Automation and Reallocation:
Will COVID-19 Usher in the Future of Work?

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Abstract

Recent evidence for the U.S. suggests that recessions play a crucial role in promoting automation and the reallocation of productive resources, which in turn increase aggregate productivity and lead to a higher standard of living. I present evidence suggesting that the same is true in Canada. In particular, since the beginning of the information and communications technology revolution, fully all of the Canadian decline in routine job employment occurred during the three recessions. A similar dynamic is likely to transpire during the COVID crisis, and in fact is likely to be more pronounced due to the scale of the recession and the health-related incentives to automate. By constructing industry-level measures of worker exposure to COVID and the fraction of routine employment, I show that the retail, construction, manufacturing, wholesale, and transportation industries are likely to experience the biggest transformations. In these industries, government attempts to maintain the status quo will only delay the process of restructuring. Instead, policies should embrace change and support workers through the transition.

1. Introduction

COVID-19 has engendered the biggest human and economic catastrophe in recent history. It has resulted in over half a million deaths worldwide and shut down entire economies. At its peak in April, more than 5.5 million Canadians had either lost their job or were working fewer than half of their regular hours. Worse, it has disproportionately impacted our most financially vulnerable: low wage earners, part-time employees, the solo self-employed, youth, and recent immigrants.

It is thus difficult to entertain that the crisis may come with silver linings. One of these is the increased solidarity that has developed from the realization that we are all in this together. Another, is the acceleration of automation and reallocation that will increase productivity and the living standard of Canadians. It is the latter legacy, and how best to implement policies that address the realities of the crisis but do not stifle economic transformation, that this paper addresses.

The notion that one should "never waste a good crisis" is particularly apt today. Economic recessions raise the incentives of firms to increase efficiencies through automation and reorganizations. The shock also results in a reallocation of productive resources from less productive (or maladapted) firms to more productive ones, increasing aggregate productivity. A number of recent papers have found evidence for the U.S. that is consistent with these mechanisms. Hershbein and Kahn (2018) show that automation and demand for skills rose most in regions that were hardest hit by the Great Recession. Jaimovich and Siu (2020) demonstrate that since the start of the information and communications technology (ICT) revolution, the downward trend in routine employment is driven almost entirely by permanent losses during recessions.

This paper presents similar evidence for Canada. In particular, I find that all of the routine job losses in Canada have occurred over the last three recessions, and that these jobs don't return. Non-routine employment, on the other hand, is stable during recessions. This suggests that recessions play a crucial role in fostering automation and reallocation in the Canadian economy. This paper also discusses similarities and differences between our current self-induced recession and past ones. This crisis will surely result in a bigger economic transformation, not just because of its scale, but also because firms have added incentives to automate to protect the health of workers and mitigate risks to their operations.

These COVID-specific incentives to automate differ across industries because workers in different industries face different levels of exposure. In addition, the feasibility of automation differs across industries as some have a higher prevalence of routine tasks than others. By quantifying workers' level of exposure and the fraction of jobs that are routine, I show that retail trade is the industry that is likely to experience the biggest transformation, along with construction, manufacturing, wholesale trade, and transportation. Policies that attempt to maintain the status-quo would thus be particularly damaging in these industries.

The paper proceeds as follows. The next section presents a literature review on the impact of recessions on aggregate productivity growth. Section 3 presents evidence for Canada suggesting that automation occurs during recessions. Section 4 discusses the extent to which this recession is likely to have similar (or bigger) transformational impacts as recent recessions, and section 5 shows how this might differ across Canadian industries. Section 6 discusses policy considerations while section 7 concludes.

2. Recessions and Automation

Since at least Schumpeter's (1942) writings on the gale of creative destruction, we have known that our economy is a dynamic entity where process and product innovation drive the incessant creation and destruction of products, jobs and firms. This innovation, whether it be process innovation that lowers input costs or product innovation that results in higher value-added outputs, propels aggregate productivity growth. We can also distinguish between *internal* innovations that improve a firm's existing product lines, and *external* innovations that allow firms to capture markets from others (Akcigit and Kerr 2018). Internal innovations increase aggregate productivity directly by making firms more productive. External innovations increase aggregate productivity through the reallocation of resources from less productive firms to more productive firms, whether it be within the same industry or not.

The extent to which aggregate productivity growth is driven by within-firm productivity increases versus between-firm reallocation has been the subject of debate for decades (see Foster et al. 2001 for an overview of the early literature). Their relative importance may depend on the sector and the historical period in question. For example, Foster, Haltiwanger, and Krisan (2006) find that productivity increases in the 1990s retail industry were primarily driven by reallocation between firms, and in particular due to entering large national retail chains. Consistent with this,

Akcigit and Kerr's (2018) model finds that the contribution of external innovation to aggregate productivity growth is between two and three times larger than that of internal innovation. On the other hand, a broader study of private businesses over a thirty-year period by Garcia-Macia, Hsieh, and Klenow (2019) concludes that within-firm innovations are relatively more important. For Canada, Baldwin and Gu (2011) find that in manufacturing within-firm productivity growth is relatively more important than between-firm, while in retail the opposite is true. These findings are representative of the wider literature in that both within-firm innovation and between-firm reallocation appear to be important in raising aggregate productivity. Thus, when thinking about the impacts of COVID-19 and possible policy responses, both are considered.

Schumpeter's insights about the dynamic nature of a capitalistic economy also extended to the important role of recessions for bringing about productivity-enhancing transformational change. In his book chapter "Depressions: Can we learn from past experience?" (Schumpeter 1934, p.16), he writes that "depressions are not simply evils, which we might attempt to suppress, but … something which has to be done, namely, adjustment to … change." This view, that recessions are required for restructuring the economy was largely forgotten over the decades that followed.

Davis and Haltiwanger (1992) once again sparked interest in the impact of recessions on aggregate productivity growth by showing that job reallocations (and especially job losses) disproportionately occur during recessions, and tend not to be industry-wide, but rather focused in specific plants. To explain these results, models need to explicitly allow heterogeneity across firms in a given industry, and this heterogeneity needs to interact with the business cycle. One class of models that can generate such results has firms with different abilities to innovate, and innovation incentives that increase during economic downturns. If productivity-enhancing activities (technological upgrading, reorganizations, and training) are disruptive to current production, we should observe more such activities during recessions when the opportunity costs are lower (Hall, 1991; Saint-Paul, 1993; Aghion and Saint-Paul, 1998). This is sometimes referred to as the Schumpeterian opportunity cost hypothesis (Barlevy, 2004; Fabrizio and Tsolmon, 2014). Two alternative explanations for why automation increases during economic downturns are that managers shift attention from growth toward efficiency due to an increased risk of firm failure (Gibbons and Roberts, 2012) and that it changes the relative costs and benefits of layoffs (Berger, 2012).

The 1990s re-examination of the Schumpeterian view that recessions enable technological upgrading is not surprising given that the economy had just experienced a recession and that it was undergoing the ICT revolution. The impact of this revolution on the labour force became the subject of enquiry, led by the seminal work of Autor, Levy, and Murnane (2003). They and others (for example Goos and Manning, 2007; Autor, Katz, and Kearney, 2008; Autor and Dorn, 2013) document the phenomenon of job polarization, whereby technology is displacing routine employment (be it cognitive or manual) in the middle of the skill and wage distribution.

This greater understanding of the ICT revolution's impact on the labour market later allowed a deeper analysis of the Great Recession's impact on automation. The Great Recession accelerated not just the ICT revolution, but also the adoption of some emerging robotics and artificial intelligence technology. Kopytov, Roussanov, and Taschereau-Dumouchel (2018) develop a model to explain the greater share of investments going towards automation (software, information processing equipment, and robots) during the Great Recession, and the associated job polarization.

A number of empirical papers have also documented these trends. Jaimovich and Siu (2020) (Henceforth JS) show that the process of job polarization accelerates during recessions. In particular, routine jobs experienced the biggest declines during each of the last three U.S. recessions and never recovered after the downturn, resulting in the much-publicized jobless recoveries. In fact, 88% of job losses in routine occupations between 1990 and 2017 occurred during the three recessions. Non-routine jobs, on the other hand, experienced only small declines and recovered quickly. Crucially, these dynamics have only been present in the three recessions since the mid-1980s (which coincides with the beginning of the ICT revolution) and not the three previous ones.

Hershbein and Kahn (2018) further show that in U.S. regions that were harder hit by the Great Recession there was more investment in automation technology and a permanent increase in the job skill requirements. Anghel, De la Rica, and Lacuesta (2014) document a similar acceleration in job polarization due to the disappearance of routine jobs during the Great Recession in Spain. Zhang (2019) shows that during economic downturns, firms that employ more routine labour invest more in machines and decrease routine employment.

Taken together, the empirical evidence overwhelmingly points to recessions as important periods of accelerating automation and therefore of increasing productivity. Not only do we

observe a relative increase in investments focused on automation, we also observe job upskilling and a permanent decline in routine jobs.

3. Recessions and Automation in Canada

With the exception of the one paper focused on Spain, all of the evidence discussed so far is for the U.S.. To the best of my knowledge, no similar Canadian studies exist. In this section, I follow a similar methodology to that of JS and show evidence that in Canada too, recessions accelerate job polarization.

I obtain data on monthly employment by 2-digit National Occupational Classification (NOC) from the Labour Force Survey (LFS) for the period from January 1987 to May 2020.[1] I adjust the data for seasonality and apply a low pass filter to remove any fluctuations with frequency higher than the inverse of 18 months.[2] This produces employment curves that retain the shape but are smoothed.

For each occupation, I determine whether the associated tasks are primarily routine or non-routine, and cognitive or manual, using the mapping provided in Table A.1 of Cortes et al. (2014).[3] Table A.1 in the appendix shows the categorization I develop for Canadian NOC codes. For the purposes of the analysis, I only differentiate between routine and non-routine occupations (and not whether they are cognitive or manual) since that is the relevant dimension for determining whether the occupation can be readily automated.

Canadian recessionary periods are defined using data from the Federal Reserve Bank of St. Louis that is based on OECD Composite Leading Indicators of GDP turning points in the growth cycle.[4] A recession is defined as starting in the month following the month containing the peak

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[1] This includes employment of all non-institutionalized civilians aged 15 and over, not living on reserves or in extremely remote areas. Excluded groups represent less than 2% of the Canadian population aged 15 and over. The data is for 40 different occupational groups where all but 2 coincide with a single 2-digit NOC code (the other two are an aggregate of several 2-digit codes).

[2] I use the Stata implementation of the bandpass filter proposed by Christiano and Fitzgerald (2003)

[3] Their table maps U.S. Census Occupational Classifications, and not NOC codes, to each category (non-routine cognitive, non-routine manual, routine cognitive, and routine manual). Most of our 40 occupational groups correspond clearly to a Census major group and hence are easily categorized using the table. For the few occupational groups where the categorization is not obvious, I identify all 4-digit NOC codes within the group, find the corresponding 2010 U.S. Census code for each, and determine the category of the Census code in the table. I then assign a category to the group based on how the majority of the 4-digit occupations that it encompasses are categorized.

[4] Data is available at https://fred.stlouisfed.org/series/CANRECD. Information on the OECD data is available at http://www.oecd.org/sdd/leadingindicators/oecdcompositeleadingindicatorsreferenceturningpointsandcomponentseries.htm

and ending in the month containing the trough (i.e. the trough is included but the peak is not). Throughout, I refer to recessions by the year of the trough. The data shows three significant recessions since 1987: the 1992 recession (from June 1989 to May 1992), the 2009 recession (from September 2007 to July 2009), and the 2016 recession (from October 2014 to June 2016). The last was a mild downturn not always considered an official recession.

Figure 1 presents monthly employment per capita for routine and non-routine jobs for the period 1987-2020, where recessionary periods are shaded in gray. The overall decline in routine jobs is apparent. Between January 1987 and December 2019, routine employment per capita fell by 5.4 percentage points, from 28.2% to 22.9%. Meanwhile, non-routine employment per capita increased by 5.6 percentage points over the same period.

< Figure 1 about here >

The fall in routine employment has not been a steady one. Rather, the figure suggests that routine employment drops precipitously during recessionary periods and is otherwise relatively stable (or even slightly increasing over the late 1990s and early 2000s). In fact, the recessionary periods, in spite of only representing 20% of the time, together account for a 6.5 percentage point drop in routine per capita employment, representing 121% of the total 5.4 percentage point drop between January 1987 and December 2019. If we compare this to the results of JS for the U.S., they suggest that in Canada recessions play an even bigger role in accelerating automation and increasing productivity.

Figure 2 examines each of the three most recent recessions more closely. Employment levels are expressed in terms of percentage deviations from employment at the trough of the recession, and are shown for the three years prior to and following the trough. In all three recessions non-routine jobs are unaffected, while routine jobs account for all of the job losses. More importantly, consistent with these jobs having been automated either directly or through reallocation, they never recover in the years that follow the recession.

< Figure 2 about here >

Overall, these trends are consistent with, and in fact stronger than, those found by JS for the U.S. in their three most recent recessions. The evidence strongly suggests that in Canada too, recessions are crucial periods for automation and reallocation that increase long-run aggregate productivity.

4. Is the COVID Recession Different?

The COVID recession is different from earlier recessions in that it was largely self-imposed. In response to a highly infectious new virus that we knew little about, and for which we were ill-prepared, we took the unprecedented step to forcibly shut down the economy in an effort to reduce its spread. However, even though the trigger for this recession was different, the shock of a generalized shutdown has produced a recession that cannot simply be reversed with a reopening.

Hopes for a v-shaped recovery are misplaced. Demand is unlikely to rebound quickly. Depressed wages and profits, and in many cases increased debt loads, will be a drag on consumer and business spending. The May LFS reported that 22.5% of Canadian households expressed difficulty meeting basic financial obligations. While this is only slightly up from April (21.1%), it is likely to increase markedly when government supports are lifted. A further drag on spending is the lingering uncertainty over the economy and potential new waves of COVID-19.

On the supply side, output is also likely to experience a slow recovery. In the face of uncertainty, firms are unlikely to rush to rehire non-essential workers. In fact, if history is any guide, many firms will choose not to rehire them at all, taking this downturn as an opportunity to automate and reorganize their operations. Because reorganizations take time, they result in a temporary dip in firm output, which exacerbates the recession (Kopytov, Roussanov, and Taschereau-Dumouchel 2018). The COVID pandemic will also result in the downsizing or failure of many firms and the resources that they release will take time to be reallocated to other firms. For example, labour and capital is currently being reallocated from brick and mortar to online stores and services, but the reallocation cannot happen instantaneously as online firms need time to expand and develop efficient operations at greater scale.

Where the COVID recession may be significantly different from previous recessions is in the greater degree of automation induced by COVID-specific health incentives. We have already witnessed a tremendous willingness of organizations to respond to the challenges posed by

COVID by adapting their operations. The April LFS showed that of the 12 million Canadians still working more than 50% of their usual hours, 5 million were mostly working from home (for 2/3 of them this was a change from before the crisis). In spite of some reopening in May, the number held steady at 4.9 million, suggesting that some of these operational changes are likely to remain after the crisis. Moreover, this is likely to be but the beginning. The physical separation and digitization of tasks may mean that they are subsequently more easily offshored or automated with artificial intelligence.

Yet automation is likely to be most prevalent, not among tasks and jobs that can be performed remotely, but rather for the majority that cannot. In these cases, organizations will have added incentives to automate parts of their processes so as to protect the health of their workers by decreasing worker to worker interactions. With the rise of interactive robots, it may be possible to intersperse these throughout their operations so as to replace human-human interactions with human-robot ones (for example, handoffs of intermediate products between one station and the next). What is more, the way for firms to truly mitigate the risks of COVID to their operations, whether it is workers getting sick or workers being ordered by government to stay home, is to completely and fully automate operations.

All of this will amount to a significant labour disruption. It is difficult to estimate exactly how many jobs will permanently disappear over the course of the COVID-19 crisis. Between February and May, seasonally adjusted employment losses totaled 1.27 million routine and 1.44 million non-routine jobs (17.3% and 12.1% of the pre-crisis levels, respectively). If this recession was like previous ones, we might expect these 1.27 million routine jobs to be lost permanently. However, these initial job losses are more related to the lockdown (which explains the also large reduction in non-routine employment) than to firm reorganizations as in previous recessions. It is thus likely that even routine jobs will rebound, yet just how many remains unclear. Adding to the difficulty of estimating permanent job losses is the fact that firm-level automation and between-firm reallocation will continue shedding routine jobs over the course of the ongoing recession.

History may be the best guide for estimating permanent job losses. The 1992, 2009, and 2016 recessions resulted in the loss of 484,000 (8.0% of pre-recession levels), 330,000 (4.6%), and 359,000 (4.9%) routine jobs, respectively. Because of the relative severity of the current crisis, and due to the discussed COVID-specific incentives to automate, it is not unreasonable to expect

routine job losses toward the upper range of 8.0% as in the 1992 recession. This would imply the permanent loss of 586,000 routine jobs (or roughly half of the routine employment losses to date), but with it important gains in productivity.[5]

In the following section we consider which industries are likely to face the biggest health-related incentives to reorganize and which are most likely to be able to do so through automation.

5. Industry Automation Incentives and Opportunities

In addition to the usual recessionary incentives to automate, this COVID-19 crisis overlays health-related incentives that vary by industry. While health care workers face high levels of potential exposure, and hence the motivation for automation is high, agriculture and forestry workers face more limited exposure.

In order to meaningfully discuss which industries face the strongest COVID-19 related incentives to automate, it is necessary to develop industry-level measures of potential worker exposure. To proxy for the degree of exposure, I use measures of occupational physical proximity and face-to-face discussions developed by the Vancouver School of Economics COVID-19 Research Program based on data from the Occupational Information Network.[6] *Proximity* refers to the extent that the job requires close physical proximity to other people, and is ranked on a scale of 1 (do not work near other people) to 5 (work very close to other people).[7] *Face-to-face* refers to how often workers in the occupation have face-to-face discussions with individuals or teams, and is also ranked on a scale of 1 (never) to 5 (every day).[8] Of the two variables, *proximity* is likely the better measure of exposure since some of what it captures is the necessity to perform physical tasks in person, whereas *face-to-face* discussions may more easily be moved online and not require automation to mitigate risks. *Face-to-face* is also less interesting in that it has relatively little useful variation; 97% of 4-digit occupations have scores between 4 (once a week or more) and 5 (every day).

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[5] Barrero, Bloom, and Davis (2020) estimate that in the U.S. 42% of COVID job losses will be permanent.
[6] A user guide for their COVID risk/reward assessment tool, including a description of the variables used, is available at: https://www.dropbox.com/s/5lvfyki4lfxw0ob/VSE%20Risk%20Tool%20Users%20Guide.pdf?dl=0
[7] The full scale for physical proximity is 1:do not work near other people, 2:work with others but not closely (e.g. private office), 3:slightly close (e. g. shared office), 4:moderately close (at arm's length), 5:very close (near touching).
[8] The full scale for face-to-face discussions is 1: never, 2: once a year or more, but not every month, 3: once a month or more, but not every week, 4: once a week or more, but not every day, and 5: every day.

To construct the industry level measure of exposure, for each industry I compute the weighted average of the level of exposure (*proximity* or *face-to-face*) faced by each occupation employed in that industry. The weights are the fraction of individuals employed in that industry that are in each of the occupations (the number of individuals employed in each occupation-industry were obtained from the 2016 Census Public Use Microdata File).

Of course, just because there are incentives to automate a sector does not mean that it will be possible to do so. For instance, health care may experience high incentives to automate but it is not clear that significant automation is feasible given current technologies. I construct a measure of feasibility of automation using the routine/non-routine categorization of occupations. To obtain an industry-level measure, I compute the fraction of workers in that industry that are in occupations that have been characterized as routine (once again using the 2016 Census Public Use Microdata File).

Using the measures of automation incentives and feasibility, we can examine which industries are most likely to actually undergo significant automation as a result of the COVID crisis. Figure 3 presents a scatterplot of the average physical proximity score (y-axis) and the degree of routineness (x-axis) for each of 19 NAICS industries. The average physical proximity scores of occupations within each industry, range from 3 (slightly close, sharing an office) to 4 (moderately close, at arm's length). Health care and social assistance is by far the industry requiring closest physical proximity, though education, accommodation and food services, and retail trade also exhibit high levels of average physical proximity. But on the dimension of automatability, health care and retail trade differ markedly.

< Figure 3 about here >

Industries toward the upper right of the figure are most likely to experience automation as a result of the COVID crisis. The most likely candidates are retail trade, but also construction, manufacturing, wholesale trade, and transportation. These industries not only have many routine tasks that are automatable, but workers in those industries also face significant exposure to COVID, giving organizations added incentives to automate.

Figure 4 presents a similar analysis but with the extent of face-to-face discussions as a proxy for COVID-specific incentives to automation. The results are similar. Retail trade

continues to appear as the most poised for automation, but other good candidates are real estate, wholesale trade, construction, manufacturing, and mining and oil.

< Figure 4 about here >

Overall, the analysis suggests that while the COVID crisis is likely to result in significant automation and reallocation that will increase aggregate productivity, the degree of transformation is likely to differ substantially across sectors.

6. Policy Considerations

Government economic responses to the COVID crisis to date have focused on supporting businesses to ensure their survival, subsidizing wages so fewer Canadians lose their jobs, and offering financial support to Canadians who did lose their job. In short, the focus has been on maintaining the economy on life support, and rightly so. But in the coming months we must start shifting from a policy of survival and maintenance of the status quo, toward one that embraces transformational change.

The productivity upgrading of our economy will occur in two ways. First, through the direct automation and reorganization by firms. Second, through the reallocation of resources from less productive firms that are shrinking or outright failing, to more productive growing ones. If our economy is to emerge from this crisis stronger, these mechanisms need to be encouraged, or at the very least not stymied. With this broader strategic objective in mind, policies that target firms, industries, and individuals are considered in turn.

Policies Targeting Businesses

The most significant economic policies targeting firms are wage subsidies and increased access to credit. The Canada Emergency Wage Subsidy (CEWS) blunts the incentives of firms to automate by artificially reducing the cost of labour, and this at the exact time that opportunity costs for reorganizing operations are low. For example, while it might be profitable to automate the tasks being performed by a worker earning $20 per hour, it is unlikely to be profitable if the firm's cost is $5 per hour (after the 75% wage subsidy). In the best-case scenario, the productivity enhancing investment will be merely delayed, in the worst-case scenario it will

never occur if by the time the subsidy is lifted opportunity costs are again too high or the firm can no longer compete with firms in other jurisdictions that did engage in productivity upgrades.

The CEWS and the multitude of financing and loans programs being offered to businesses on preferential terms all represent subsidies that have the potential to prop up inefficient firms, or ones that have been made obsolete by COVID-19. The crisis will cause large and persistent shifts in demand patterns (less demand for international travel, eat-in restaurants, in-person shopping) so that without subsidies many firms either wouldn't survive the crisis or would shrink in size. These subsidies are costly, not just due to their burden on the tax payer, but also because they may slow the reallocation of productive resources from less to more efficient (or less to more adapted) firms, and thus lessen the productivity enhancing role of recessions. Such subsidies could also lengthen the time to recovery.

To be sure, a delicate policy balance must be achieved between supporting good firms that might otherwise not survive the COVID shock and allowing the process of Creative Destruction to play its role. A 75% wage subsidy might have been warranted early in the crisis, but it almost surely won't be once the worst of the shock is behind us. As we move through this crisis, we must shift from policies that attempt to maintain the status-quo to ones that foster innovation and reorganization, within both firms and industries. Such supports for innovation might be especially critical if firms have the will and know-how to reorganize, but not the financial strength to do so due to the crisis. In this regard, the recently announced $58M Ontario Investment for Adoption of Digital Technologies is a great initiative that can hopefully pave the way for bigger ones like it. To go along with such investments, we also need to develop programs that help mobilize the tremendous expertise in robotics and artificial intelligence that reside in our universities and research centres for the benefit of Canadian businesses.

Policies Targeting Industries

The federal government has announced numerous measures to support specific industries during the crisis. Many of these are aimed at the agriculture, agri-food and fisheries sector, which are strategically important for food security. In addition, special supports have also been put in place for the culture, heritage, and sport, air transportation, tourism, and higher education/ research industries. However, the most significant supports (CEWS and loans) apply equally across all industries.

This is problematic because the impact of the COVID crisis, and in particular the relative costs and benefits of economic supports, differ widely by sector. Retail trade is undergoing a massive transformation. Individual organizations are embarking on major automation efforts. In physical stores this is spurred on by the tougher economic times, in online stores by a need to increase capacity, and in both cases by the necessity to limit the COVID exposure of workers. Yet the biggest component of the transformation is not within firms, but across them, in the form of a reallocation of market share and resources. Within this context, wage subsidies that attempt to maintain jobs are largely futile. In the case of expanding firms, they have little impact on employment and only serve as a transfer from tax payers to (mostly large) firms. In the case of contracting firms, they only temporarily save jobs, slowing the process of reallocation and recovery.

While retail is the clearest example of an industry where generous wage and loan supports seem counter-productive (it resides in the top right quadrant of figure 3), other industries like construction, manufacturing, and transportation present similarly poor cases for government wage or loan subsidies. Instead, these industries could be offered supports that target R&D, innovation, and technological transformation.

At the other extreme, industries in the top left quadrant (health care, education, accommodation and food services) present a good case for maintenance policies. Not only are they disproportionately impacted by COVID due to the high level of exposure of their employees, but government support in these sectors is less likely to stifle reorganizations.

As we move forward and leave behind the worst of this crisis, which in economic terms was probably in mid-April, it is important that the current broad business supports are not renewed as they are set to expire. Instead, smaller, more targeted interventions, should be deployed on an industry by industry basis.

Policies Targeting Individuals

Often lost in the shuffle of economic transformations are the individuals whose job has been affected. While investing in automation and facilitating reallocation are crucial to ensure continued aggregate productivity growth and the increasing standard of living of Canadians, it can carry a real human cost. Policies need to be in place to help individuals navigate the health crisis and ensuing economic transformation.

The most significant policy introduced to help individuals through the crisis is the Canada Emergency Response Benefit (CERB). It has been crucial in ensuring that people can stay home and still financially navigate the health crisis. It is not wholly without reproach, as it is well established that jobless benefits slow the reallocation of workers because they have less incentive to find new jobs (Katz and Meyer, 1990; Krueger and Mueller, 2010). But the current situation is one where working generates negative externalities in the form of increased infection rates.

Regardless, the CERB is in place because individuals need it. Even as we move beyond the health crisis, some form of support will be required to navigate the upheaval of economic transformation. This should take the form of some continued financial support (an extended CERB, employment insurance, or a different program altogether) but also retraining programs for workers whose jobs have been automated or reallocated.

This crisis may in fact be an opportunity to reimagine Canada's social safety net. COVID has generated a sense of solidarity and a newfound conviction about the important role of government. It has therefore created an opportunity to build institutions that will help Canadians not just through this current crisis, but also through future ones. We could consider, for example, a universal basic income that would replace not just the CERB, but other current benefits, simplifying programs and ensuring that all Canadians enjoy a minimum standard of living regardless of circumstances.

7. Conclusion

In drafting the appropriate response to the COVID pandemic and its aftermath, it is important to consider its many facets. This paper makes the case that recessions, and this COVID crisis in particular, are periods of rapid automation and reorganization that are important to long run aggregate productivity growth. Any policy should thus be seen within this context and evaluated for whether it is likely to facilitate or hinder technological change and reallocation.

Put differently, it is time to start shifting from reactive policies designed to maintain the status-quo to strategic policies designed to ensure that we emerge stronger from the crisis. For years, the AI and robotics revolution has appeared on the horizon as a bogeyman that will steal countless jobs. But to only see it as a challenge to be mitigated is to miss the point that automation will make Canadians richer and jobs more meaningful by removing the menial tasks.

It is a change that will come, and our choices are twofold: how quickly to adopt it, and what governance to put in place so that all Canadians benefit.

With respect to the first choice, faster is better. We are at an inflection point where the right policies can usher in rapid technological change and productivity increases. True, these will generate a period of significant labour market upheaval as jobs are transformed, destroyed, and created. But now is the time to undergo such a transformation. The opportunity cost is lower because labour markets are already disrupted by the pandemic. Our choice is whether to pull off the band-aid slowly (and perhaps multiple times) or quickly, and emerge out the other end stronger.

There is a further reason why now is the time to embrace change, and it relates to our second choice. This crisis has created a sense of solidarity, that we are all in this together. It has also shaped a strong belief in the important role of government. This is an historic opportunity to rethink our social safety net, not just to help individuals weather the transition, but also to ensure all Canadians share in the benefits of automation now, and for generations to come.

It is hard to imagine a silver lining from this COVID pandemic, but with the right vision and leadership a richer and fairer Canada may emerge.

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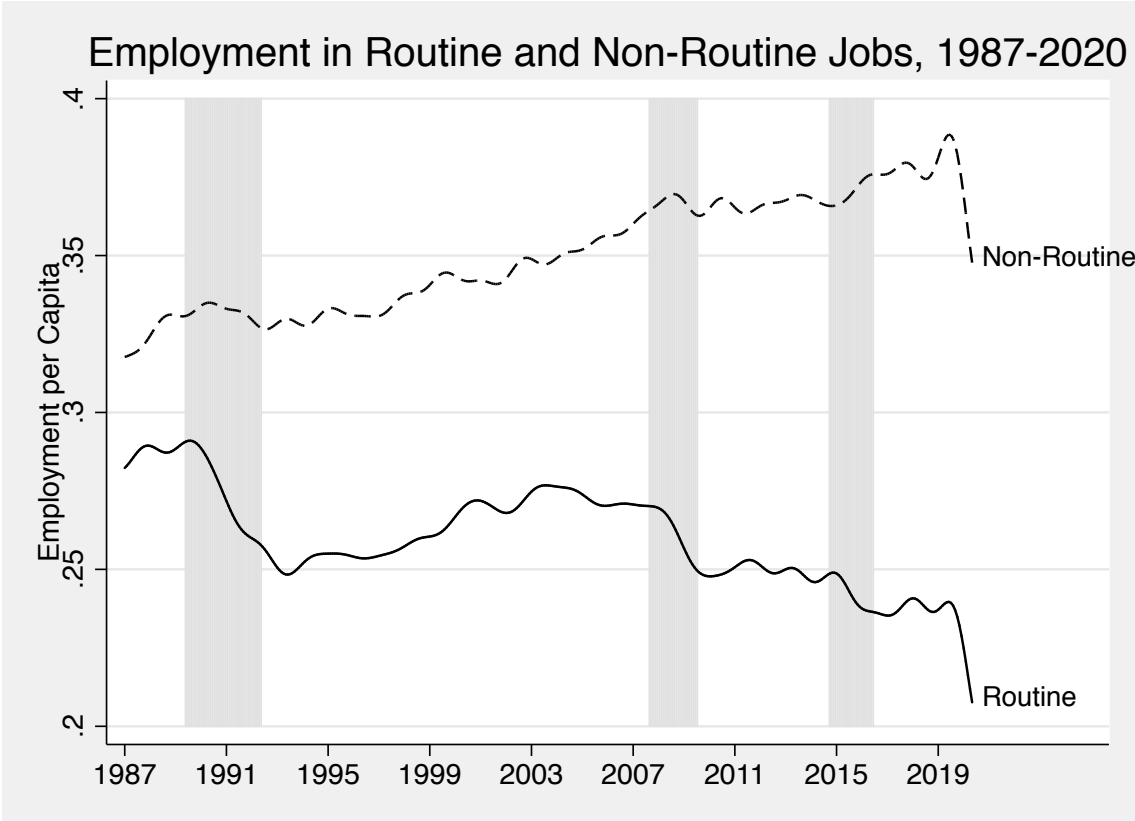
Figures

Figure 1: Monthly employment in routine and non-routine jobs between January 1987 and May 2020
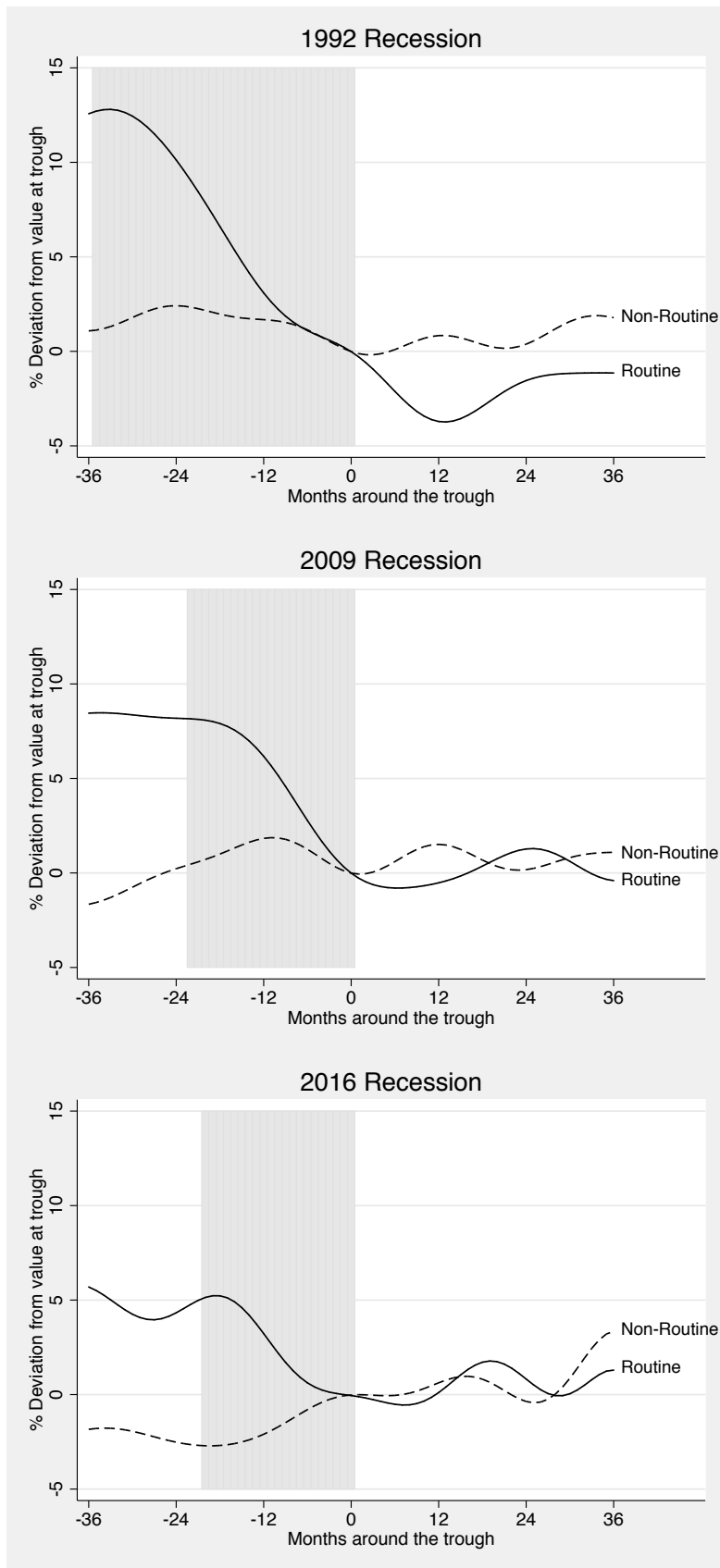
Figure 2: Monthly employment in routine and non-routine jobs for the 1992, 2009, and 2016 recessions
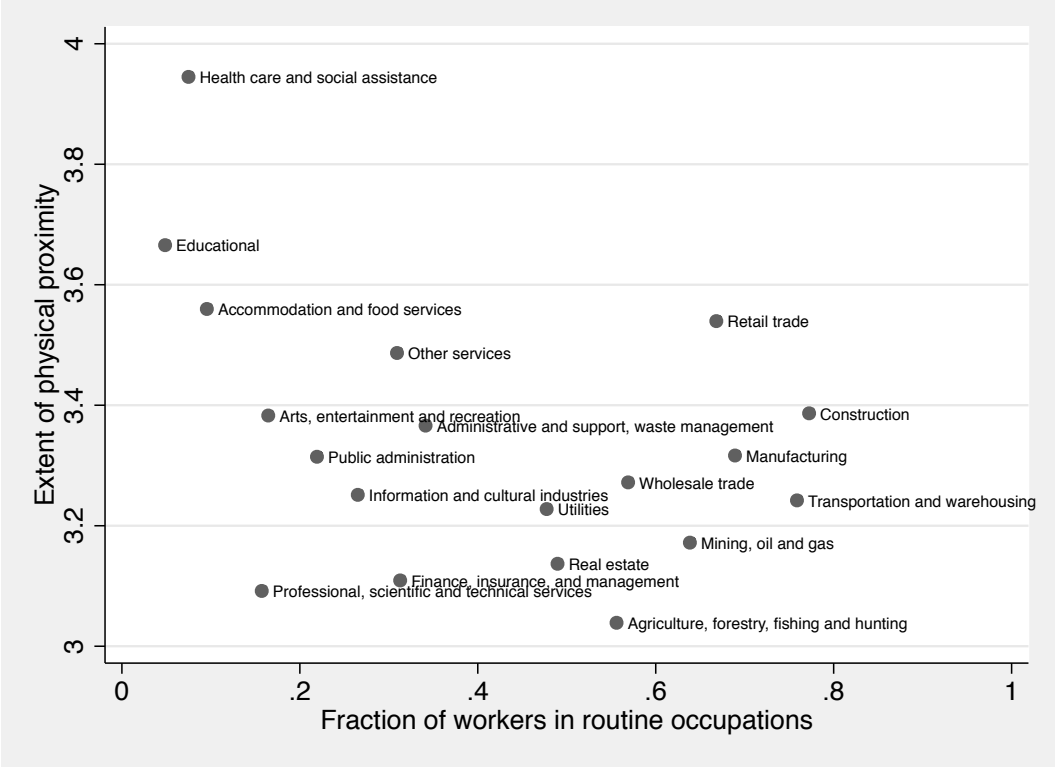
Figure 3: Extent of physical proximity and fraction of tasks that are routine for 19 different NAICS industries
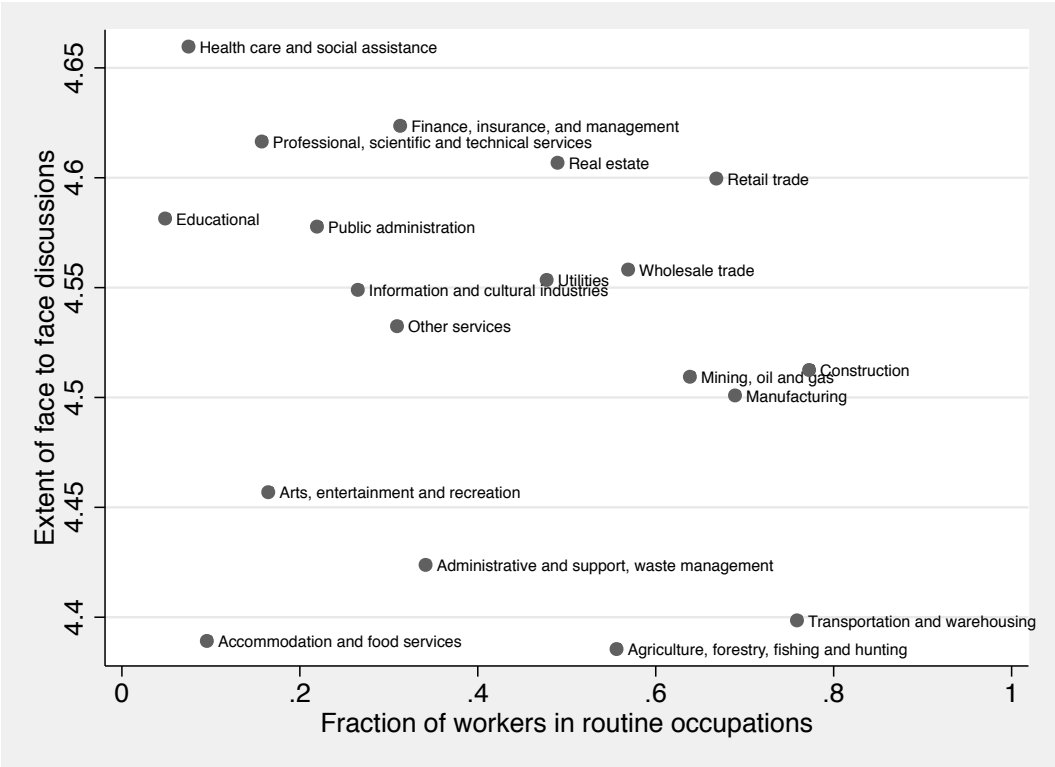

Figure 4: Extent of face-to-face discussions and fraction of tasks that are routine for 19 different NAICS industries

Appendix

	Non-Routine	Routine
Cognitive	00 Senior management 01-05 Specialized middle management 06 Middle management in retail and wholesale 07-09 Middle management in trades, transportation, production 11 Professionals in business and finance 12 Administrative and financial supervisors and administrative 21 Professionals in natural and applied sciences 22 Natural and applied sciences technicians 30 Nursing professionals 31 Health professionals 32 Health technicians 40 Education professionals 41 Professionals in law, social, community, and government 42 Paraprofessionals in law, social, community, and education 51 Professionals in art and culture 52 Technicians in art, culture, recreation, and sport	13 Finance and insurance administrative 14 Office support 15 Distribution, tracking, and scheduling 62 Retail sales supervisors and specialised sales 64 Sales representatives and salespersons - retail and wholesale
Manual	34 Health support workers 43 Front-line public protection services 44 Care providers and education, legal, and public protection support 63 Service supervisors and specialised service occupations 65 Service representatives and personal services 67 Service support	66 Sales support 72 Industrial, electrical and construction trades 73 Maintenance and equipment operation trades 74 Other installers, repairers, and servicers and material handlers 75 Transport and heavy equipment operators and maintenance 76 Trades helpers and construction labourers 82 Supervisors and technicians in natural resources and agriculture 84 Workers in natural resources and agriculture 86 Harvesting, landscaping, and natural resources labourers 92 Processing and manufacturing supervisors and control operators 94 Processing and manufacturing machine operators 95 Assemblers in manufacturing 96 Labourers in processing, manufacturing and utilities

Table A.1: Categorization of 2-digit NOC occupations by routine/non-routine and cognitive/manual