A Study of Canadian Bankruptcies, 2014-2022

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USRI 2022

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Introduction

This paper studies Canadian monthly bankruptcy data from January 2014 to February 2022 with an aim towards identifying the existence of underlying heterogeneity in the decision-making of firms across different industry sectors during periods of economic adversity. The data used include provincial two-digit NAICS bankruptcy level data, provincial pandemic-related data concerning the evolution of cases and stringency of adopted policies, and external factors pertaining to the domestic and foreign economies such as industry GDP, the overnight rate target, exchange rates, imports and exports, prices, and bond liquidity premium. The method is two-fold. First, we identify changes in bankruptcy trends caused by the pandemic both provincially and by industry sector, and then contrast the findings with the results from a zero-inflated Poisson GLM model that assesses the probability of bankruptcies occurring at different points in time given the set of inputs described above. Second, the model is used to predict bankruptcy numbers for three different intervals during the reference period: 2019, 2020-2022, and 2021-2022. It is noted that despite the model's ability to accurately predict bankruptcy values for 2019, its accuracy decreases for the pandemic period, even when pandemic-related variables are controlled for. The conclusion is that the drop in Canadian bankruptcies during the pandemic seen in the data must be accounted for some other factor that upheld firms' continued operations, such as the Canadian Emergency Business Account (CEBA) program, which facilitated access to credit. The presence of underlying heterogeneity is inferred from the fact that if heterogeneity was not present, then controlling for industry sector would suffice to capture the effect of such a program, thus increasing the accuracy of predictions for the pandemic period.

The rest of the paper is divided into six sections. The first details data sources, the second explains data characteristics and transformations applied, the third presents descriptive statistics and plots, the fourth shows the model findings, the fifth depicts the predictions, and the sixth concludes.

I. Data Sources

Data were mostly collected from statistical databases and government websites. For the 2014-2022 period, monthly bankruptcy data were collected from the annual *Monthly Insolvency Statistics in Canada* reports by Industry Canada, which list the monthly number of bankruptcies

and business proposals[1] by province for each industry type under the NAICS classification. Monthly bankruptcy observations used in this paper include both the number of bankruptcies and business proposals for each industry. Daily provincial COVID cases were also collected directly from the Government of Canada website under its COVID-19 epidemiology update.

The Oxford Stringency Index was adopted as a measure of COVID policy stringency. It quantifies the severity of COVID-related policies such as school and workplace closings, international travel controls, and cancellation of public events using a 0-100 scale of increasing stringency.[2] Index data for Canadian provinces is published by Statistics Canada on a monthly basis and includes values for the vaccinated, unvaccinated, and total populations. Only values for the total population were used in this paper.

Other data collected from Statistics Canada include monthly GDP by industry under the NAICS classification and national imports. Industrial GDP values are presented in the form of seasonally adjusted at annual rates chained 2012 dollars. Monthly imports data was generated by multiplying seasonally adjusted Paasche price indexes and Laspeyres volume indexes on a balance of payments basis. For the imports, only the total of all merchandise was considered.

Finally, monetary data was collected from the Bank of Canada and FRED websites. It includes monthly target overnight rates (relative to the last day of each month); monthly exchange rates between the Canadian dollar and the US dollar, the British pound, the Japanese yen, and the Chinese renminbi (indicative rates obtained from averages of aggregated price quotes from financial institutions[3]); the monthly Canadian CPI percentage change over the previous 12 months; and monthly Federal Funds Effective Rate for the United States. It should be noted that the calculation methodology for the monthly exchange rates adopted by the Bank of Canada up to April 2017 differed from the current one.[4]

II. Data Transformations

Bankruptcies

The complete bankruptcy dataset containing all the information from the *Monthly Insolvency Statistics in Canada* reports for the January 2014 to February 2022 period consisted of 3,034,211 observations, 96.18% of which had 0 bankruptcies plus business proposals (hereafter referred to simply as "bankruptcies") associated with them. Under the assumption that results would not differ significantly across industry subsectors of each NAICS sector, all subsector observations were removed from the dataset, leaving it with 32,919 total monthly observations for the main industry sectors under the NAICS classification (sectors 11, 21, 22, 23, 31, 32, 33, 41, 44, 45, 48,

[1] Refers to corporate proposals (filed by a corporate entity, with 100 percent of its liabilities business related) and proposals filed by an individual with 50 percent or more of his/her liabilities business related and less than 50 percent consumer related.
[2] The index calculation method can be found at Index construction - 2020 (statcan.gc.ca).
[3] Monthly Exchange Rates - Bank of Canada
[4] https://www.bankofcanada.ca/rates/exchange/legacy-noon-and-closing-rates/

49, 51, 52, 53, 54, 55, 56, 61, 62, 71, 72, 81, and 91). A total of 72.27% of the observations in the reduced data frame had 0 bankruptcies associated with them.

Because the industry GDP data obtained from Statistics Canada aggregates the Manufacturing (31-33), Retail trade (44-45), and Transportation and warehousing (48-49) sectors, the same was done to the bankruptcy dataset. The resulting bankruptcy dataset had 27,431 observations, 71.72% of which had 0 bankruptcies associated with them.

Restriction Indexes

As previously noted, the restriction indexes dataset initially displayed indexes for the vaccinated, unvaccinated, and total populations for each month, totalling 15,600 observations from January 2020 to January 2022. The first two categories were discarded, leaving the dataset with 5,200 observations on COVID-related monthly restriction indexes by province and by restriction level (gym closings, restrictions on internal movement, etc.) for the total Canadian population. Secondly, monthly index values for 2014-2019 and for February 2022 were generated as 0, leaving the dataset with 20,384 total observations from January 2014 to February 2022. Finally, a column with monthly changes in restriction indexes was added to the dataset.

COVID Cases

Daily values of 0 for the 2014-2019 period were also included in the COVID cases dataset, and the daily data was aggregated to month for each province. This yielded a data frame with 1,239 total observations from January 2014 to February 2022. Observations were then converted into monthly percentage changes.

Imports

The imports dataset obtained from Statistics Canada was initially reduced to contain only seasonally adjusted values for the total of all merchandise on a balance of payments basis. The reduced dataset totalled 339 monthly observations on the Laspeyres fixed weighted price and volume indexes and the Paasche current weighted price index. Then, an imports column was generated by multiplying the Paasche price index and the Laspeyres volume index for each month. The final dataset holding only monthly import values from January 2014 to February 2022 contained 98 observations. Finally, import values were converted into monthly percentage changes.

Industry GDP

The complete industry GDP dataset obtained from Statistics Canada was first reduced by removing non-NAICS sectors and leaving it with only seasonally adjusted GDP values based on chained 2012 dollars. This resulted in a dataset with 1,960 observations from January 2014 to February 2022.

To allow the model to capture the effect of industry GDP on bankruptcies for different industry sectors, the dataset was split into 19 other datasets, one for each NAICS sector. Each of these datasets carried the original GDP values for one NAICS sector and values of 0 for the remaining sectors. GDP values were then transformed into monthly percentage changes.

Liquidity Premium

The liquidity premium was calculated from the monthly long and short bond yields obtained from the FRED website. It is the difference between the long and short bond rates. The dataset contained 98 observations from January 2014 to February 2022.

Exchange Rates

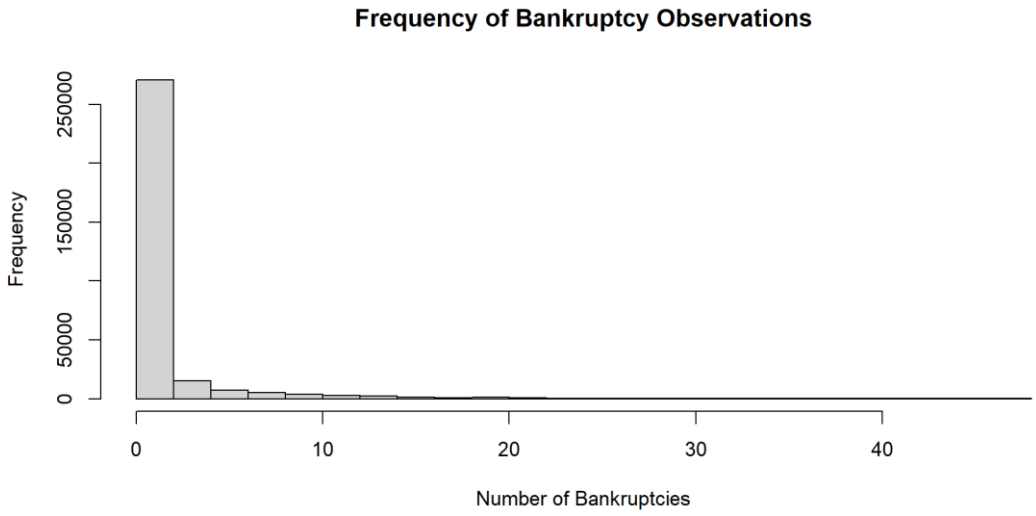
Obtained from the Bank of Canada website, monthly exchange rates between the Canadian Dollar and the American Dollar, Japanese Yen, British Pound and Chinese Renminbi were converted into monthly percentage changes. The final dataset contained 392 observations from January 2014 to February 2022.

After applying the above transformations, individual datasets for each variable were merged into a single dataset with 407,536 observations for the reference period. Because Canadian territories showed very little or no variation in bankruptcies over the reference period, as shown in the next section, they were removed from the dataset, leaving it with 313,456 observations.

III. Descriptive Statistics and Plots

The first plot shows a histogram of bankruptcies in the complete dataset. With 68.36% of zeroes, it shows that the bankruptcy data is zero-inflated.

Plot 1: Frequency of Bankruptcy Observations, 2014-2022 Data



The following two tables show the NAICS sectors adopted in the paper and descriptive statistics for the variables used, respectively.

Table 1
NAICS Sectors by Code

Code	Sector
11	Agriculture, forestry, fishing and hunting
21	Mining, quarrying, and oil and gas extraction
22	Utilities
23	Construction
31-33	Manufacturing
41	Wholesale trade
44-45	Retail trade
48-49	Transportation and warehousing
51	Information and cultural industries
52	Finance and insurance
53	Real estate and rental and leasing
54	Professional, scientific and technical services
55	Management of companies and enterprises
56	Administrative and support, waste management and remediation services
61	Educational services
62	Health care and social assistance
71	Arts, entertainment and recreation
72	Accommodation and food services
81	Other services (except public administration)
91	Public administration

Table 2
Descriptive Statistics, 2014-2022 Data

Variable	Number of Observations	Provincial or National	Mean	Variance	Minimum	Maximum
Bankruptcies	27,431	Provincial	1.131	13.8	0	47
Restriction Indexes Monthly Change	20,383	Provincial	0.8172	18.7636	0	76.21
COVID Cases	1,239	Provincial	558137	6.79E+12	0	30052473
Overnight Rate Target	98	National	0.8265	0.2773	0.25	1.75
Industry GDP % Change - Sector 11	98	National	0.0672	1.5845	-5.0874	4.4776
Industry GDP % Change - Sector 21	98	National	0.1679	6.7842	-8.5061	7.8235
Industry GDP % Change - Sector 22	98	National	0.0521	2.6321	-4.1685	4.0771
Industry GDP % Change - Sector 23	98	National	0.1256	7.1574	-18.5015	14.133
Industry GDP % Change - Sectors 31-33	98	National	0.109	8.68	20.3436	11.7942
Industry GDP % Change - Sector 41	98	National	0.1693	8.3225	-17.9874	16.288
Industry GDP % Change - Sectors 44-45	98	National	0.2233	15.3594	-20.3628	19.1498
Industry GDP % Change - Sectors 48-49	98	National	0.068	8.1566	-21.2	8.0259
Industry GDP % Change - Sector 51	98	National	0.2705	0.6315	-4.94	1.8071

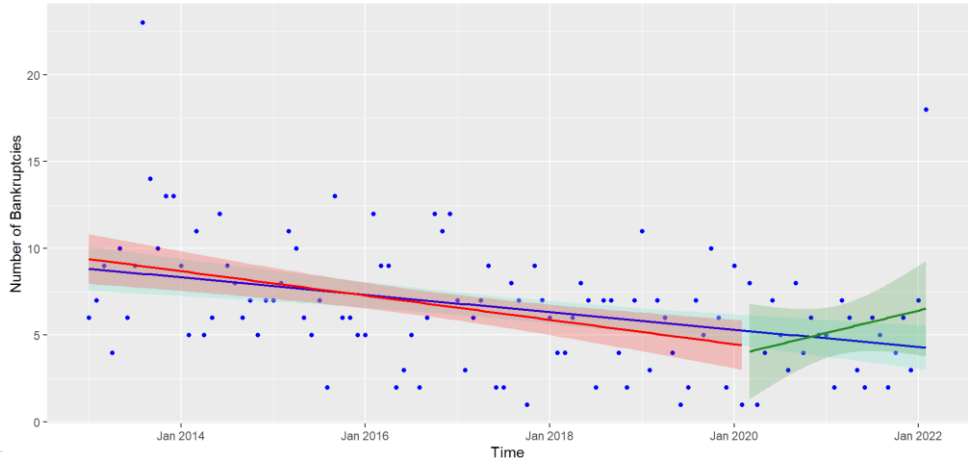
Industry GDP % Change - Sector 52	98	National	0.3343	0.4162	-2.3774	2.0335
Industry GDP % Change - Sector 53	98	National	0.2213	0.3185	-3.414	2.4982
Industry GDP % Change - Sector 54	98	National	0.288	1.6755	-10.7944	2.8017
Industry GDP % Change - Sector 55	98	National	-1.7067	2.7388	-8.914	2.4093
Industry GDP % Change - Sector 56	98	National	0.0315	6.476	-15.5805	10.7992
Industry GDP % Change - Sector 61	98	National	0.1341	3.096	-9.5698	6.9587
Industry GDP % Change - Sector 62	98	National	0.1848	3.3855	-11.7179	8.9281
Industry GDP % Change - Sector 71	98	National	0.0645	37.655	-39.399	15.5844
Industry GDP % Change - Sector 72	98	National	0.3687	62.7516	-43.2307	29.3605
Industry GDP % Change - Sector 81	98	National	0.1017	13.1677	-27.5765	11.5118
Industry GDP % Change - Sector 91	98	National	0.1432	0.5145	-5.2044	1.852
Imports % Change	98	National	0.4191	17.4815	-23.7025	20.652
USDCAD Rate % Change	98	National	0.1983	3.3106	-4.5796	5.0883
JPYCAD Rate % Change	98	National	0.1017	6.2239	-7.1082	7.3737
GBPCAD Rate % Change	98	National	0.0057	3.7504	-6.3534	4.4578
CNYCAD Rate % Change	98	National	0.1513	2.7909	-4.045	4.634
CPI % Change	98	National	1.874	1.1754	-0.4	5.7
Liquidity Premium	98	National	0.0627	0.0032	-0.0727	0.1609

i. Plots: monthly bankruptcies by NAICS sector over time

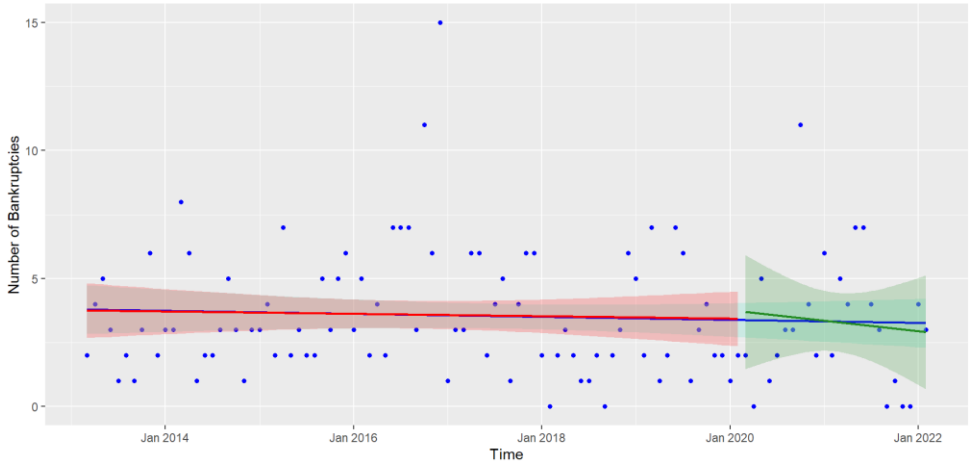
Plots 2-21 depict the evolution of the number of bankruptcies over the reference period for each NAICS sector. Bankruptcy numbers are aggregated to Canada. Three lines are shown on each plot: a blue line, which is the trend over the entire period analyzed; a red line, which represents the trend in bankruptcies pre-March 2022; and a green line, which shows the trend in bankruptcies post-March 2022. The shadings around the lines portray the standard errors.

Sectors 21, 22, 61, and 91 showed little or no difference in their pre- and post-pandemic bankruptcy trends. By contrast, sectors 11, 23, 48-49, 54, 56, and 81 suffered a change in the slope of their trends, from declining to increasing. Other sectors that suffered slope changes include sectors 31-33, 52 and 72, whose declines in bankruptcies decelerated, sector 44-45, whose decline in bankruptcies accelerated, sectors 51 and 62, whose rise in bankruptcies accelerated, and sectors 53 and 55, which went from increasing to declining bankruptcy trends. Moreover, sectors 23, 31-33, 41, 51, 54, and 72 also suffered level changes in their bankruptcies, which dropped significantly during the pandemic period.

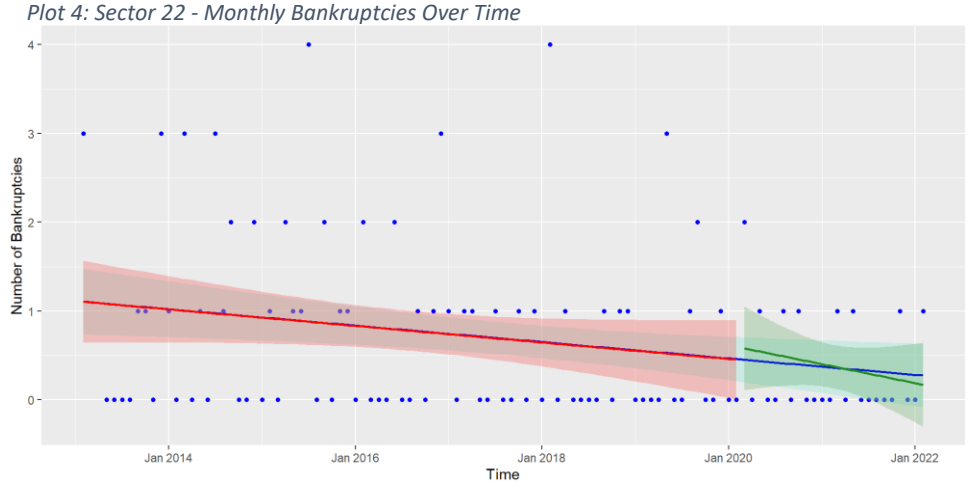
Plot 2: Sector 11 - Monthly Bankruptcies Over Time



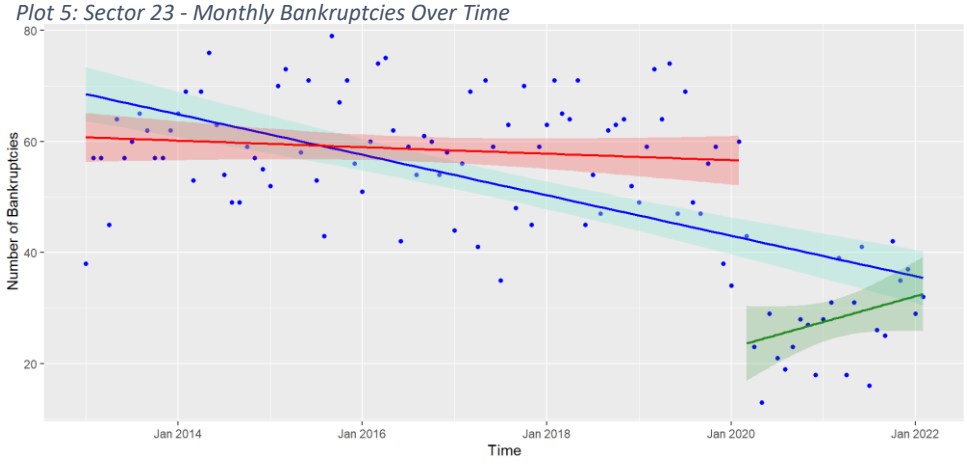
Plot 3: Sector 21 - Monthly Bankruptcies Over Time



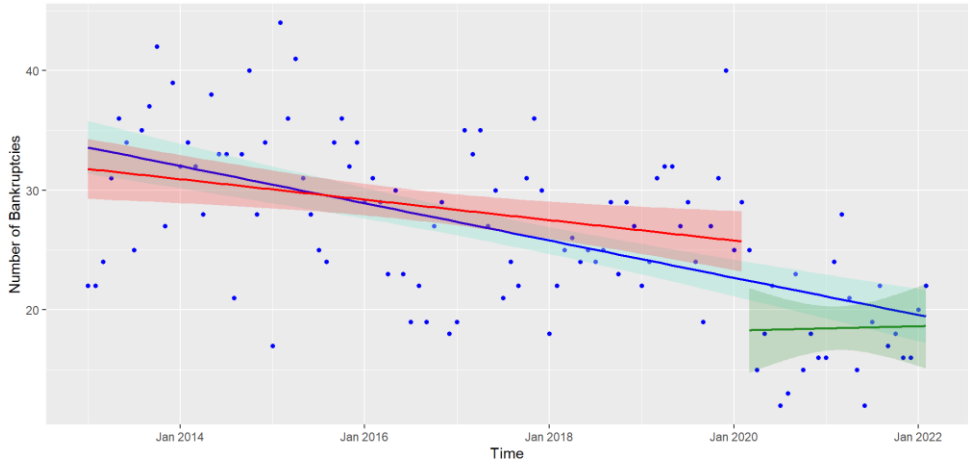
Plot 4: Sector 22 - Monthly Bankruptcies Over Time



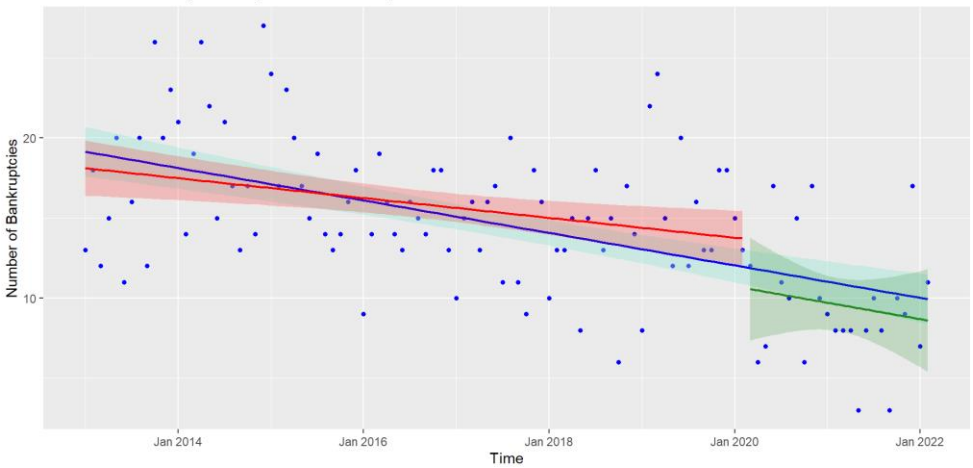
Plot 5: Sector 23 - Monthly Bankruptcies Over Time

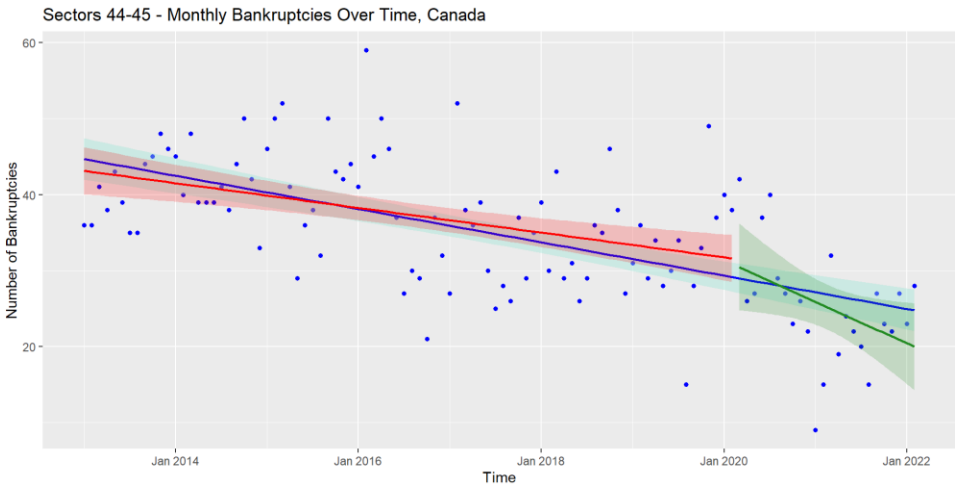


Plot 6: Sectors 31-33 - Monthly Bankruptcies Over Time

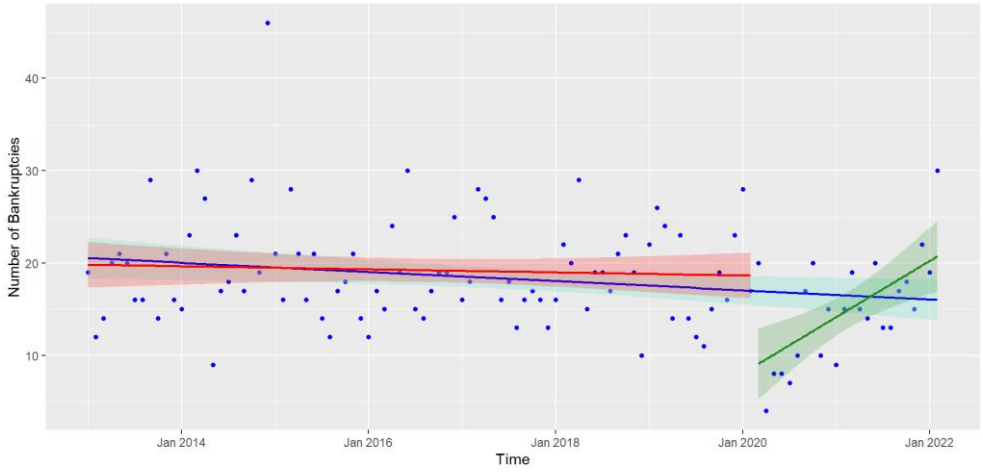


Plot 7: Sector 41 - Monthly Bankruptcies Over Time

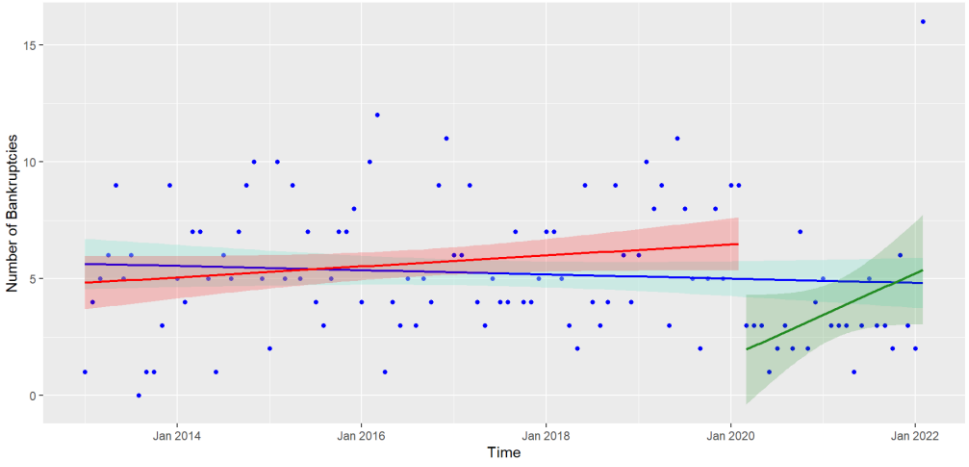




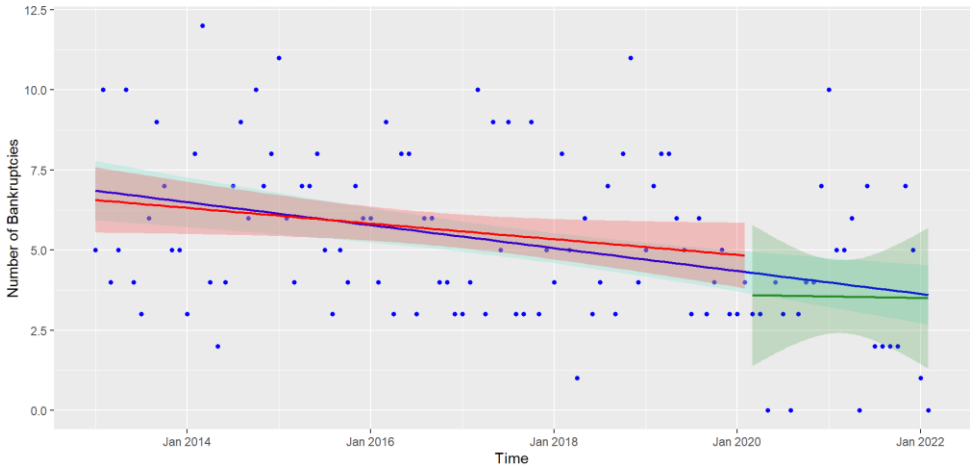
Plot 9: Sectors 48-49 - Monthly Bankruptcies Over Time



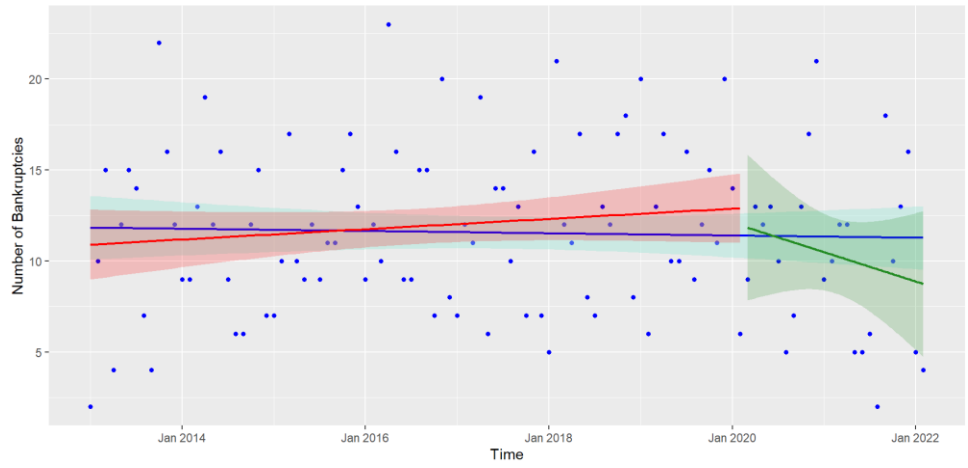
Plot 10: Sector 51 - Monthly Bankruptcies Over Time



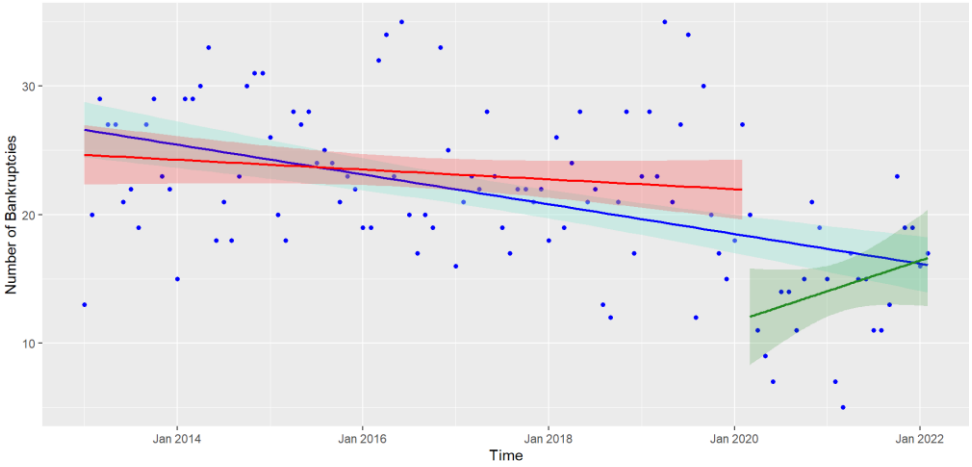
Plot 11: Sector 52 - Monthly Bankruptcies Over Time, Canada



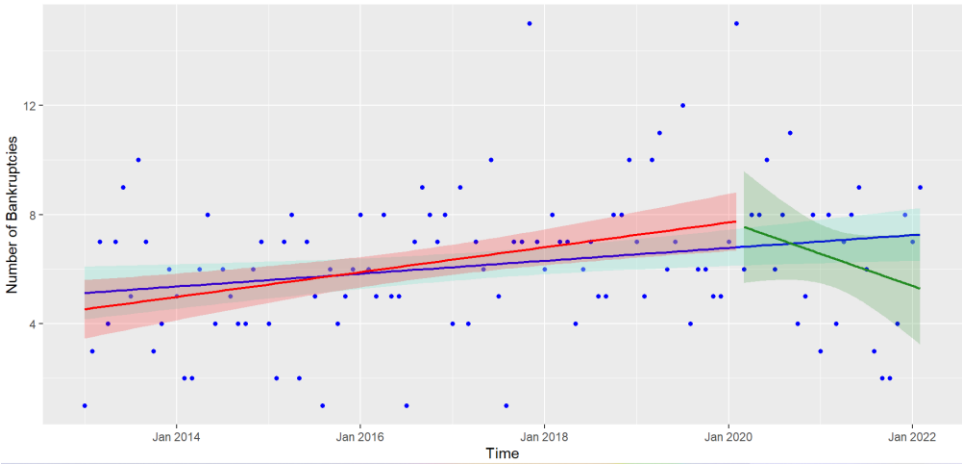
Plot 12: Sector 53 - Monthly Bankruptcies Over Time, Canada



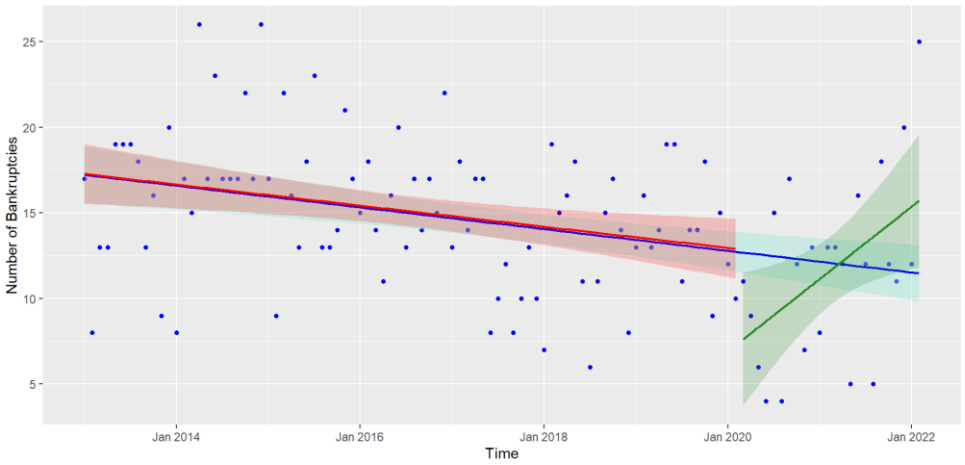
Plot 13: Sector 54 - Monthly Bankruptcies Over Time, Canada



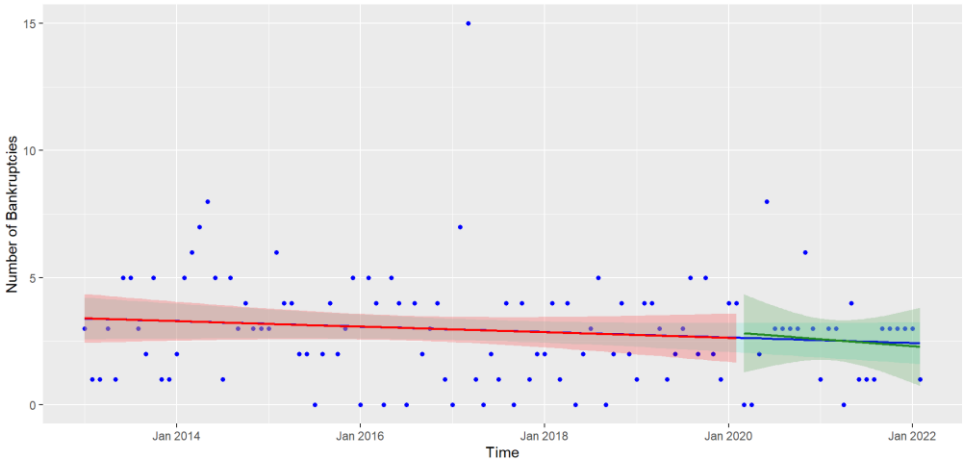
Plot 14: Sector 55 - Monthly Bankruptcies Over Time, Canada



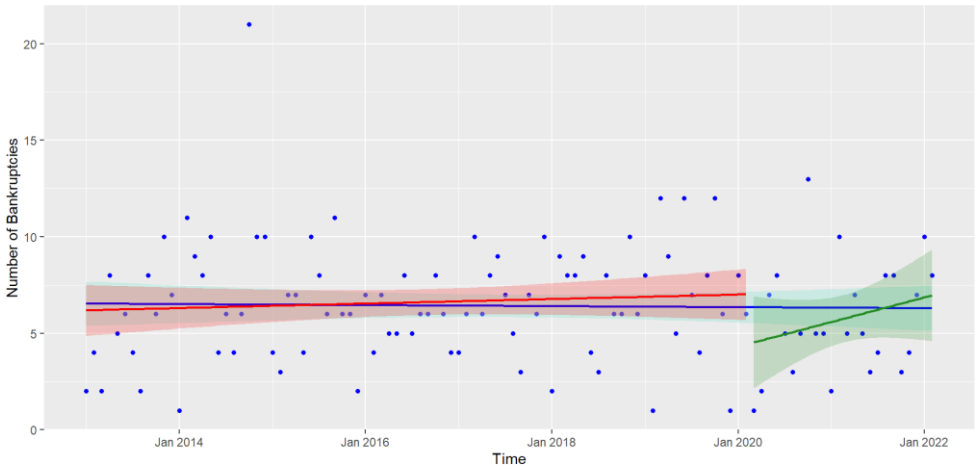
Plot 15: Sector 56 - Monthly Bankruptcies Over Time, Canada



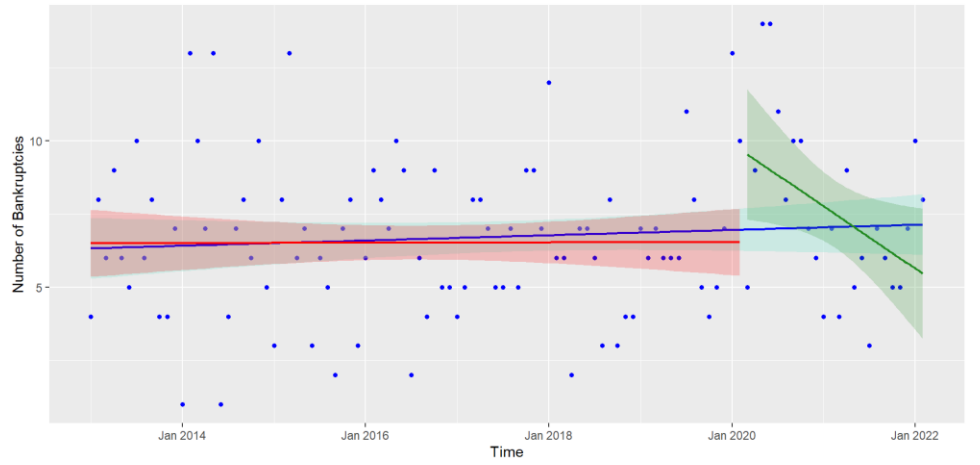
Plot 16: Sector 61 - Monthly Bankruptcies Over Time, Canada



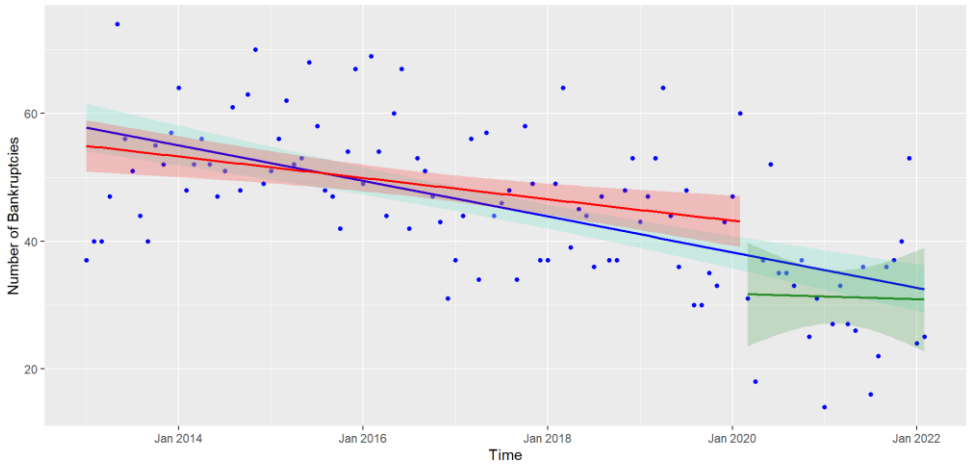
Plot 17: Sector 62 - Monthly Bankruptcies Over Time, Canada

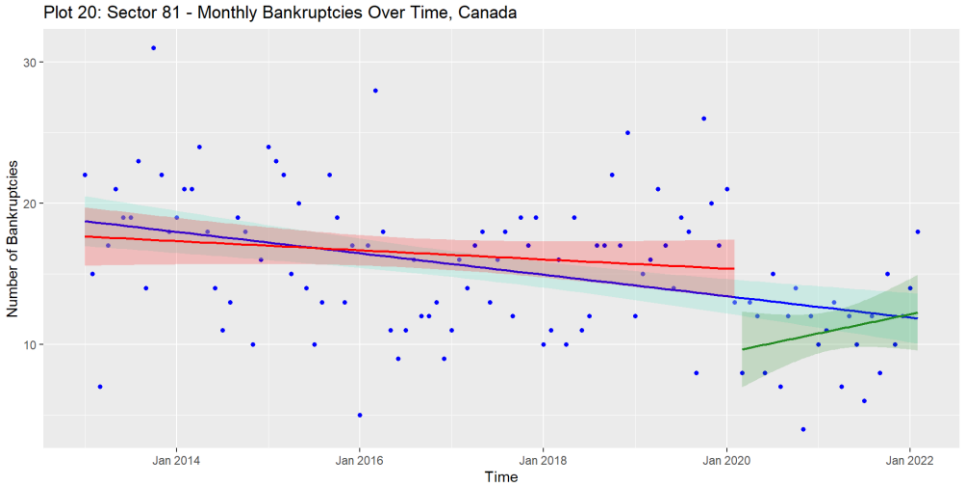


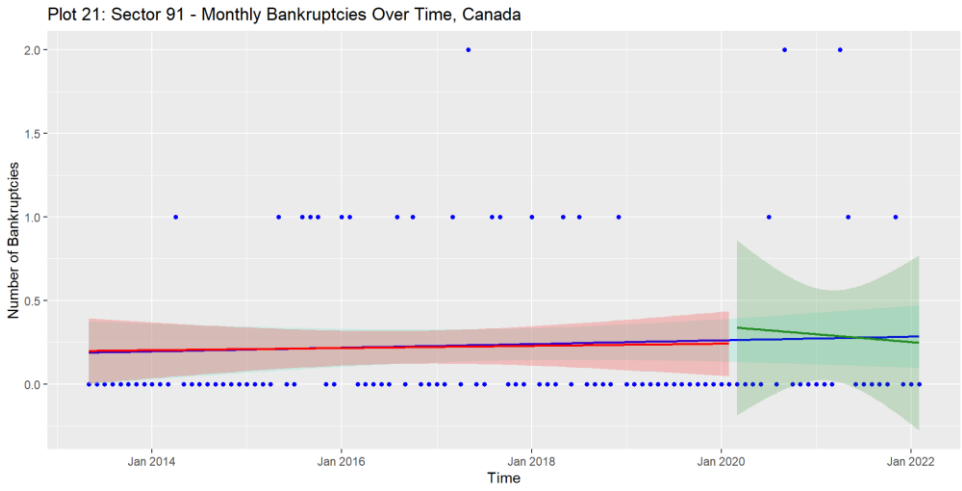
Plot 18: Sector 71 - Monthly Bankruptcies Over Time, Canada



Plot 19: Sector 72 - Monthly Bankruptcies Over Time, Canada







ii. Plots: monthly bankruptcies by province over time

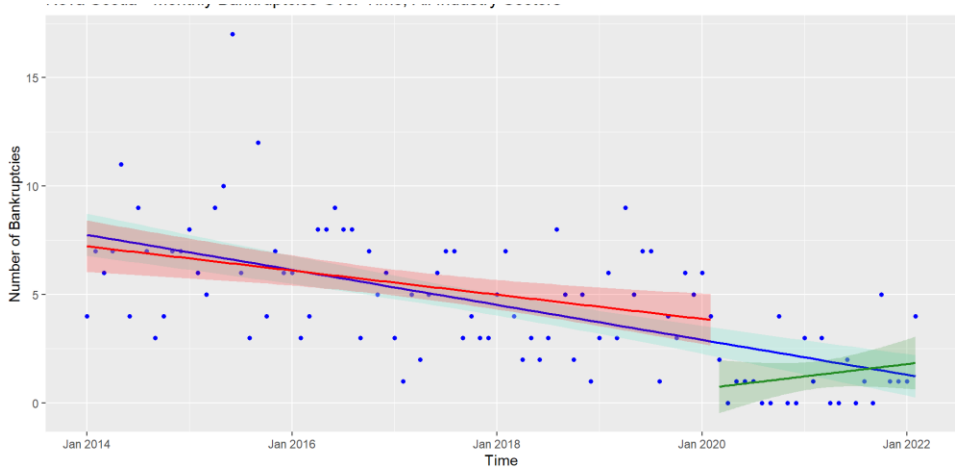
Plots 22-34 show the evolution of the number of bankruptcies over the reference period for each province. Bankruptcy numbers are aggregated to all industry sectors. Like in the previous section, the blue line on each plot depicts the overall trend, with the red line showing the pre-March 2022 trend and the green line representing the post-March 2022 trend. The shadings around the lines portray the standard errors.

Notably, the Northwest Territories had no bankruptcies during the reference period, with Yukon and Nunavut having just a few. This miniscule variation in bankruptcy numbers justified the exclusion of the territories in the subsequent analysis.

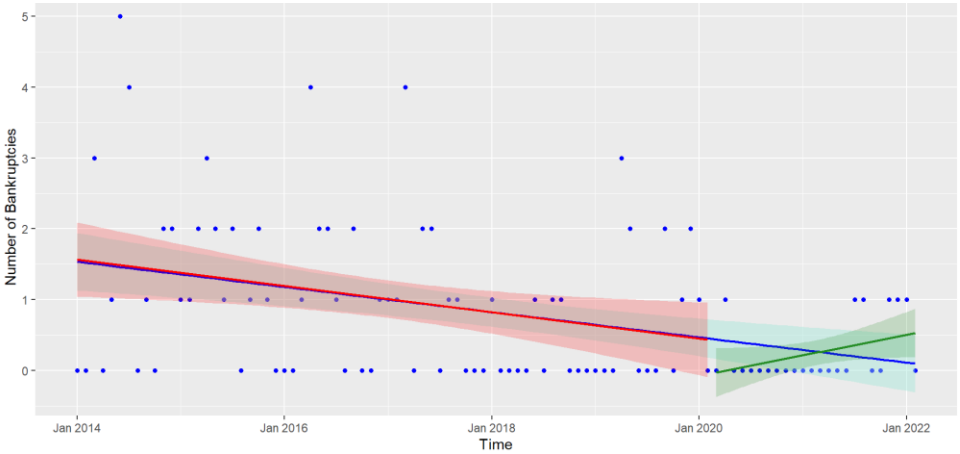
It can be observed that Nova Scotia, Prince Edward Island, New Brunswick, Quebec and Saskatchewan went from having decreasing bankruptcy numbers before the pandemic to having increasing numbers since its start. By contrast, Alberta and Newfoundland and Labrador suffered

a change in the slope of their trends in the opposite direction. Although not suffering a change in the sign of its slope, Ontario's post-March 2022 trend shows a deceleration in the decline of bankruptcies in the province. The opposite is true for Manitoba, whose decline in bankruptcies accelerated since the start of the pandemic in the country. Finally, British Columbia's plot does not show a noticeable change in the trend's slope, although its level increased. Other provinces that had visible level changes in their bankruptcies include Quebec, Ontario, Manitoba, Saskatchewan, and Newfoundland and Labrador. Canada, as a whole, experienced both a level decline in bankruptcies and a slope change in its trend because of the pandemic – it went from declining to increasing overall bankruptcies.

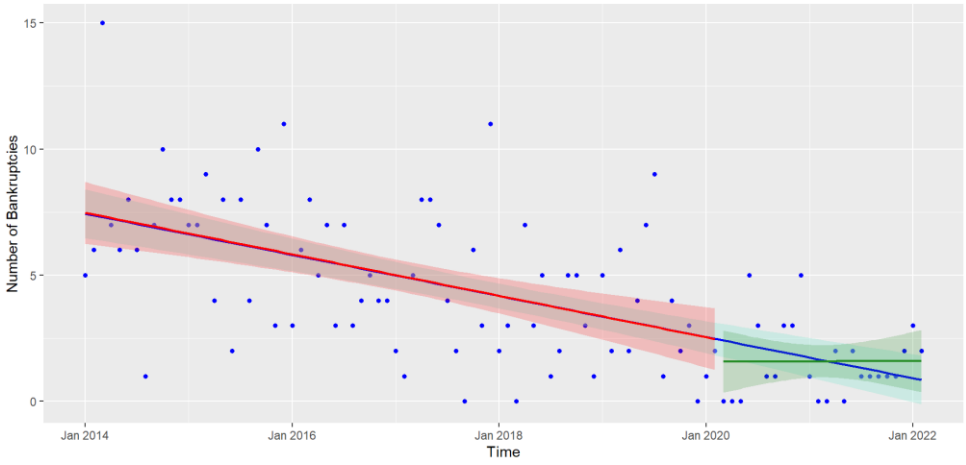
Plot 22: Nova Scotia - Monthly Bankruptcies Over Time



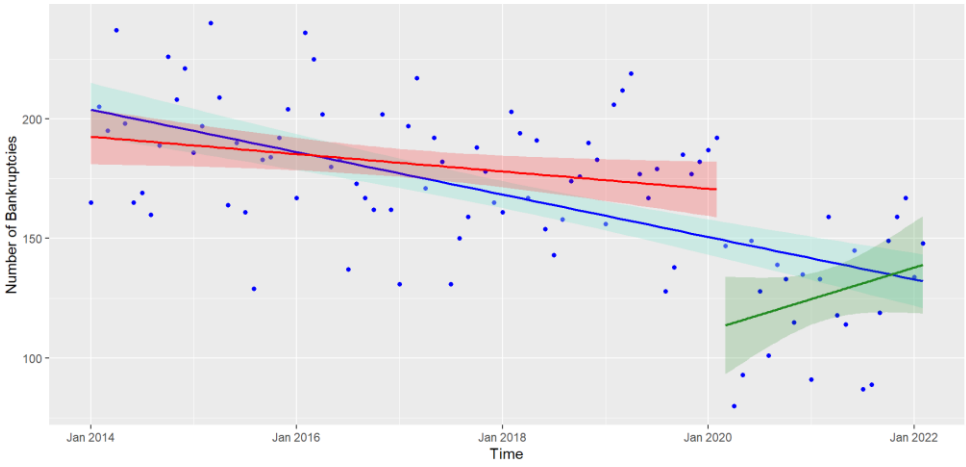
Plot 23: Prince Edward Island - Monthly Bankruptcies Over Time



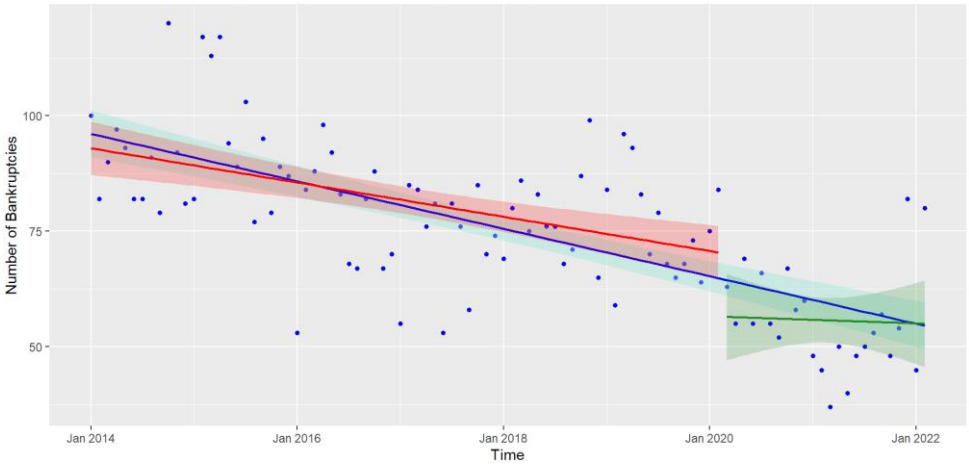
Plot 24: New Brunswick - Monthly Bankruptcies Over Time, All Industry Sectors



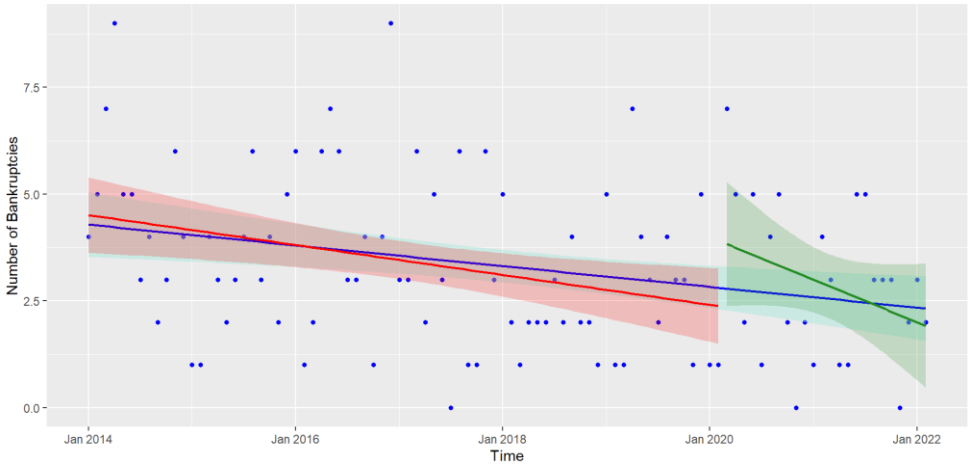
Plot 25: Quebec - Monthly Bankruptcies Over Time, All Industry Sectors



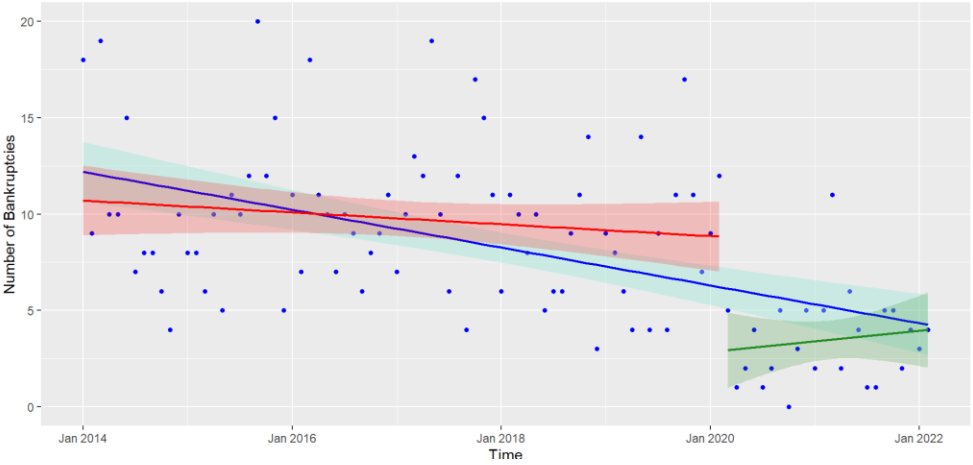
Plot 26: Ontario - Monthly Bankruptcies Over Time, All Industry Sectors



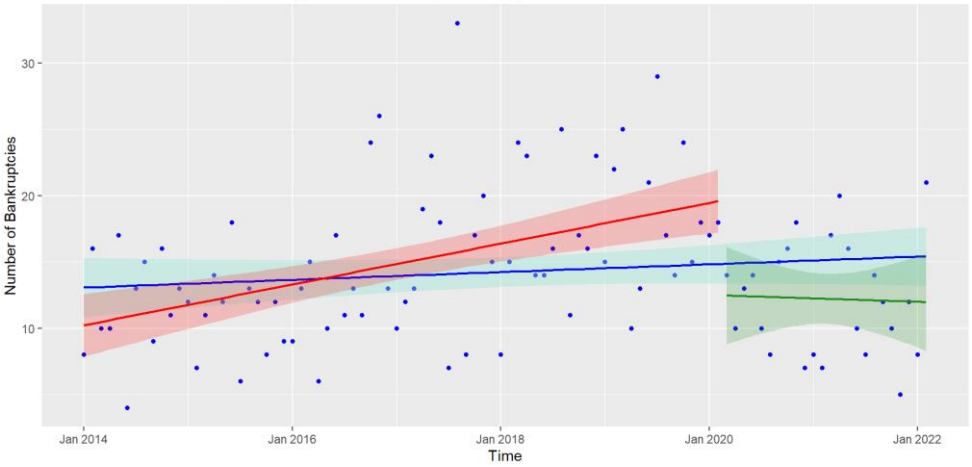
Plot 26: Manitoba - Monthly Bankruptcies Over Time, All Industry Sectors



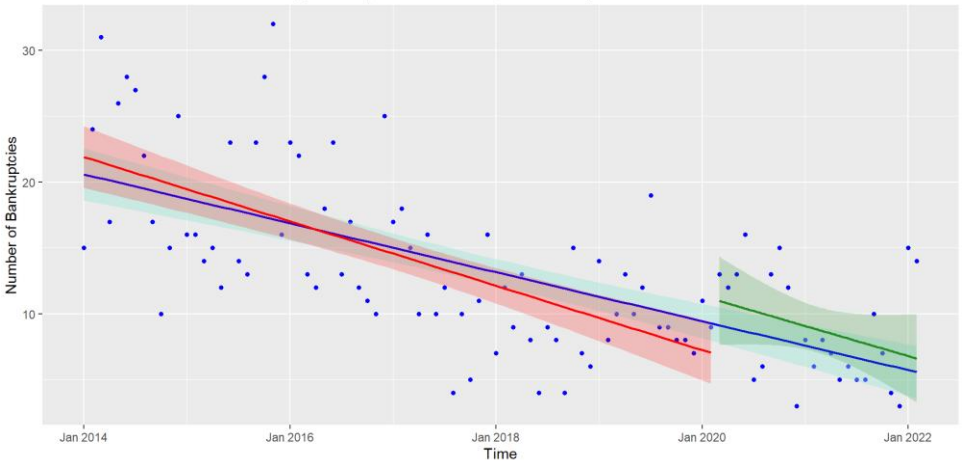
Plot 27: Saskatchewan - Monthly Bankruptcies Over Time, All Industry Sectors



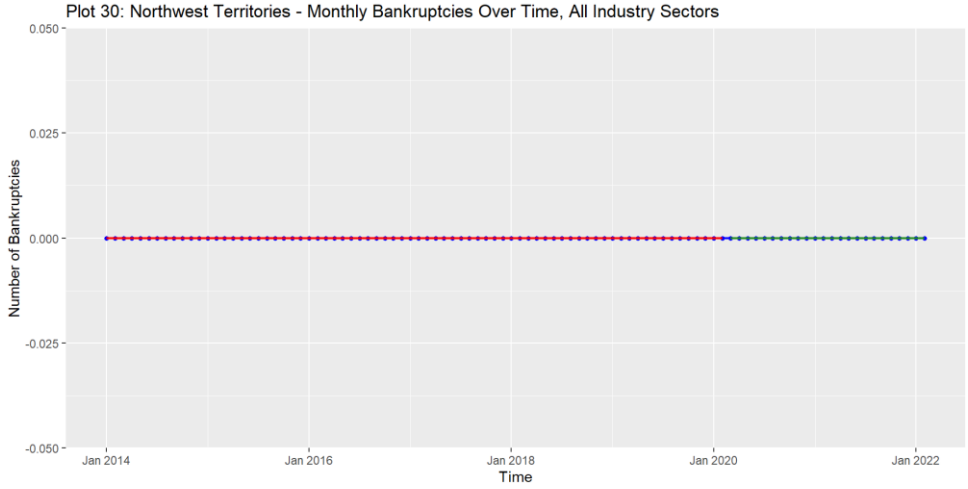
Plot 28: Alberta - Monthly Bankruptcies Over Time, All Industry Sectors



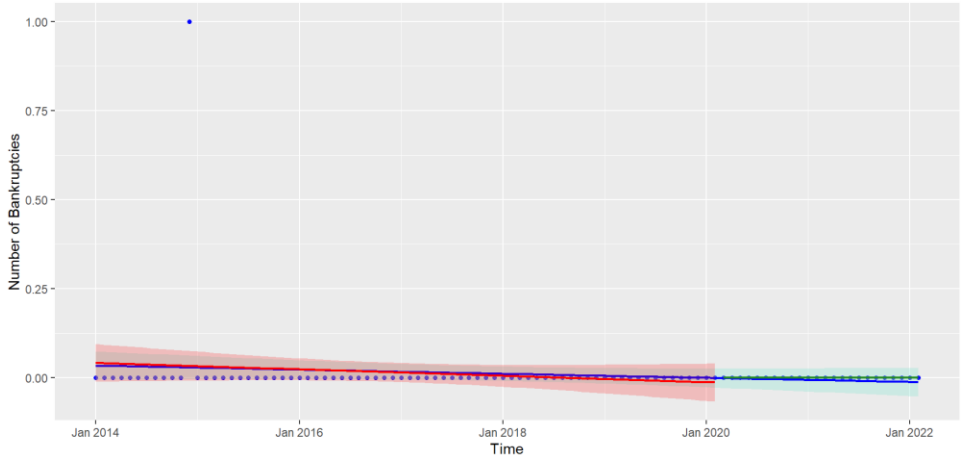
Plot 29: British Columbia - Monthly Bankruptcies Over Time, All Industry Sectors



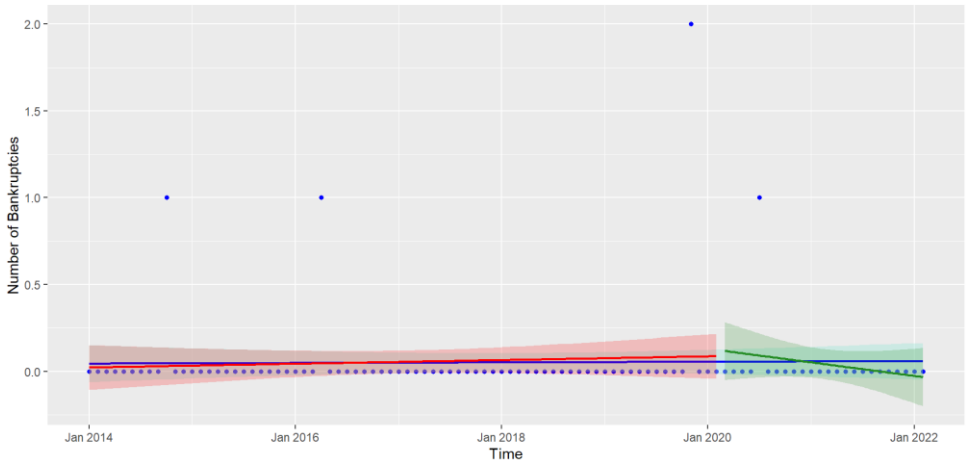
Plot 30: Northwest Territories - Monthly Bankruptcies Over Time, All Industry Sectors



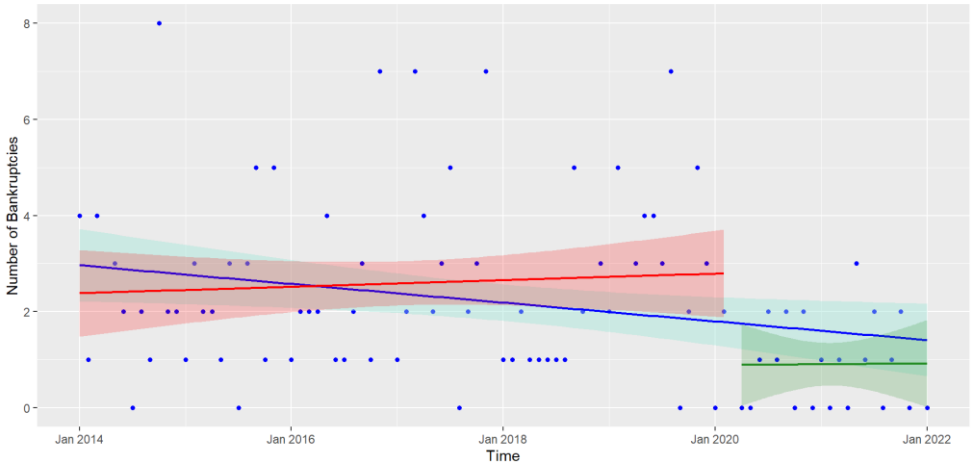
Plot 31: Yukon - Monthly Bankruptcies Over Time, All Industry Sectors



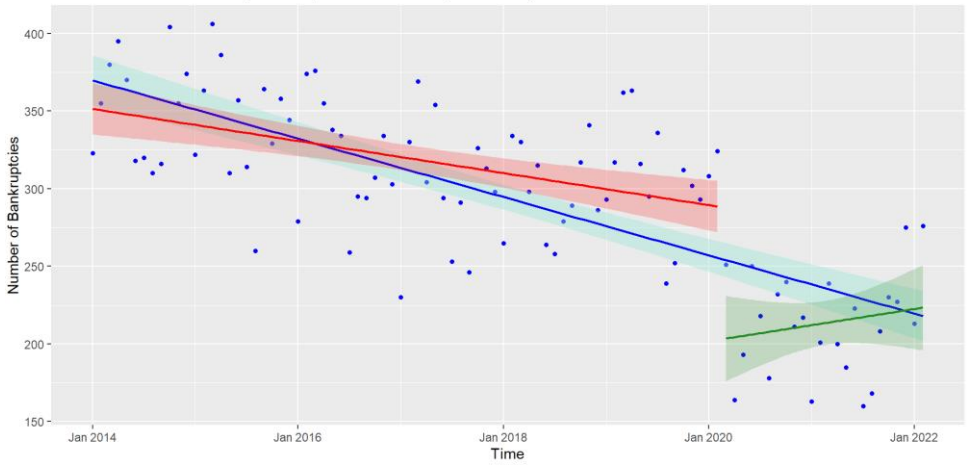
Plot 32: Nunavut - Monthly Bankruptcies Over Time, All Industry Sectors



Plot 33: Newfoundland and Labrador - Monthly Bankruptcies Over Time, All Industry Sectors



Plot 34: Canada - Monthly Bankruptcies Over Time, All Industry Sectors



IV. Results

Table 3 displays the estimation results. It was found that during the 2014-2022 period, all provinces and NAICS sectors were very statistically significant relative to their respective benchmarks – Alberta and sector 72 – in explaining the probability of bankruptcies occurring. This is unsurprising given the obvious variation in economic conditions across provinces and the differing impacts of changing economic circumstances on the different industry sectors. Moreover, most industry sectors' monthly percentage change in GDP is also significant, with the exceptions being the GDP change of sectors 41, 44-45, 48-49, and 52, which had very little or no significant coefficients. Other significant variables include the monthly percentage changes in CPI, exports, imports, and exchange rates (apart from USDCAD), as well as the liquidity premium, the monthly change in the restriction index, and the dummy variable for the pandemic period. These results are all expected, since these factors, which represent the bulk of external conditions faced by firms (such as prices, competition, and access to capital), affect their decisions and capability to stay afloat.

The high insignificance of the overnight rate target and restriction levels (categories) relative to their benchmark, "Cancel public events", was unexpected. A possible explanation for this finding, with regards to the overnight rate, is that its effect might already be captured by the variation in the other variables, particularly the dummy variable for the pandemic period: the strong lowering of the overnight rate by the Bank of Canada in response to demand shocks caused by the pandemic certainly affected bankruptcies by facilitating access to credit; however, this effect is nullified when we control for the pandemic period. As for restriction levels, it seems that despite restrictions being significant in the aggregate, as shown by the low p-value found for the changes in the restriction index, restrictions imposed on different sectors of the economy affected bankruptcies similarly.

The signs of the estimated coefficients tell us that, among provinces, only Ontario and Quebec were more likely than Alberta to contain firms that shut down. The respective average marginal effects (AME) show that Quebec was the most likely to contain bankruptcies relative to Alberta, while Prince Edward Island was the least likely. Among industry sectors, the model findings show that only sector 23 (Construction) was more likely to suffer bankruptcies than sector 72 (Accommodation and food services), albeit this increased probability was small as per the respective AME. This is perfectly in line with expectations, given that these two sectors were the most affected by the pandemic. Also, relative to sector 72, sector 91 (Public administration) was the least likely to suffer bankruptcies. This is also expected, given that public agencies rarely go bankrupt.

With regards to percentage changes in industry GDP, the results were mixed. For some sectors, an increase in percentage GDP change increased the probability of bankruptcies, while the opposite was true for other sectors. Despite these effects being small according to the estimates AMEs, this is curious and warrants further investigation.

With respect to percentage changes in exchange rates, a higher depreciation of the Canadian Dollar relative to Japanese Yen and British Pound led to a decreased probability of bankruptcies,

while the opposite was true for a depreciation of the Canadian Dollar relative to the Chinese renminbi. This is in line with economic theory and Canadian foreign trade: according to the Observatory of Economic Complexity (OEC), Canada is a net exporter relative to the UK and Japan, and a net importer relative to China.[5] Thus, when the CAD depreciates relative to the GBP or JPY, Canadian net revenue from trade with those countries increases, augmenting the profits of Canadian domestic firms and lowering the probability of bankruptcies. The opposite is true when the CAD depreciates relative to the CNY. In this case, Canada loses money since its Chinese imports exceed its exports to China, and hence domestic profits suffer, increasing the probability of bankruptcies. The low significance of the USDCAD coefficient can also be explained in these terms: since Canada's net exports with the US are very small[6], a change in exchange rates likely does not alter domestic profits significantly. Moreover, estimated AMEs show that changes in CNYCAD had the biggest effect on bankruptcy probability among the exchange rates studied. This reflects the very low value of Canadian net exports with China – according to OEC, Canada imported $49.5 billion from China, while only exporting $19.3 billion to that country.

The sign of the coefficient of the percentage change in CPI also accords with theory. Ceteris paribus, higher prices augment the profits of firms, thus decreasing the probability of bankruptcies. Nonetheless, the respective AME was small. With regards to percentage changes in imports and exports, the signs of their coefficients reflect the impacts of foreign competition on the domestic economy. When domestic firms export more, their profits increase, lowering the probability of bankruptcies. On the other hand, when domestic consumers import more, and assuming little variation in their incomes, they buy less from domestic firms, therefore reducing profits of those firms and increasing the probability of bankruptcies.

Finally, the negative sign on the coefficient of the pandemic dummy variable suggests that firms were less likely to go bankrupt during the pandemic relative to the preceding six years. This is consistent with the plots shown above, which depict drops in bankruptcy levels for many industry sectors and provinces during the onset of the pandemic. Given our control of factors that reflect domestic demand and foreign economic conditions, this suggests that some measure(s) implemented in the country in response to the pandemic boosted firms' capacity to stay afloat. The Canada Emergency Business Account (CEBA) program, adopted by the Canadian government in 2020 to provide relief to firms in the form of interest-free loans of up to $40,000[7], is a strong contender for such a measure. Hence the inclusion of CEBA loan data in future analyses may be fruitful.

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[5] Japan (JPN) and Canada (CAN) Trade | OEC - The Observatory of Economic Complexity; Canada (CAN) and United Kingdom (GBR) Trade | OEC - The Observatory of Economic Complexity; China (CHN) and Canada (CAN) Trade | OEC - The Observatory of Economic Complexity.

[6] Canada | United States Trade Representative (ustr.gov)

[7] Canada Emergency Business Account (CEBA) (ceba-cuec.ca)

Table 3
Zero-Inflated Poisson GLM Model Results, 2014-2022 Data

	Estimate	P-Value	AME
Intercept	8.72E-01	< 2e-16 (***)	
Provinces, relative to Alberta			
British Columbia	-9.34E-02	< 2e-16 (***)	-0.0644
Manitoba	-1.47E+00	< 2e-16 (***)	-0.5569
New Brunswick	-1.25E+00	< 2e-16 (***)	-0.5149
Newfoundland and Labrador	-1.91E+00	< 2e-16 (***)	-0.6154
Nova Scotia	-1.17E+00	< 2e-16 (***)	-0.4974
Ontario	1.64E+00	< 2e-16 (***)	2.994
Prince Edward Island	-2.87E+00	< 2e-16 (***)	-0.6815
Quebec	2.43E+00	< 2e-16 (***)	7.5286
Saskatchewan	-5.60E-01	< 2e-16 (***)	-0.3095
Restriction Index, Monthly Change	-1.07E-05	< 2e-16 (***)	0
NAICS, relative to Sector 72			
Sector 11	-1.97E+00	< 2e-16 (***)	-3.8679
Sector 21	-1.87E+00	< 2e-16 (***)	-4.1114
Sector 22	-4.22E+00	< 2e-16 (***)	-4.4264
Sector 23	1.38E-01	< 2e-16 (***)	0.6661
Sectors 31-33	-5.47E-01	< 2e-16 (***)	-1.89
Sector 41	-1.14E+00	< 2e-16 (***)	-3.062
Sectors 44-45	-2.73E-01	< 2e-16 (***)	-1.0718
Sectors 48-49	-8.96E-01	< 2e-16 (***)	-2.6558
Sector 51	-2.13E+00	< 2e-16 (***)	-3.9571
Sector 52	-2.16E+00	< 2e-16 (***)	-3.9751
Sector 53	-1.33E+00	< 2e-16 (***)	-3.305
Sector 54	-7.42E-01	< 2e-16 (***)	-2.3515
Sector 55	-2.11E+00	< 2e-16 (***)	-3.9483
Sector 56	-1.14E+00	< 2e-16 (***)	-3.0597
Sector 61	-2.72E+00	< 2e-16 (***)	-4.199
Sector 62	-1.92E+00	< 2e-16 (***)	-3.8374
Sector 71	-1.87E+00	< 2e-16 (***)	-3.8017
Sector 81	-1.10E+00	< 2e-16 (***)	-2.9966
Sector 91	-5.29E+00	< 2e-16 (***)	-4.4697
Industry GDP % Change			
Sector 11	2.94E-02	0.000947 (***)	0.0427
Sector 21	5.99E-02	< 2e-16 (***)	0.0868
Sector 22	-1.71E-01	< 2e-16 (***)	-0.2479
Sector 23	-1.61E-02	< 2e-16 (***)	-0.0234
Sectors 31-33	-5.74E-03	0.007517 (**)	-0.0083
Sector 41	5.39E-03	0.059415 (.)	0.0078
Sectors 44-45	-1.85E-03	0.185759	-0.0027
Sectors 48-49	-1.28E-03	0.644761	-0.0019

Sector 51	5.01E-02	0.005742 (**)	0.0727
Sector 52	3.36E-02	0.060426 (.)	0.0488
Sector 53	-3.96E-02	0.012581 (*)	-0.0574
Sector 54	-3.54E-02	1.55e-15 (***)	-0.0514
Sector 55	-9.57E-02	< 2e-16 (***)	-0.1389
Sector 56	-1.44E-02	3.34e-06 (***)	-0.0209
Sector 61	1.06E-01	< 2e-16 (***)	0.1537
Sector 62	6.23E-02	< 2e-16 (***)	0.0903
Sector 71	-8.88E-03	5.34e-07 (***)	-0.0129
Sector 72	3.47E-03	5.34e-07 (***)	0.005
Sector 81	-8.79E-03	6.61e-05 (***)	-0.0127
Sector 91	6.03E-01	3.57e-08 (***)	0.8751
Overnight Rate	4.67E-04	0.928523	0.0007
Restriction Level, relative to "Cancel public events"			
Close public transport	-6.89E-06	0.999345	0
Daycare closing	-3.37E-06	0.999679	0
Gym closings	9.80E-07	0.999907	0
Hair salons and barbershop closures	5.71E-07	0.999946	0
International travel controls	-6.60E-08	0.999994	0
Public information campaigns	1.32E-06	0.999875	0
Restrictions on gathering indoor	5.74E-07	0.999945	0
Restrictions on gathering outdoor	-2.04E-07	0.999981	0
Restrictions on internal movement	-2.48E-07	0.999976	0
Restrictions on non-essential retail businesses	-7.14E-07	0.999932	0
Restrictions on restaurant for in-person dining	-6.81E-08	0.999994	0
School closing	-2.72E-07	0.999974	0
Stay at home requirements	-5.13E-06	0.999512	0
Workplace closing	-4.17E-07	0.99996	0
Exchange Rates % Change			
CNYCAD	2.17E-02	< 2e-16 (***)	0.0315
JPYCAD	-5.34E-03	4.25e-10 (***)	-0.0078
GBPCAD	-6.47E-03	1.15e-11 (***)	-0.0094
USDCAD	-2.90E-03	0.085346 (.)	-0.0042
CPI % Change	-8.96E-03	9.69e-06 (***)	-0.013
Exports % Change	-1.42E-03	0.010737 (*)	-0.0021
Imports % Change	9.95E-03	< 2e-16 (***)	0.0144
Liquidity Premium	5.49E-01	< 2e-16 (***)	0.7967
During Pandemic (Yes or No)	-4.33E-01	< 2e-16 (***)	-0.628

V. Predictions

This last section presents the results from four predictions made using the specified model – for bankruptcies in 2019, 2020-2022, 2021-2022 (without pandemic data) and 2021-2022 (with pandemic data). The choice of prediction intervals was motivated by the desire to identify the

existence of structural differences across industry sectors that lead to differing decisions in the face of credit constraints, as the one occasioned by the pandemic. The point is to contrast the model's ability to correctly predict bankruptcy values in different periods. The coupling of the model's capability to accurately predict bankruptcies before the pandemic with its inability to do so for the pandemic period suggests an underlying heterogeneity in firms' decisions. This is in line with our prediction results.

Four pieces of information are provided for each prediction: a frequency table showing the percentage of observations that the model accurately predicted to be either 0 or different than 0, a plot of the natural log of non-zero actual values versus the natural log of non-zero predicted values along with a trend in blue and a 45-degree line in red, a table with the percentage of points above and below the 45-degree line in the respective plot, and plots of the prediction errors. For the purpose of the frequency tables and choice of observations to exclude from the plot, because the model produces non-discrete predictions, predicted values below 0.5 were considered as 0, while values above 0.5 were considered as "not 0".

Visually, the trend line in the 2019 plot was the closest to the 45-degree line, suggesting that this period had the best predictions. This is reinforced by the percentage of "correct" (either 0 or not 0) predictions shown in the frequency tables: 81.91% for 2019, 72.85% for 2020-2022, 73.08% for 2021-2022 (without pandemic data), and 78.67% for 2021-2022 (with pandemic data). By contrast, 2020-2022 had both the worst trend and least correct predictions.

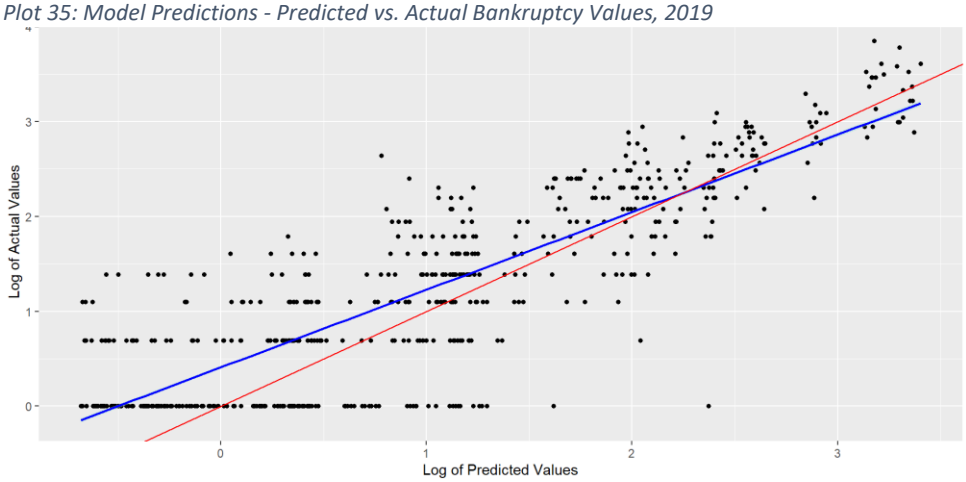
The inclusion of pandemic-related variables (restriction levels, restriction index change, and dummy for the pandemic period) in the predictions for 2021-2022 increased the model's accuracy relative to the predictions both for the same period without pandemic data and for 2020-2022. The increased precision appears to have come from the considerably higher percentage of values that the model correctly predicted as 0 – 51.8% for 2020-2022, 51.14% for 2021-2022 without pandemic data, and 58.36% for 2021-2022 with pandemic data.

Interestingly, attempting to predict bankruptcy values for the pandemic period without the inclusion of pandemic data results in a higher number of overestimations – for 2020-2022 and 2021-2022 (without pandemic data), 47.53% and 46.25%, respectively, of model predictions exceeded actual values. This stands in contrast with 33.96% of overestimations for 2021-2022 with the inclusion of pandemic data. Accordingly, predictions in the latter case mostly underestimated actual values.

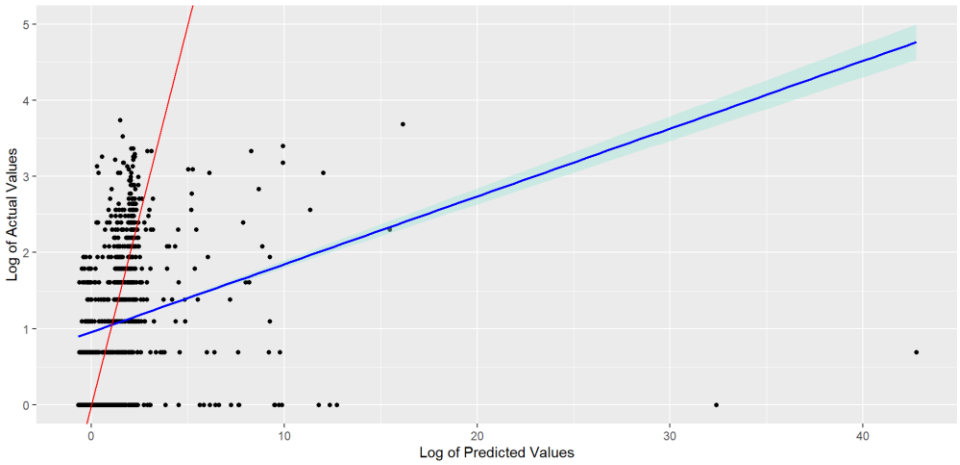
Finally, the prediction errors of all four predictions were heteroskedastic, with errors for the 2020-2022 prediction showing the weakest heteroskedasticity. Moreover, errors for the 2021-2022 predictions seem to be heavily skewed to the left, with the prediction using bankruptcy data being the most skewed.

i. Plots: Predicted vs. Actual Bankruptcy Values (non-zero)

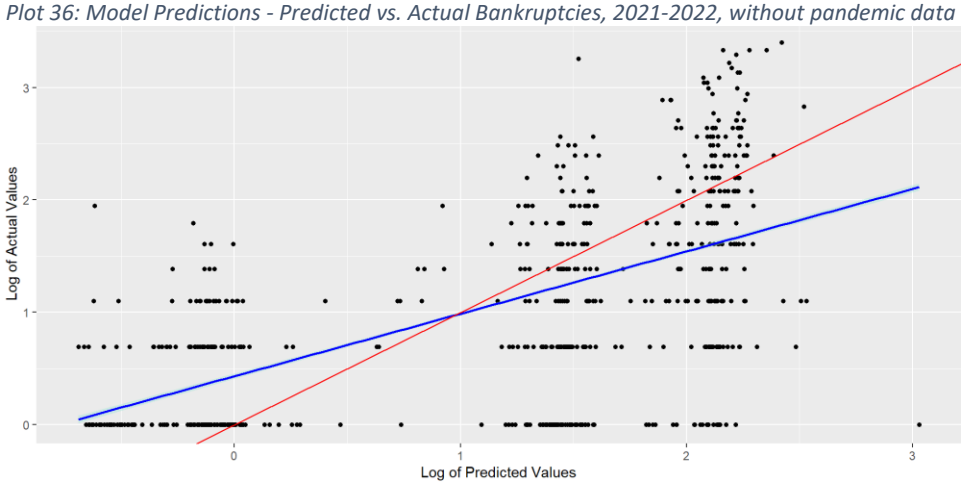
Plot 35: Model Predictions - Predicted vs. Actual Bankruptcy Values, 2019



Plot 36: Model Predictions - Predicted vs. Actual Bankruptcy Values, 2020-2022



Plot 36: Model Predictions - Predicted vs. Actual Bankruptcies, 2021-2022, without pandemic data



Zero-Inflated Poisson GLM: Predicted vs. Actual Bankruptcy Values, 2021-2022, with pandemic data

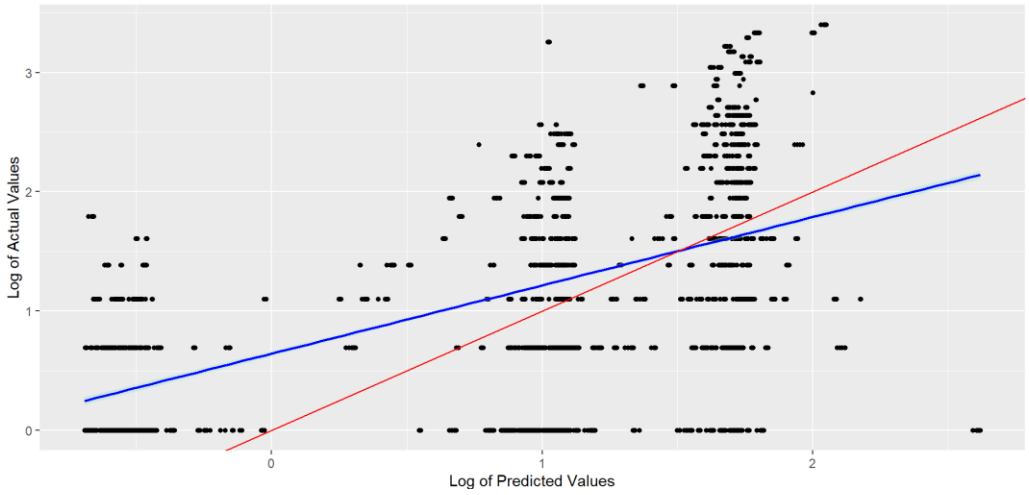


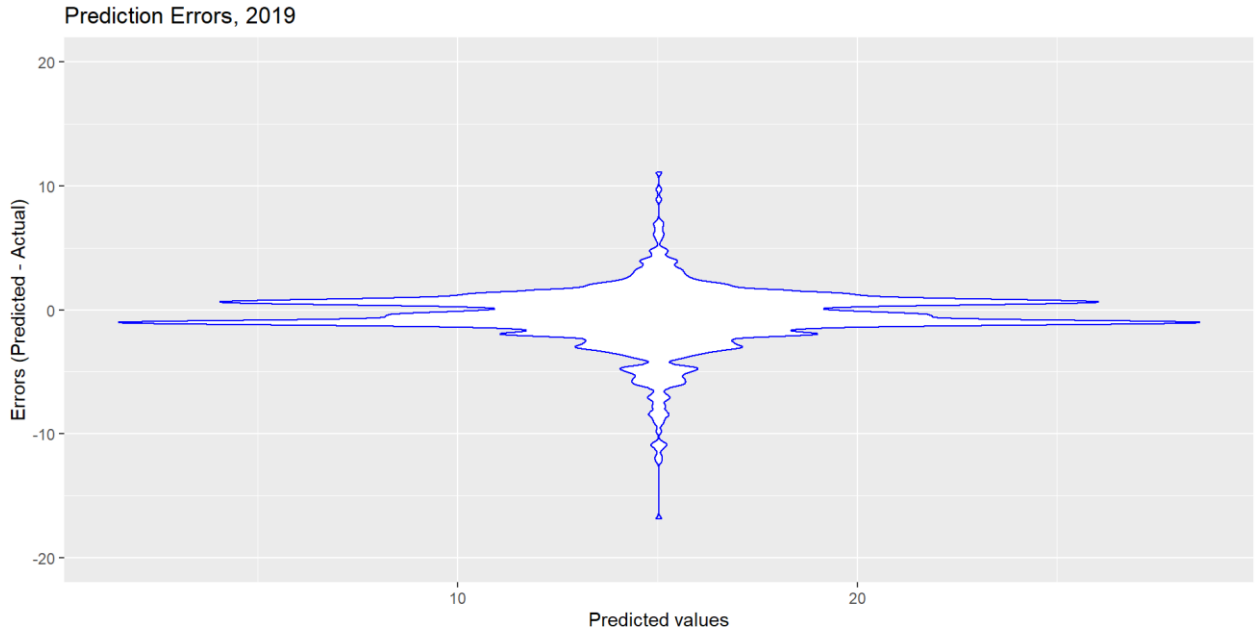
Table 4
Predictions: predicted and actual values, 0 or not 0

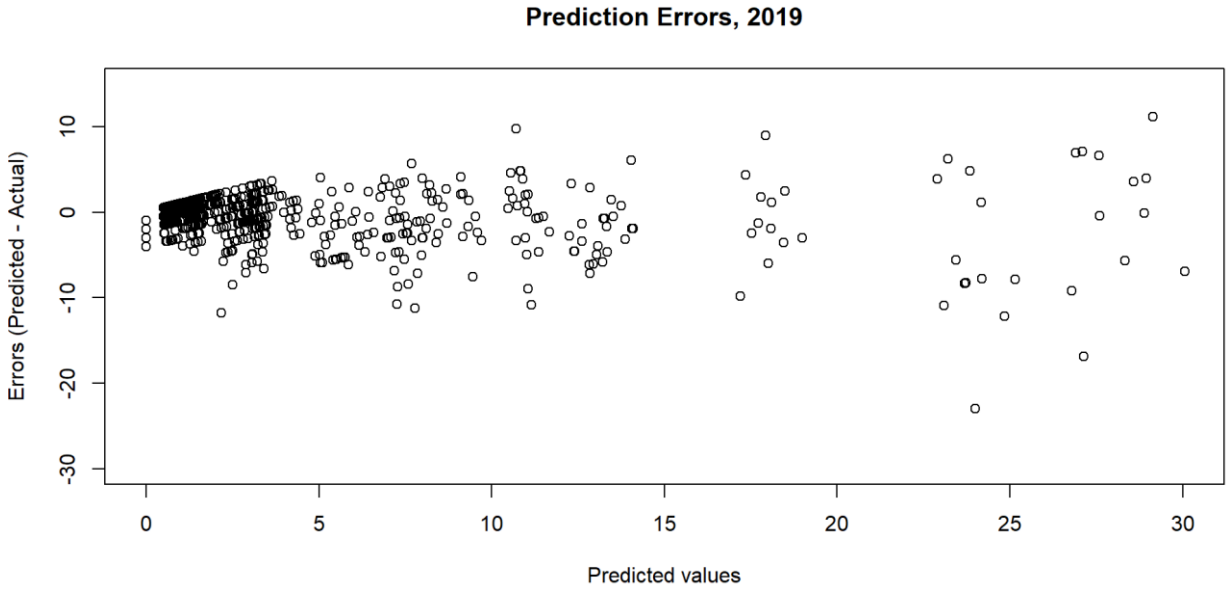
Period	Predicted vs. Actual Values (0 or not 0)			
			Predicted	
2019	**Actual**		0 (below 0.5)	not 0 (above 0.5)
		0	22208 (57.86%)	3296 (8.59%)
		not 0	3648 (9.5%)	9232 (24.05%)
			Predicted	
2020-2022	**Actual**		0 (below 0.5)	not 0 (above 0.5)
		0	43072 (51.8%)	4304 (5.18%)
		not 0	18272 (21.97%)	17504 (21.05%)
			Predicted	
2021-2022 (without pandemic data)	**Actual**		0 (below 0.5)	not 0 (above 0.5)
		0	22896 (51.14%)	1504 (3.36%)
		Not 0	10544 (23.55%)	9824 (21.94%)
			Predicted	
2021-2022 (with pandemic data)	**Actual**		0 (below 0.5)	not 0 (above 0.5)
		0	26127 (58.36%)	2234 (4.99%)
		not 0	7313 (16.34%)	9094 (20.31%)

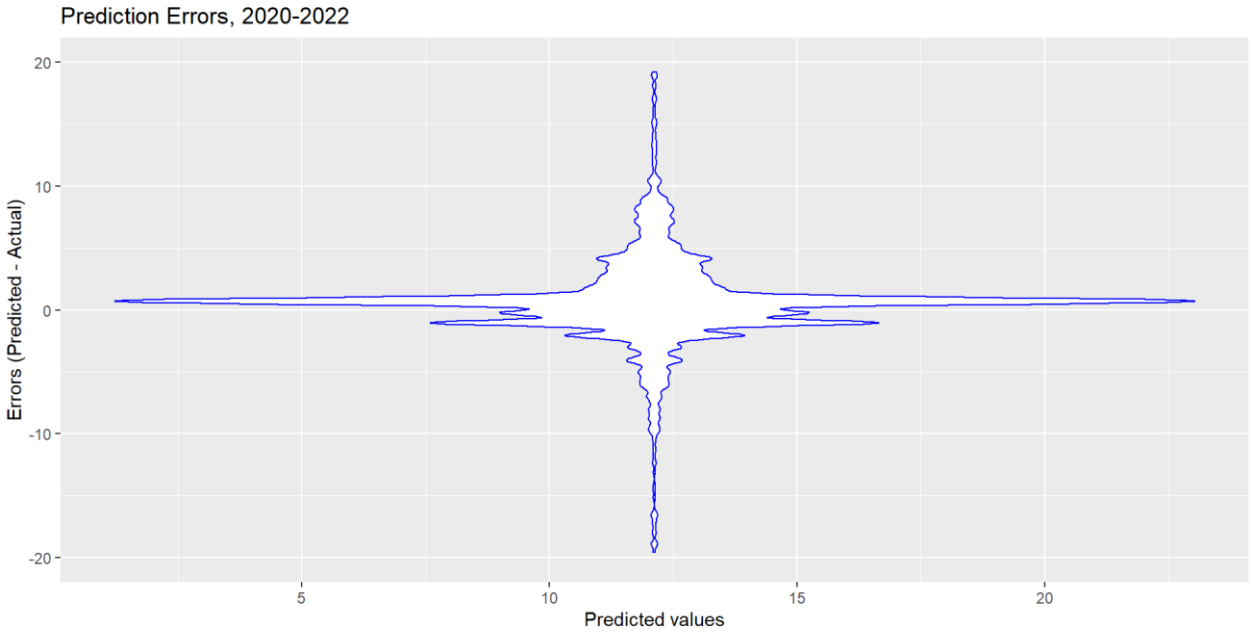
Table 5
Predictions: number of points below and above 45° line in plot of predicted and actual values

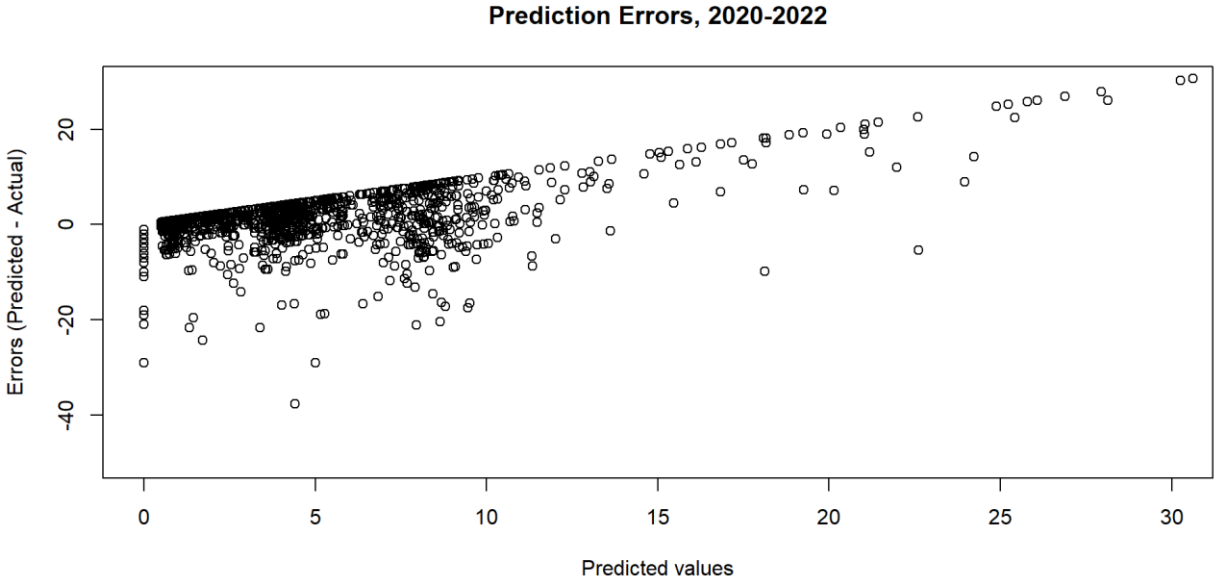
Period	Number of points below 45° line	Number of points above 45° line
2019	2912 (31.54%)	6320 (68.46%)
2020-2022	8320 (47.53%)	9184 (52.47%)
2021-2022 (without pandemic data)	4544 (46.25%)	5280 (53.75%)
2021-2022 (with pandemic data)	3088 (33.96%)	6006 (66.04%)

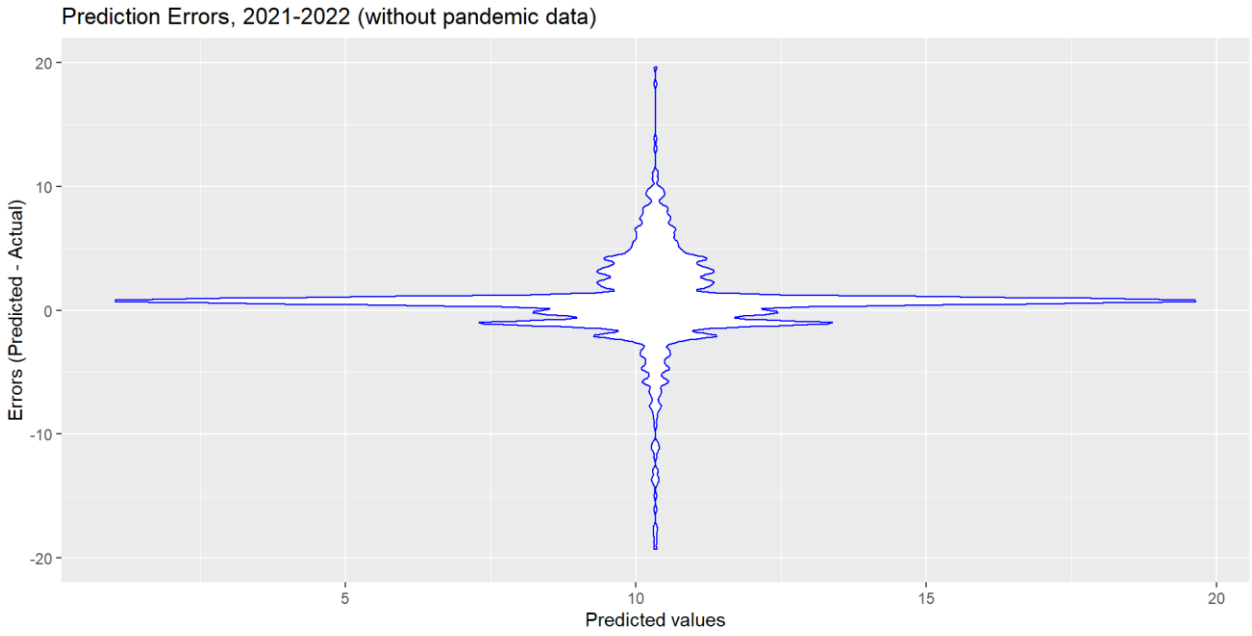
ii. Plots: Prediction Errors (non-zero)

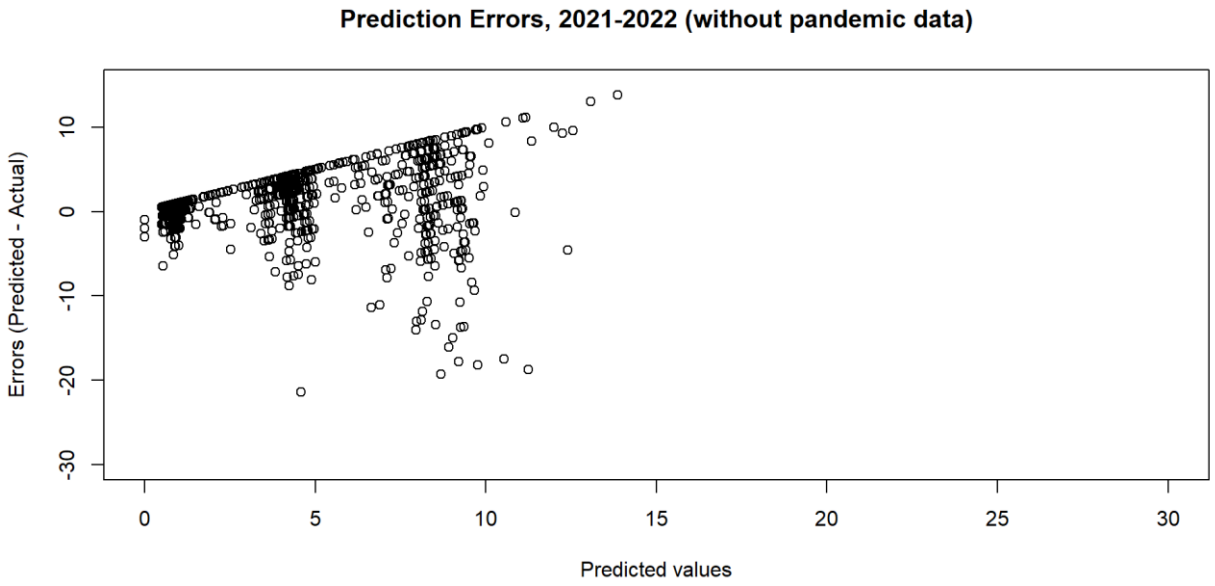


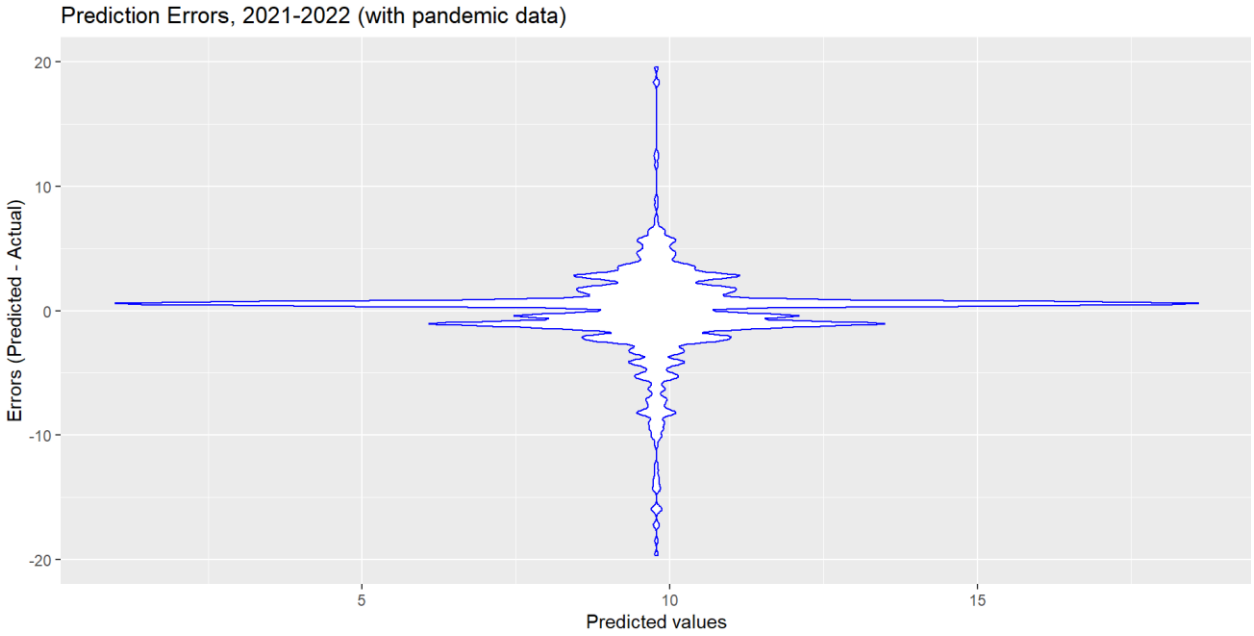


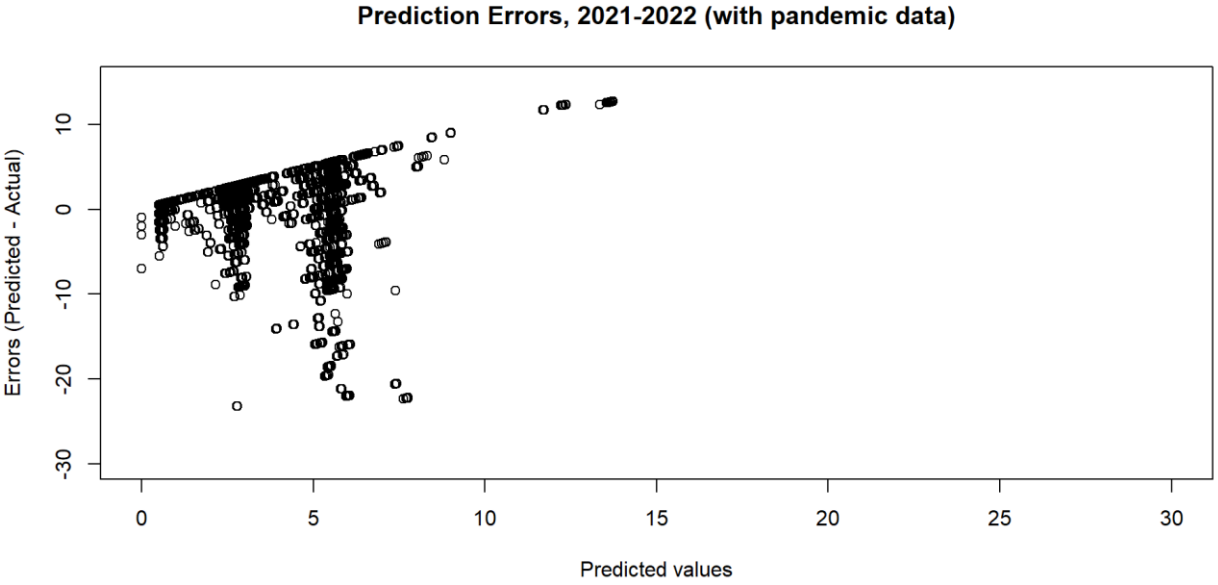

Prediction Errors, 2020-2022
Errors (Predicted - Actual)
20
10
0
-10
-20
5
10
15
20
Predicted values


Prediction Errors, 2020-2022
Errors (Predicted - Actual)
20
0
-20
-40
0
5
10
15
20
25
30
Predicted values


Prediction Errors, 2021-2022 (without pandemic data)
Errors (Predicted - Actual)
20
10
0
-10
-20
5
10
15
20
Predicted values


Prediction Errors, 2021-2022 (without pandemic data)
Errors (Predicted - Actual)
10
0
-10
-20
-30
0
5
10
15
20
25
30
Predicted values


Prediction Errors, 2021-2022 (with pandemic data)
Errors (Predicted - Actual)
20
10
0
-10
-20
5
10
15
Predicted values


Prediction Errors, 2021-2022 (with pandemic data)
Errors (Predicted - Actual)
10
0
-10
-20
-30
0
5
10
15
20
25
30
Predicted values

VI. Conclusion

The previous results accord with the previous findings that, in the aggregate, bankruptcies went down during the pandemic. Moreover, it is noticeable that despite controlling for different industry sectors as well as provincial and national frictions that directly resulted from the pandemic, such as lower industry GDPs, restriction levels and indexes, distortions to foreign trade, and financial easing by the central bank, the model still did not fully capture changes in bankruptcy levels. This is evidence that some other external measure influenced firms' decisions to shut down, and that this measure affected different industry sectors differently.

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