-June 2015. The numbers of observations are 3,289,542, 3,589,079, and 5,686,650 in Panel A, B, and C, respectively. Adjusted R^2s are 0.23, 0.1, 0.65 in Panel A, B, and C, respectively. Adjusted R^2s are identical across columns within each panel. Robust standard errors are clustered at the level of province, gender, educational level, and marital status and t-statistics are reported in parentheses. Significance levels: '***' 0.01 '**' 0.05 '*' 0.1.

[4] This assumption also called Individualistic Treatment Response (ITR) as in Manski (2013). For further discussion see Clarke (2017).

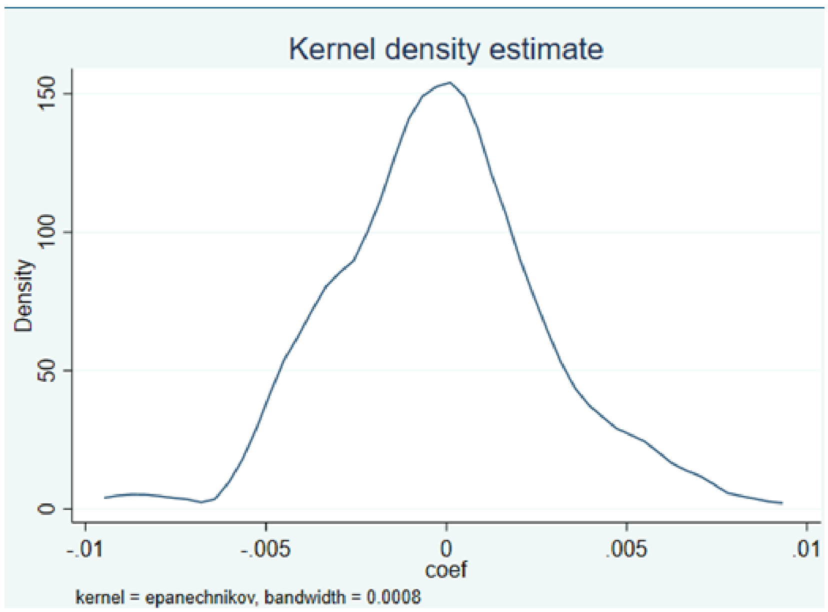
[5] To check the SUTVA assumption in their paper, Ahmadi et al. (2022) re-estimate their model using only the provinces that have the least inter-provincial trade volume with BC.

5.2 Permutation Test

In this subsection we build placebo carbon taxes to examine the robustness of results to a different policy time and treatment province. Based on Equation 2 the treatment variable is the interaction of three variables, i.e., Post $\times$ BC $\times$ GGS. We randomly select a set of different year/month and province treatments to construct a "placebo carbon tax". We estimate the effect of this placebo carbon tax on one of the variables of interest like the unemployment rate of jobs with higher green skills and then repeat this process 1,000 times to generate a distribution of placebo effects. The resulting effect of the carbon tax on the unemployment rate of jobs with higher green skills should be zero, on average, because these placebo carbon taxes are randomly constructed.

Figure 6 plots a kernel density distribution of the GGS unemployment effect of the placebo carbon taxes. The mean of the placebo estimates is centered around zero and the point estimates from the main results in Table 4 fall in the extreme left tail of the distribution. This provides further evidence that the SUTVA is not violated in our main model.

Figure 6: Kernel density distribution of 1000 placebo estimates of the unemployment effects of the carbon tax on high GGS jobs. The x-axis is the placebo unemployment estimates



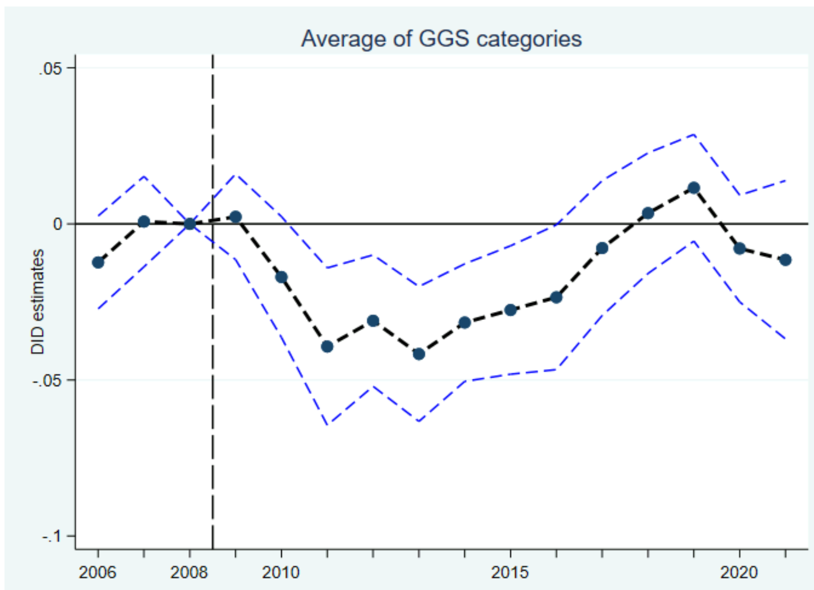
5.3 Extending the sample to 2020

We can extend the sample to include the more recent data from LFS, and do so here using data up to 2020. As discussed in section 3, the Canadian Federal Government introduced the Pan-Canadian Framework on Clean Growth and Climate Change in late 2016. This legislation included a national carbon pricing strategy which required all provinces and territories to implement a carbon price of similar stringency by April 2019, either by designing their own plan, or by adopting a federal backstop carbon price.

For our study, this federal carbon pricing strategy means that after 2016 our identification strategy suffers as our control group of other provinces becomes part of the treatment. We would therefore expect any effect of the BC carbon tax that we identified to fade after 2016, as the labour market in other provinces begin to respond to the introduction of the Pan Canadian Framework. Figure 7 shows the effect of the BC carbon tax on unemployment outcomes for occupations with higher GGS when we extend the treatment period to run from 2008 to 2020. As shown the unemployment effect of the policy was significant until 2016 and after that it is not significantly different than zero, exactly as would be expected given the introduction of the new national carbon pricing strategy.

That the results behave as expected lends some confindence to our identification in this paper. However, it is important to clarify that this result doesn't mean that the findings from previous sections suggesting the BC carbon tax reduces unemployment for green skilled workers fade over time, simply that we can no longer identify them versus a control group of other provinces after 2016.

Figure 7: The effect of carbon tax on unemployment rate for average GGS and sub-categories



6 Conclusion

The objective of this paper is to deepen understanding of the labour market effects of the BC carbon tax by extending beyond previous studies which looked at overall employment outcomes to focus specifically on demand for green skills. To do this, we develop a novel dataset by building off of a recent methodology developed in the US for classifying green versus non-green skill requirements by occupation, and merging this with Canadian-specific individual-level labour market data. The results show that BC's carbon tax did not have a measurable impact on either hours worked or labour force participation rates for workers in occupations with higher green skill requirements. However, the policy is found to have significantly reduced the unemployment rate in occupations requiring higher green skills by 2 percentage points relative to other occupations. We find that this higher demand for green skills was more significant in emission-intensive industries.

We also investigate the heterogeneous effects of the policy in the labour market, finding that the impact of the carbon tax in reducing unemployment was stronger for male workers with green skills who are medium- or lower-educated. In addition, we show that the BC carbon tax also changes the nature of unemployment for workers in occupations requiring higher green skills, with the likelihood increasing after introduction of the policy that layoffs are voluntary (versus involuntary), and that they are classified as temporary (versus permanent).

Overall, our findings suggest that the impact of the BC carbon tax on labour markets differed significantly for occupations with more green skills via changes in unemployment outcomes. These results help add insight to an otherwise contested literature on overall employment outcomes from the policy.

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7 Appendix

Table 9: Brown industries

No	NAICS	NAICS Title
1	111	Crop production
2	112	Animal production and aquaculture
3	113	Forestry and logging
4	211	Oil and Gas Extraction
5	221	Utilities
6	311	Food Manufacturing
7	321	Wood product manufacturing
8	322	Paper Manufacturing
9	324	Petroleum and coal product manufacturing
10	325	Chemical Manufacturing
11	327	Non-Metallic Mineral Product Manufacturing
12	331	Primary metal manufacturing
13	481	Air transportation
14	483	Water transportation
15	484	Truck transportation
16	486	Pipeline transportation
17	212	Mining (except Oil and Gas)
18	411	Farm Product Wholesaler-Distributors
19	488	Transit, ground passenger and scenic and sightseeing transportation
20	314	Textile and textile product mills
21	482	Rail transportation
22	493	Warehousing and storage
23	312	Beverage and Tobacco Product Manufacturing
24	313	Textile and textile product mills
25	316	Clothing and leather and allied product manufacturing
26	323	Printing and Related Support Activities
27	412	Petroleum Product Wholesaler-Distributors

Table 10: Brown occupation codes and titles

No.	Code	Occupation Title	No.	Code	Occupation Title
1	821	Managers in agriculture	30	9213	Supervisors, food and beverage processing
2	822	Managers in horticulture	31	9215	Supervisors, forest products processing
3	823	Managers in aquaculture	32	9231	Central control and process operators, mineral and metal processing
4	1315	Custom brokers	33	9232	Central control and process operators, petroleum, gas and chemical processing
5	2271	Pilots	34	9235	Pulping control operators
6	2272	Air traffic controllers	35	9241	Power systems operators
7	6522	Flight attendants	36	9243	Water treatment plant operators
8	6523	Airline passenger and ticket agents	37	9411	Machine operators, mineral and metal processing
9	7243	Power system electricians	38	9412	Manual mouldmakers
10	7303	Supervisors, printing and related occupations	39	9413	Glass process control operators
11	7304	Supervisors, railway transport operations	40	9414	Concrete products forming and finishing workers
12	7305	Supervisors, motor transport and other ground transit operators	41	9421	Chemical plant machine operators
13	7315	Aircraft mechanics	42	9431	Sawmill machine operators
14	7361	Railway locomotive engineers	43	9432	Pulp mill machine operators
15	7362	Railway conductors	44	9433	Papermaking and finishing machine operators
16	7381	Printing press operators	45	9434	Other wood processing machine operators
17	7451	Longshore workers	46	9435	Paper converting machine operators
18	7511	Long-haul truck drivers	47	9436	Lumber graders
19	7531	Railway yard workers	48	9461	Process control operators, food and beverage processing
20	7534	Air transport ramp attendants	49	9462	Industrial butchers
21	8221	Supervisors, mining and quarrying	50	9463	Fish and seafood plant machine operators
22	8231	Underground production and development miners	51	9465	Testers and graders, food and beverage processing
23	8411	Underground mine service and support workers	52	9471	Plateless printing equipment operators
24	8431	General farm workers	53	9533	Other wood products assemblers
25	8432	Nursery and greenhouse workers	54	9611	Labourers in mineral and metal processing
26	8611	Harvesting labourers	55	9613	Labourers in chemical products processing and utilities
27	8613	Aquaculture support workers	56	9614	Labourers in wood, pulp and paper processing
28	8614	Mine labourers	57	9617	Labourers in food and beverage processing
29	9211	Supervisors, mineral and metal processing	58	9618	Labourers in fish and seafood processing

Table 11: Green occupations

No.	Title	No.	Title
1	Chief Sustainability Officers	20	Climate Change Policy Analysts
2	Green Marketers	21	Industrial Ecologists
3	Geothermal Production Managers	22	Environmental Economists
4	Biofuels Production Managers	23	Environmental Science and Protection Technicians, Including Health
5	Methane/Landfill Gas Collection System Operators	24	Energy Brokers
6	Hydroelectric Production Managers	25	Solar Sales Representatives and Assessors
7	Biofuels/Biodiesel Technology and Product Development Managers	26	Solar Energy Installation Managers
8	Water Resource Specialists	27	Solar Thermal Installers and Technicians
9	Wind Energy Operations Managers	28	Solar Photovoltaic Installers
10	Wind Energy Development Managers	29	Energy Auditors
11	Sustainability Specialists	30	Hazardous Materials Removal Workers
12	Environmental Engineers	31	Wind Turbine Service Technicians
13	Fuel Cell Engineers	32	Hydroelectric Plant Technicians
14	Energy Engineers, Except Wind and Solar	33	Biofuels Processing Technicians
15	Wind Energy Engineers	34	Methane/Landfill Gas Generation System Technicians
16	Solar Energy Systems Engineers	35	Recycling Coordinators
17	Environmental Engineering Technologists and Technicians	36	Recycling and Reclamation Workers
18	Fuel Cell Technicians	37	Refuse and Recyclable Material Collectors
19	Soil and Water Conservationists		