

HAS THE CANADIAN LABOUR MARKET POLARIZED?

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We use Census and Labour Force Survey (LFS) data for the period from 1971 to 2012 to investigate whether the Canadian wage and employment structures have polarized, that is, whether wages and employment have grown more in high and low than in middle paying occupations. We find that there has been faster growth in employment in both high and low paying occupations than those in the middle since 1981. However, up to 2005, the wage pattern reflects a simple increase in inequality with greater growth in high paid than middle paid occupations and greater growth in middle than low paid occupations. Since 2005, there has been some polarization but this is present only in some parts of the country and seems to be related more to the resource boom than technological change. We present results for the US to provide a benchmark. The Canadian patterns fit with those in the US and other countries apart from the 1990s when the US undergoes wage polarization not seen elsewhere. We argue that the Canadian data do not fit with the standard technological change model of polarization developed for the U.S..

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1. INTRODUCTION

A growing body of research has demonstrated that over the past several decades, employment growth in the U.S. and other advanced economies has been characterized by a marked pattern of ‘job polarization’ (See, for example, [Acemoglu and Autor \(2010\)](#)). Job polarization occurs when the shares of employment accounted for by high-skill and low-skill jobs grow faster than the employment share accounted for by middle-skill jobs. The most widely hypothesized explanation for this employment growth pattern is a nuanced version of skill-biased technological change based on the “routinization” model developed by [Autor, Levy, and Murnane \(2003\)](#).

The causes and consequences of these shifts in the occupation structure have attracted the attention of policy makers and economists alike, particularly in light of the most recent recession in which many more blue- and white-collar, middle-paying jobs were shed relative to professional jobs and jobs in the service sector ([Economist, 2010](#)). The loss of good jobs with wages that could provide financial security for less educated workers raises the spectre of an increasingly unequal society. Moreover, the loss of those jobs could have spill-over effects that imply further wage declines in low-end, service sector jobs ([Beaudry, Green, and Sand \(2012\)](#)).

While polarization has been extensively studied in the U.S. and, to some extent, Europe, to this point there has been no investigation of whether or to what extent this pattern has emerged in the Canadian labour market. The goal of this paper is to provide evidence on changes in wage inequality and on employment and wage polarization for the period from 1970 to 2011. The results are potentially interesting for Canadian policy discussions but are also useful when compared to other countries. Several papers make comparisons in employment and wage polarization patterns across countries with the goal of using differences to evaluate theories of the source of the patterns (for example, [Goos, Manning, and Salomons \(2009\)](#) and [Antonczyk, DeLeire, and Fitzenberger \(2010\)](#)). For example, it is commonly argued that shifts that are common across economies may point to explanations based on technological change or outsourcing while differences in shifts may point to explanations based on changes in economic institutions ([Berman, Bound, and Machin, 1998](#)). In this regard, Canada, whose institutional and labour market features lie somewhere between those of the U.S. and continental Europe (see, for example, [Card, Kramarz, and Lemieux \(1999\)](#)), may be of particular interest. Because of this, we begin the paper with a brief overview of the literature, with an emphasis on describing the differences or similarities of patterns across countries. A key point from that literature is that it is “centred” on the U.S. in the sense that studies for other countries often compare their patterns to U.S., that the main models developed to explain these patterns pertain most directly to U.S., and that the bulk of the literature examines U.S. data. Based on this, we will present results from U.S. data alongside the Canadian patterns to allow readers to link our results to what is known in the

literature. We don't uncover anything new in the U.S. data, but by using the same methods on Canadian and U.S. data we insure cleaner comparisons than if we simply referenced results from papers based on the U.S..

We make use of three datasets in our investigation. The first is Canadian Census data for each available year between 1971 and 2006. As argued in [Frenette, Green, and Milligan \(2007\)](#) and [Boudarbat, Lemieux, and Riddell \(2010a\)](#), the Census (prior to the change in procedures in 2011) provides the most consistent data for comparisons in wage and earnings movements over time. However, we are also interested in patterns after 2006 and for that we use the Labour Force Survey (LFS). We demonstrate that the LFS and the Census generate substantially similar wage patterns in the years of overlap (2000 to 2005).¹ For U.S. comparisons, we use data from the 1970, 1980, 1990, and 2000 U.S. Censuses and from the 2007 American Community Survey.

Our key findings are that Canada experienced a polarization in employment before 2000 that is much like that in the U.S., the U.K. and European countries. In all countries, both high- and low-paying occupations experience employment growth relative to middle-skill occupations in the 1980s and 1990s.² In terms of wage movements, the Canadian data reveal a pattern of a simple increase in inequality with wages in low-skill occupations falling relative to those in middle-skill occupations and middle-skill occupations falling behind high-skill occupations. This is similar to what has been found for the U.K. and European countries and for the U.S. after 2000 but differs strongly from the pattern of wage polarization observed for the U.S. in the 1990s. Based on this, we argue that the most common model of technological change in which technologically induced demand shifts generate wage and employment increases in both tails of the skill distribution is, at best, only partly applicable to Canada. For Canada, changes in wages and employment in the lower tail of the distribution look more like the outcome of an outward supply shift than a demand shift. We also show that any explanation for Canada needs to take account of the resource boom in the West after 2000.

The paper proceeds in six sections including the introduction. In the second section, we provide a brief overview of the literature. In section three, we describe our data and our empirical approach. The fourth section contains the results. These consist of descriptions of movements in wage inequality and then in employment and wage growth by occupation. We then look at more detailed occupational descriptions and breakdowns by gender. We also provide results separately for Ontario and Alberta after 2000 when there appears to be a regional divergence in wage and employment patterns. In section 5, we provide a discussion of the empirical results in relation to patterns that have been documented for other countries and to the main model used to explain the patterns.

¹Questions on wages were not asked in the LFS until 1997.

²As we explain later, the finding that polarization in the U.S. started before 1990 is somewhat controversial but fits with [Lefter and Sand \(2010\)](#) who provide an explanation for why the earlier literature comes to a different conclusion.

Section 6 concludes.

2. PREVIOUS LITERATURE

Job polarization is strongly related to the extensive literature that examines wage inequality and its causes. Much of the early literature had a strong U.S. focus and began by documenting the changes in the U.S. wage structure that started in the late 1970s and accelerated through the 1980s. These changes in the wage structure were in stark contrast to a period of relative stability in wage inequality during previous decades. Much of the attention in the early literature was on a documented substantial growth in the wage differential between college and less-than college educated workers. Since this was accompanied by an increase in the employment of the college educated relative to the non-college educated, a key conclusion from the literature was that the U.S. was experiencing the effects of a relative demand shift favouring more skilled workers ([Katz and Murphy \(1992\)](#), [Bound and Johnson \(1992\)](#), and [Juhn, Murphy, and Pierce \(1993\)](#)). While institutional factors were given consideration ([Card \(1992\)](#); [DiNardo, Fortin, and Lemieux \(1996\)](#)), the most common explanation for this shift was that it reflected a skill biased technical change (SBTC) that was likely related to the onset of the computer revolution.

With the incorporation of data from the 1990s, several authors questioned whether a model with a simple skill biased technical change offset by shifts in the supply of college educated workers could really explain the data ([Card and DiNardo \(2002\)](#), [Beaudry and Green \(2005\)](#) and ([Lemieux, 2006](#))). For Canada, initial investigations claimed that the Canadian data fit with the skill biased technical change model, though in a subtle way. Using data from the Survey of Consumer Finances, [Freeman and Needels \(1993\)](#), [Murphy, Riddell, and Romer \(1998\)](#), and [Burbidge, Magee, and Robb \(2002\)](#) all portray the Canadian skill premium as essentially flat through the 1980s. These authors argued that this reflected a skill-biased demand shift fully offset by a supply shift (a relative increase in the proportion of the workforce with a university degree) that occurred approximately a decade after a similar shift in the U.S.. However, [Beaudry and Green \(1998\)](#) show that the premium actually rose in this decade when one concentrates on younger workers – the very people whose wages should have been most affected by any relative supply shift. Furthermore, [Boudarbat, Lemieux, and Riddell \(2010b\)](#) argue that the earlier finding of a flat premium in the 1980s actually reflects a combination of the data set being used, the use of weekly rather than hourly wages, and a lack of controls for shifts in the age structure. Once they take account of these factors, [Boudarbat, Lemieux, and Riddell \(2010b\)](#) find the same pattern as [Beaudry and Green \(1998\)](#).

Partially in response to these criticisms, a number of papers have argued for a more nuanced version of SBTC that is “based on a more realistic model of how computerization affects task demands” ([Autor, Katz, and Kearney, 2008](#)). In particular, [Autor, Levy, and Murnane \(2003\)](#) offer a model of computer adop-

tion that is based on the types of worker-tasks that computers are likely to either complement or replace. In their framework, computing technology complements high-skill workers who perform non-routine cognitive tasks and substitutes for workers performing routine tasks that are based on well-defined rules and procedures. Based on this idea, [Goos and Manning \(2007\)](#) suggest that computer technology can have non-monotonic effects on the demand for occupations ranked by wages. They show that high-wage occupations tend to be intensive in non-routine tasks, while middle-wage occupations are more likely to involve routine tasks. The very lowest-wage occupations, such as service occupations, are likely to be intensive in non-routine manual tasks. Therefore, computing technology should increase employment in the highest and lowest paid occupations relative to occupations in the middle of the wage distribution. [Goos and Manning \(2007\)](#) refer to this as a ‘polarization’ of jobs, and find evidence in favour of this ‘routinization’ hypothesis in U.K. occupational employment changes since the late 1970s.

Building on this insight, [Autor, Katz, and Kearney \(2006\)](#) and [Autor, Katz, and Kearney \(2008\)](#) follow the same general approach using U.S. Census data. [Autor, Katz, and Kearney \(2008\)](#) rank occupations based on either average occupational wages or average years of schooling and sort occupations into percentiles of employment in 1980. They then examine the percentage change in employment in each occupational skill-percentile and find that the 1980s were characterized by a change in demand that was monotonic in skill. That is, employment, in relative terms, fell for the lowest-skilled occupations and increased in each successive skill percentile. In contrast, during the 1990s, they find that employment fell for occupations in the middle of the occupational skill distribution and grew at both the top- and bottom-end of the skill distribution. The patterns of changes in occupation composition mirror closely the observed changes in the U.S. wage structure over the 1980s and the 1990s. In particular, monotonic shifts in occupational employment over the 1980s match a monotonic growth in wage inequality in the same decade, while polarization of employment in the 1990s coincides with a matching polarization of wage growth. [Autor, Katz, and Kearney \(2008\)](#) argue that this correspondence of changes in occupational employment and wages is supportive of the hypothesis that changes in demand are a proximate cause of changes in the wage structure between the 1980s and the 1990s.

A number of papers have since followed this framework for measuring demand shifts. Using German data, [Dustmann, Ludsteck, and Schoenberg \(2009\)](#) show that employment polarized over both the 1980s and the 1990s. [Goos, Manning, and Salomons \(2009\)](#) document that employment grew in high-wage and low-wage occupations relative to middle-paying occupations in 16 European Union countries between 1993 and 2006. [Spitz-Oener \(2006\)](#), using German data on occupational task intensities, shows that changes in the type of tasks performed over the past several decades closely correspond to the ALM hypothesis. In a recent paper, [Kampelmann and Rycx \(2011\)](#) confirm polarization in occupations in Germany over the longer period from 1985-2008. To this point, though, there

has been no attempt to investigate whether the same patterns are present in Canadian data.

While there appears to be international evidence of job polarization, there is also evidence that the timing of the phenomenon is not uniform across countries. The U.S. literature suggests that the occupational structure began to polarize in the 1990s relative to the 1980s. In contrast, [Goos and Manning \(2007\)](#) find that the job structure polarized over a longer period from the late 1970s to the early 2000s in the U.K., and [Dustmann, Ludsteck, and Schoenberg \(2009\)](#), [Spitz-Oener \(2006\)](#), and [Kampelmann and Rycx \(2011\)](#) find that Germany exhibited a polarized occupation structure in both the 1980s and the 1990s. [Lefter and Sand \(2010\)](#) provide evidence that, once the appropriate adjustments are made to occupation categories, shifts in the employment structure of the U.S. reflect longer-term trends, similar to the U.K. and Germany. More specifically, they show that polarization was of approximately the same size in the 1980s and the 1990s for the U.S., with the size of the increase for the low-skilled occupations in both decades being much smaller than what the previous literature found for the 1990s. This implies a longer term, gradually polarizing trend in employment rather than an abrupt shift toward polarization in the 1990s.³

Interestingly, this conclusion fits with results in an earlier literature. Using an approach developed by [Freeman \(1980\)](#), [Juhn, Murphy, and Pierce \(1993\)](#) find that between 1959 and the late 1980s, demand for labour became increasingly concentrated at the top of the skill distribution. Using the same method, [Juhn and Murphy \(1995\)](#) contrast the 1980s with earlier decades. They find, again, that demand has become increasingly concentrated at the top of the skill distribution and that the greatest difference between the 1980s and earlier decades was that the relative demand for those in the middle of the skill distribution had fallen. [Juhn \(1994, 1999\)](#) examines cross-decade patterns in the demand for male workers and argues that the fall in demand for workers in the middle of the skill distribution, perhaps due to the decline in manufacturing, is a potential explanation for why inequality grew so rapidly in the 1980s compared to the relative stability of previous decades. Thus, in contrast to the recent polarization literature which argues that the fall in demand for workers in the middle of the skill distribution reduces lower-tail inequality, Juhn argues that this is a *cause* for the increase in wage inequality in the 1980s.⁴ Thus, understanding the timing

³In particular, [Lefter and Sand \(2010\)](#) argue that patterns are strongly determined by how one addresses changes in occupational definitions across U.S. Censuses between 1990 and 2000. They provide a method for consistently handling these changes based on the U.S. Census Bureau and we use that method in working with both our U.S. and Canadian data

⁴These findings fit with claims about general increases in inequality in two ways. First, while bottom-tail demand growth exceeds that measured for middle-skilled occupations, both are dwarfed by implied increases in demand for high-skilled occupations. Second, much of the debate on inequality actually focussed on shifts in the ratio of wages of university educated workers to those of high school graduates. Many of the latter workers were in occupations in the middle of the skill distribution, implying that the skill-wage ratio measure of inequality actually reflected changes in the ratio of high- to medium-skilled wages.

of changes in the employment structure is crucial for evaluating explanations for those changes. While job polarization in the U.S. is largely thought of as a 1990s phenomenon, these earlier papers indicate that the decline in demand for workers in the middle of the skill distribution may have started much earlier than is suggested by the recent literature on job polarization.

While the timing of employment changes may or may not be different between the U.S. and other countries, wage patterns are different: the main difference between the experience in the U.S. and that of the U.K. and Germany is that wage polarization has thus far remained a U.S. development and, even in the U.S., is confined to the 1990s. In particular, [Goos and Manning \(2007\)](#), find that for the UK there has been growth in wages at the high-end of the occupational distribution accompanying employment growth in these occupations but that wages in low-skill occupations declined over the time period they consider. Similarly, [Dustmann, Ludsteck, and Schoenberg \(2009\)](#) find that jobs polarized in Germany in both the 1980s and the 1990s, but that lower-tail wage inequality actually began to expand in Germany in the mid-1990s. In a study that compares movements in both employment and wages between the U.S. and Germany, [Antonczyk, DeLeire, and Fitzenberger \(2010\)](#) find that, although there are similarities in occupational employment between the two countries that is consistent with technological change, the differences in the evolution of the wage distribution between the two countries is so large that technology alone cannot explain the wage trends. [Kampelmann and Rycx \(2011\)](#) find that while changes in occupational shares exhibit polarization associated with routine task intensities in Germany, occupational wages do not move in the same direction. The main models of polarization are ones that emphasize an increase in demand for both manual-task occupations (largely service occupations) and cognitive-task occupations (largely professional and managerial occupations). This fits with the U.S. patterns in the 1990s, where both wages and employment were increasing for these low- and high-wage occupations. Its relevance for other countries, and possibly for the U.S. in other decades, is less clear.

3. DATA AND METHODS

3.1. *Data*

3.1.1. *Canadian Data*

Our main data source is the Canadian Census Master Files for the Census years 1971, 1981, 1986, 1991, 1996, 2001, and 2006.⁵ The Census provides information on individuals that includes demographic characteristics (such as age and gender) as well as relatively detailed information on educational attainment. The Census also includes information on wages and salary earned and the number of weeks worked in the year prior to the Census. We combine this information to calculate

⁵We accessed the data in the York University Regional Data Centre. The interpretation and opinions expressed are those of the authors and do not represent those of Statistics Canada.

weekly wages for workers who report working full-time (see Data Appendix A.1 for details.) and convert to real (2000) dollars using the CPI. Our choice to focus on the weekly wage of full-time workers stems from the lack of information on annual hours worked and is common in the inequality literature (Juhn, Murphy, and Pierce, 1993; Katz and Murphy, 1992; Boudarbat, Lemieux, and Riddell, 2010a). Throughout this paper, when we refer to ‘wages’, we are referring to the weekly wages of full-time workers. Following Boudarbat, Lemieux, and Riddell (2010b) and Boudarbat, Lemieux, and Riddell (2010a), we drop observations for which weekly wages are below \$75 in 2000 dollars.

In order to extend our sample period beyond 2005, we also use Canadian Labour Force Survey (LFS) data. The LFS is a representative sample of the Canadian population collected monthly. Since 1997, it has included questions on wage rates for jobs held during the survey week. In the LFS design, respondents are surveyed in six consecutive months. Importantly, a respondent is asked his or her wage on a job either when the person first appears in the survey or when he or she changes jobs. Wage questions are not re-asked for people who report being on the same job in consecutive months. This results in a “staleness” in the wage observations. To avoid any potential problems with this, we use data only from the March and November surveys in each year, pooling the samples from the two months together to get our annual level data. All calculations are obtained using the LFS weights.

3.2. *U.S. Data*

In order to draw comparisons between Canada and the U.S., we also use U.S. Census data for the years 1970, 1980, 1990, and 2000 and data from the American Community Survey for 2007. The Census data come from IPUMS-USA (Ruggles, Sobek, Alexander, Fitch, Goeken, Hall, King, and Ronnander (2008)) and include labour force and demographic information for 1 percent of the U.S. population in 1970, and 5 percent of the population in each of the remaining three years. The main advantage of the Census data is the large sample sizes, which are necessary for an analysis of employment changes within detailed occupational categories. We produce our extract to match as closely as possible our Canadian data. More details on the processing of the data and the construction of the samples can be found in Appendix A.

3.3. *Methodological Framework*

3.3.1. *Occupational Employment Changes*

Studying the changing structure of Canadian jobs over the past 30 years requires a definition of jobs. Typically, in the recent literature, jobs refer to occupations (rather than industries or occupation-industry cells). When examining the occupation structure over such a long period, a major challenge is occupation coding inconsistency. Over the past several decades, the nature of work in

Canada has been changing and occupation coding schemes have been revised to reflect this. However, over-time comparisons of occupation employment composition require data with a consistent categorization of occupations over the period of study.

Our method for constructing consistent occupation codes across Censuses relies on using the 1991 Census to bridge the pre- and post-1991 Censuses. To do this, we base our final, consistent occupation codes on the 1991 Standard Occupational Classification (SOC). Our strategy contains two parts. First, we exploit the fact that the 1991 Census is double-coded with previous occupational coding schemes (the 1981 SOC and the 1971 SOC) and, second, post-1991 Censuses are double-coded with an historical comparison occupation classification based on the 1991 SOC, making comparisons relatively easy. Our final occupation coding scheme is a slightly aggregated version of the 1991 SOC that is directly comparable over the 1991-2006 period.⁶

Making occupation comparisons at the 1991 SOC level with pre-1991 data is more difficult than with the post-1991 data. Since our analysis takes place at the occupation rather than the individual level, we use the double-coded 1991 Census to derive weights that convert worker counts in the 1971 SOC codes into 1991 SOC codes. We choose to bridge the 1971 SOC to the 1991 SOC because the former is available in the 1971, 1981, and 1986 Census years.

We construct our crosswalk in the following way. For each individual in the 1991 Census, we observe both their 1991 occupation code and their 1971 occupation code. We calculate, for each 1991 occupation category, the proportion of individuals across the 1971 codes. This gives the probability that an individual with a given occupation code in 1971 was assigned to a particular 1991 SOC code. Next, we aggregate the pre-1991 Censuses at the 1971 SOC level to obtain the number of workers or hours supplied in each occupation. Using our crosswalk, we then apply the estimated proportions from the 1991 Census to obtain the number of workers or hours supplied in each 1991 SOC code. We can then use the resulting data set to make direct comparisons of occupation share changes between all available Census years.

Once jobs are defined in a comparable way across Census years, one can analyze the nature of the changing employment composition. The body of literature on job polarization largely follows [Goos and Manning \(2007\)](#), who identify shifts in the relative demand for skills by ranking occupations based on some measure of occupational skill content, and examining changes in the shares of employment accounted for by different occupational skill groups. [Goos and Manning \(2007\)](#) and [Dustmann, Ludsteck, and Schoenberg \(2009\)](#) measure the skill content of occupations by the occupational median wage, [Autor and Dorn \(2009, 2010\)](#), [Goos, Manning, and Salomons \(2009\)](#), and [Acemoglu and Autor \(2010\)](#) by the occupational mean wage, and [Autor, Katz, and Kearney \(2006, 2008\)](#) by aver-

⁶The 1991 SOC contains 520 occupation groups while our final coding scheme uses 443 occupation units. We refer to our occupation categories as the 1991 SOC throughout.

age years of education in each occupation. In all cases, the exercise is to rank occupations based on the chosen skill content measure in a base year and then examine how the distribution of employment changes across different percentiles of the occupational employment distribution.

We rank occupations based on the average weekly wage of full-time workers.⁷ This approach is consistent with [Goos and Manning \(2007\)](#); [Dustmann, Ludsteck, and Schoenberg \(2009\)](#); [Autor and Dorn \(2009, 2010\)](#); [Goos, Manning, and Salomons \(2009\)](#); and [Acemoglu and Autor \(2010\)](#), who use various measures of wages to rank occupations. [Goos and Manning \(2007\)](#) argue that using wages to measure occupational skill can be thought of as a single index skill model, where wages are a function of workers' individual skill attributes. Using wages to measure occupational skill can be problematic if wages reflect factors other than workers' skill characteristics, such as wage-setting institutions or compensating differentials. However, ([Goos and Manning, 2007](#)) and ([Autor, Katz, and Kearney, 2008](#)) show that high wages in an occupation are correlated with non-routine cognitive tasks and low wages are correlated with non-routine manual tasks. In the next section, we show that our wage measure is correlated with other measures of skill in an occupation. We use 1991 as our base period because our occupation categories are based on the 1991 Census. This side-steps any issues of having to use average wages constructed using the pre-1991 data cross-walks as a base-period wage measure. It is more common to use as a base period the earliest period available in the data. However, [Goos and Manning \(2007\)](#) show that the base period chosen did not affect their results and occupations' ranks within the occupational wage distribution are reasonably stable over time ([Acemoglu, 1999](#); [Autor, Katz, and Kearney, 2008](#)).

4. RESULTS

In this section, we provide an overview of occupational employment and wage trends in the Canadian labour market for the past four decades, and offer comparisons with the U.S. labour market over the same time period. We begin with a characterization of movements in overall wage inequality before moving to an examination of employment and wage polarization. Since we want to place the Canadian situation within the context of the growing literature on job and wage polarization, we follow closely many of the methods and procedures of that literature. We point out any modifications we have to make due to restrictions or limitations in the Canadian data at the relevant points

⁷As argued earlier, we do not use hourly wages because of problems in matching the reporting period for hours with that for earnings. However, we can construct an hourly wage using earnings and weeks worked in the previous year in combination with hours worked in the survey week. When we use that measure to rank occupations the ranking is largely unchanged and so our main results remain the same.

4.1. *Movements in the Wage Distribution*4.1.1. *Census Data, 1981-2006*

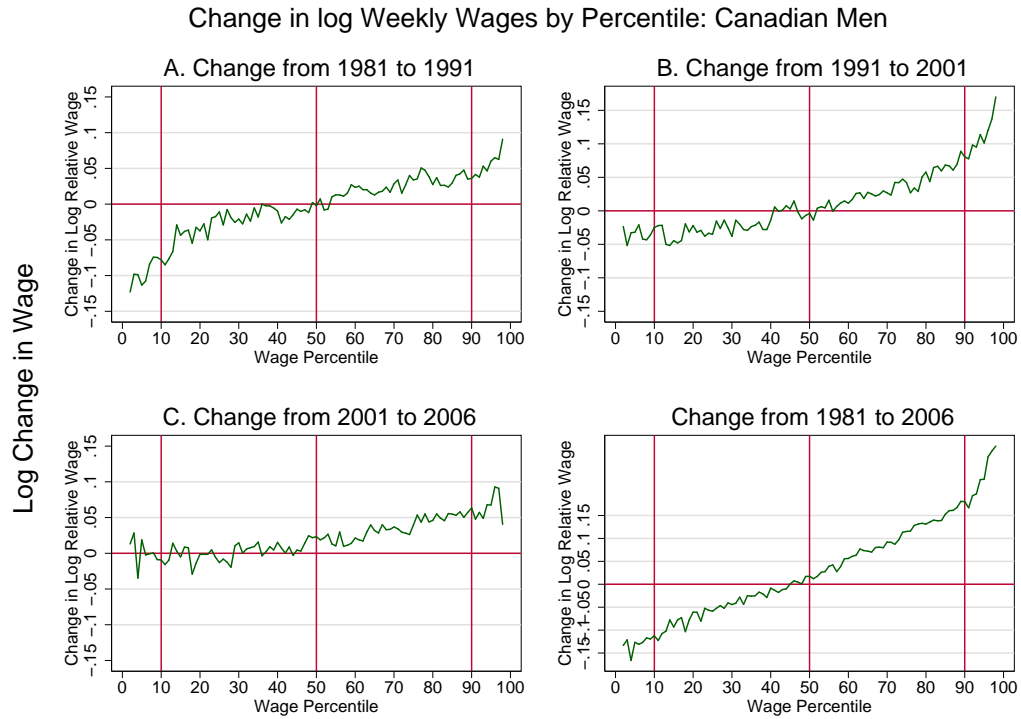
We begin with an examination of movements in the overall wage distribution using the method initiated in [Juhn, Murphy, and Pierce \(1993\)](#) and used in papers such as [Autor, Katz, and Kearney \(2008\)](#). More specifically, we plot the change in log wages between Censuses at each percentile of the wage distribution against the relevant percentile. In figures of this type, lines sloping up and to the right correspond to larger increases (or smaller decreases) at higher percentiles and, so, indicate increasing inequality. We present the wage change figures separately by gender and over various time periods. We view the results in this section as complementing the discussions of movements in earnings and income inequality in [Frenette, Green, and Milligan \(2007\)](#) and in educational differentials in [Boudarbat, Lemieux, and Riddell \(2010a\)](#).

Figure 1 reports the relative growth in Canadian men's log weekly wages by percentile over three different sub-periods as well as the overall change between 2006 and 1980. The wages reported in this figure are 'raw' in the sense that we do not control for observable characteristics. Panel D, the last panel in the figure, looks at wage growth over the full period (1981-2006). As can be seen in this panel, overall male wage inequality grew substantially over this time. Wages at the 90th percentile grew roughly 15 percent, whereas wages of workers at the 10th percentile fell about 5 percent. One noticeable feature of this figure is that the growth in inequality is ubiquitous across the entire wage distribution, and appears to be an almost linear function of wage percentile. The clear message from this figure is that men's wages have not polarized since 1980: workers at the bottom of the wage distribution lost ground relative to those in the middle, who, in turn, lost ground compared to the highest paid workers. Interestingly, the median real wage shows almost no growth over the quarter century captured in the figure.

The other panels of Figure 1 show how inequality has changed over time by breaking down the overall change by decade. The plots in panel A (showing wage changes over the 1980s) and panel B (1990s changes) are similar to the plot for the entire period. They show a nearly linear pattern in the wage percentile with gains in wages with wage growth concentrated among highly paid workers, wage declines concentrated among the low paid, and virtually no change in the median real wage. Thus, for the 1980s, 1990s and the overall period, one would not characterize the changes in the Canadian wage distribution as polarizing. Instead, it shows a simple, persistent increase in inequality. The differential between 2001 and 2006 (panel C) looks similar to the other panels above the median but differs in showing essentially no change in wages below the median. This combined pattern comes closer to what is described as polarization but, as we will see when we move to the LFS data, movements in the 2000s have a strong regional element that needs to be taken into account in any conclusions.

Figure 2 presents comparable results for U.S. men in the same format as

FIGURE 1.— Changes in relative wages by percentile: Men 1981-2006

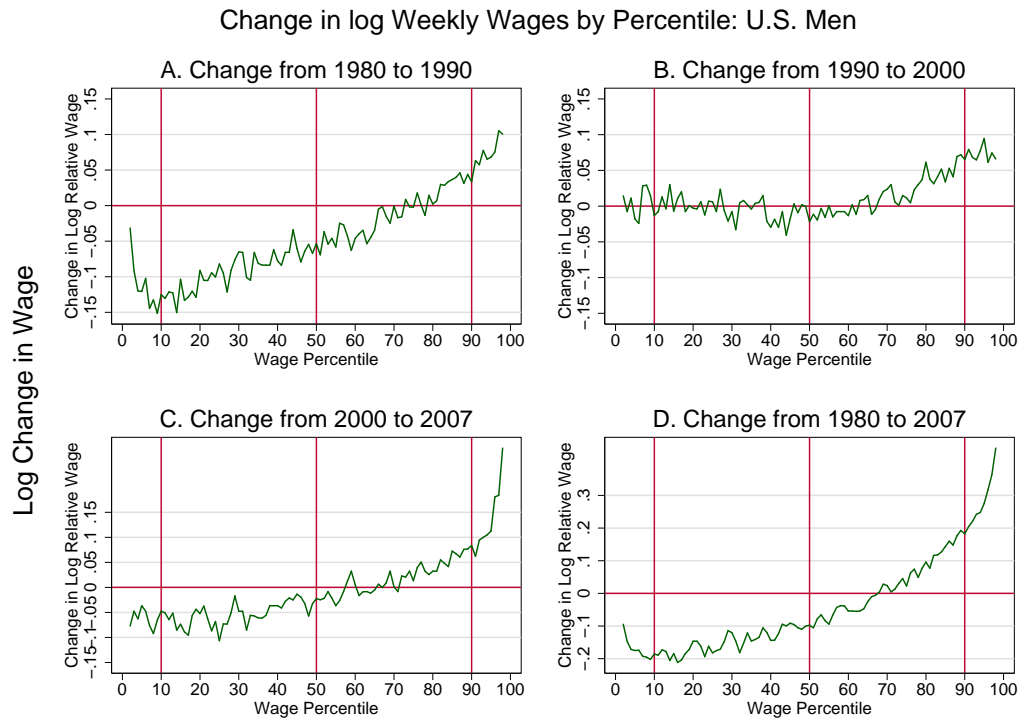


Changes in Men's log weekly wage percentiles. Data comes from the Canadian Census Public Use Files from 1981, 1986, 1991, 1996, 2001, 2006. Wage data refers to income earned in the year prior to the Census, and includes all men working full-time and at least one week for Wages and Salary.

Figure 1. The pattern for the whole period in panel D is less linear than in the comparable Canadian figure because the declines below the median are less steep across percentiles than the gains above the median. The size of the changes are also much larger for the U.S. (note that the scales are different in panel D in the two figures). The 90-10 differential increases by approximately 0.4 log points for the U.S. but by just over 0.25 log points for Canada between 1980 and the mid-2000s. Finally, for U.S. men, the median real wage fell by almost 10 percent over this period. Nonetheless, despite these differences, the overall pattern is similar to that in the Canadian data: the appropriate characterization over the whole period is one of increased inequality in all parts of the wage distribution, not polarization.

The more bowed shape to the wage change profile in the U.S. has its source

FIGURE 2.— Changes in relative wages by percentile: U.S. Men 1980-2007

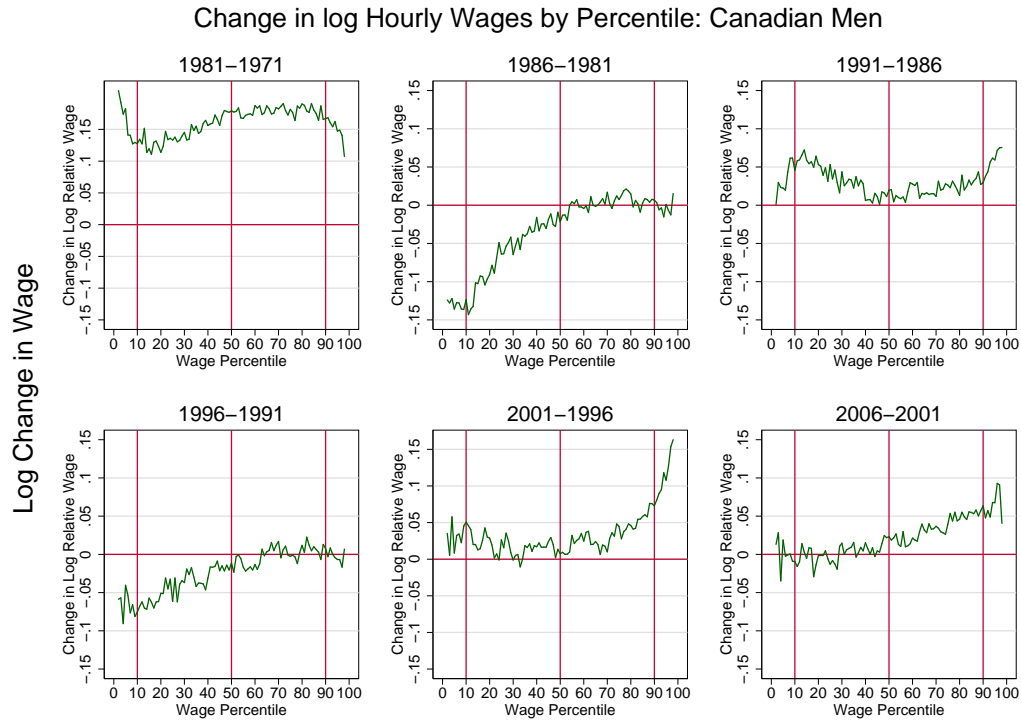


Changes in Men's log weekly wage percentiles. Data comes from the U.S. Census Public Use Files from 1980, 1990, 2000, and the 2007 American Community Survey. Wage data refers to income earned in the year prior to the Census, and includes all men working full-time and at least one week for Wages and Salary.

mainly in the 1990s. For the 1980s changes (panel A), the wage change line is nearly linear as in Canada, though the increase in inequality is larger and the median real wage declines. But the 1990s changes correspond somewhat to what might be called polarization, with near zero growth at the bottom, slight declines toward the middle and growth at the top of the wage distribution. Interestingly, this polarization pattern does not persist as the 2000-2007 plot in panel C looks close to linear again. This is the first look at one recurring theme: that the U.S. in the 1990s was special.

In Figure 3 we repeat the exercise for Canada, breaking the decades down into 5 year intervals (apart from the 1970s). In both the 1980s and 1990s, the first half of the decade contained a substantial recession. In both those half decades, inequality in the lower half of the wage distribution increased substantially while

FIGURE 3.— Changes in relative wages by percentile: Men 1971-2006



Changes in Men's log weekly wage percentiles. Data comes from the Canadian Census Public Use Files from 1971, 1981, 1986, 1991, 1996, 2001, 2006. Wage data refers to income earned in the year prior to the Census, and includes all men working full-time and at least one week for Wages and Salary.

real wages were essentially flat above the median. In the second (boom) halves of the decades, the wage patterns look polarized as both top and bottom earners experienced real wage gains.⁸ Overall, growth in upper-tail inequality (the difference between the 90th percentile of the wage distribution and the median) was positive for every sub-period, while lower-tail inequality was much more variable. This pattern fits with ongoing forces driving up the wages of more skilled workers while lower-skill workers faced difficulties in recessionary periods followed by recovery in expansionary periods. Given that wage polarization is a medium to long term issue typically related to technical change – as opposed to a cyclical

⁸These broad patterns fit with the patterns of entry wages for low-skilled men examined in [Green and Townsend \(2010\)](#). They show that much of these declines are in the entry wages of successive cohorts of job entrants rather than reflecting general declines for workers of all lengths of job tenure.

issue – the right place to focus in assessing polarization trends for Canada is on the roughly cyclically similar points of 1981, 1991, 2001, and 2006. From this vantage point, it is clear that the recoveries of low-skilled workers during the expansions of the late 1980s and 1990s were not enough to offset their declines in wages during the preceding recessionary periods.

Figures 4 and 5 present the results for Canadian and U.S. women, respectively. Like Canadian men, inequality among women (especially lower-tail inequality) grew the most during the 1980s, continuing to grow at a slower pace during the 1990s. The growth in wage inequality for women over the full period between 1981-2006 occurs over the entire wage distribution, but is relatively concentrated at the top. As with men, if there is any period that looks at all like polarization, it would be 2001-2006. For U.S. women, over the full period, growth in wage inequality is remarkably uniform. One difference between U.S. men and women is the growth in wage inequality during the 1990s. Men’s wages show a marked pattern of wage polarization, whereas growth in women’s inequality slows but does not reverse in the lower tail of the wage distribution as it does for men. As can be seen from Panel D in both of these figures, both U.S. and Canadian women have seen an increase in their wages at almost every percentile of the wage distribution in remarkable contrast to men over the same period.

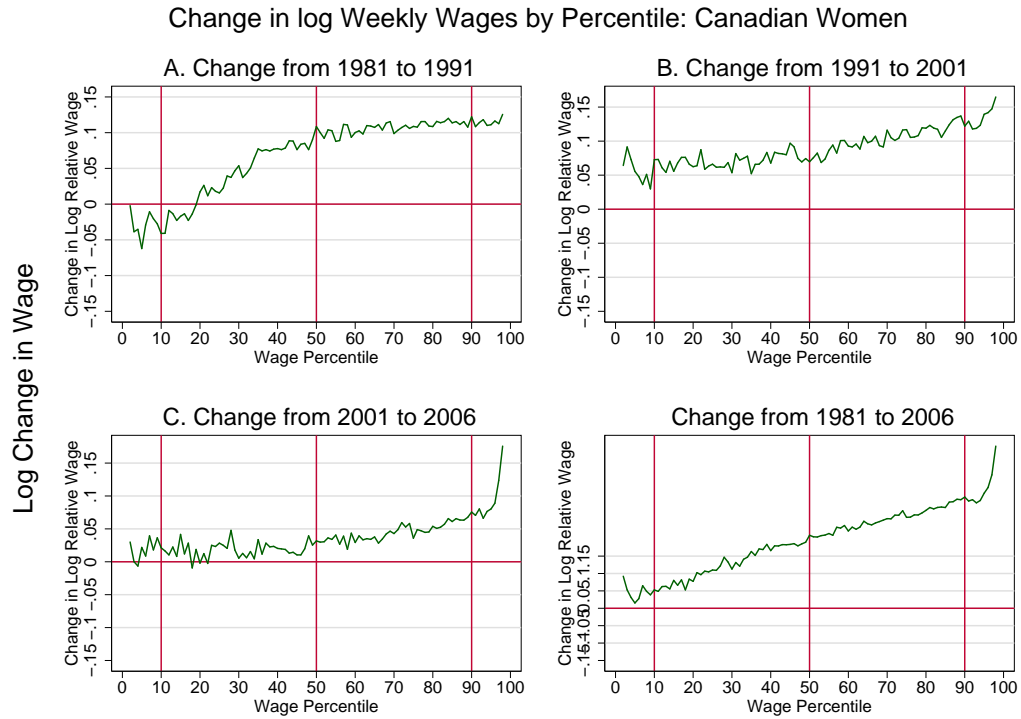
In summary, the long term-patterns of wage inequality are similar in Canada and the U.S., for both genders. In particular, over the 1980 to late 2000s period, wage inequality grew in both countries across the entire wage distribution, with U.S. inequality expanding to a much greater extent than in Canada. However, growth in inequality for different sub-periods of data shows differences between the two countries. In particular, lower-tail inequality wage continued to expand for Canadian men during the 1990s, while it contracted among American men. Upper-tail wage inequality has been increasing steadily in both countries since 1980.

4.1.2. *LFS Data, 1997 - 2011*

We move next to working with the LFS data, which will allow us to extend the sample period to 2011. In Figure 6, we plot wage change figures for men for 1997 to 2001, 2001 to 2006, 2006 to 2011, and 2000 to 2011. The 1997 to 2001 plot in panel A looks very similar to the plot for the latter half of the 1990s based on Census data in figure 3. The plots for the first half of the 2000s using the two datasets are also very similar, providing confidence in using the LFS to extend the analysis into the second half of the 2000s. For the period from 2006 to 2011, the wage change profile across percentiles is quite flat, though with less growth between the 20th percentile and the median. The latter, combined with the upper end growth between 2001 and 2006 results in a polarized profile for the whole decade.

Is the U-shaped profile for the 2000’s just the U.S. pattern coming to Canada with a lag of a decade? Should we think of the type of technical change models

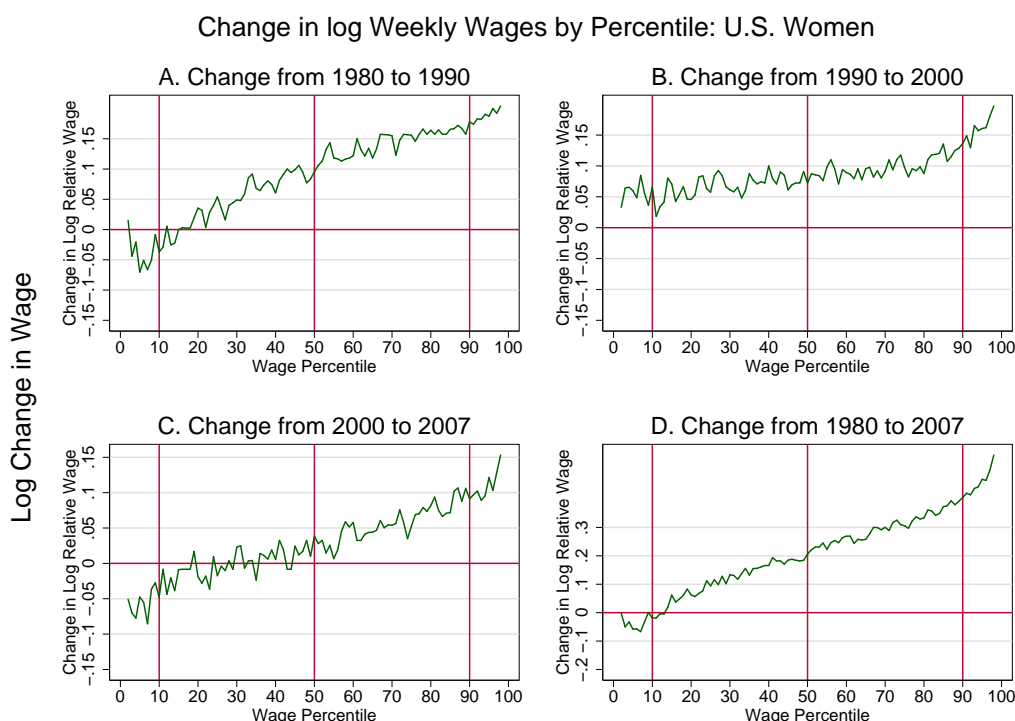
FIGURE 4.— Changes in relative wages by percentile: Women 1981-2006



Changes in Women's log weekly wage percentiles. Data comes from the Canadian Census Public Use Files from 1981, 1986, 1991, 1996, 2001, 2006. Wage data refers to income earned in the year prior to the Census, and includes all women working full-time and at least one week for Wages and Salary.

applied to the U.S. in the 1990s as driving wages in the 2000s in Canada? Something is certainly different about the 2000s, and particularly the latter half of the 2000s. In strong contrast to earlier half-decades including substantial recessions, the median-wage growth is positive and there is no evidence of lower-wage workers experiencing wage losses relative to the high-wage workers. This could be because the 2008 recession has been different or because the whole half-decade includes both a very strong boom and a recession, and that if we focused in just on the recession we would see the pattern from earlier recessions emerge. However, [Fortin and Lemieux \(2014\)](#), using LFS data to examine provincial and national wage patterns, present annual plots that show the 10th percentile continues to grow relative to the 50th percentile after 2008. They provide evidence that most of the polarization at the very bottom can be attributed to minimum

FIGURE 5.— Changes in relative wages by percentile: U.S. Women 1980-2007

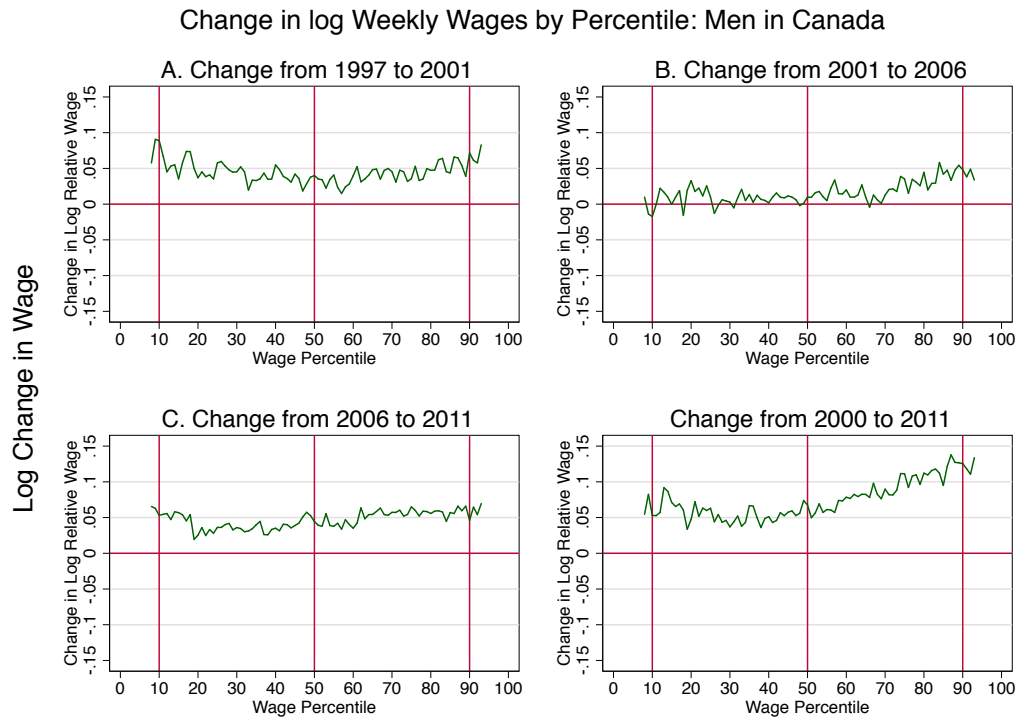


Changes in Women's log weekly wage percentiles. Data comes from the U.S. Census Public Use Files from 1980, 1990, 2000, and the 2007 American Community Survey. Wage data refers to income earned in the year prior to the Census, and includes all women working full-time and at least one week for Wages and Salary.

wage changes, particularly in the Atlantic provinces.

The other factor that could be affecting the 2000s Canadian patterns is the strong regional difference in economic growth. We investigate whether this shows up in wage patterns by showing figures for Alberta and Ontario, separately. The plots in the first panels of figure 7 for Ontario and figure 8 for Alberta both pertain to the 1997 to 2001 changes and are very similar across provinces. However, the provinces part company after 2000. For Ontario, the first half of the 2000s looks like a familiar pattern, and one that is very similar to the U.S. in this period. Wage inequality increases in an almost linear manner across percentiles. In contrast, Alberta wage changes show the opposite pattern with larger increases at the bottom of the distribution in this period. This fits with stories that employers like fast food outlets who typically employ low-wage workers had

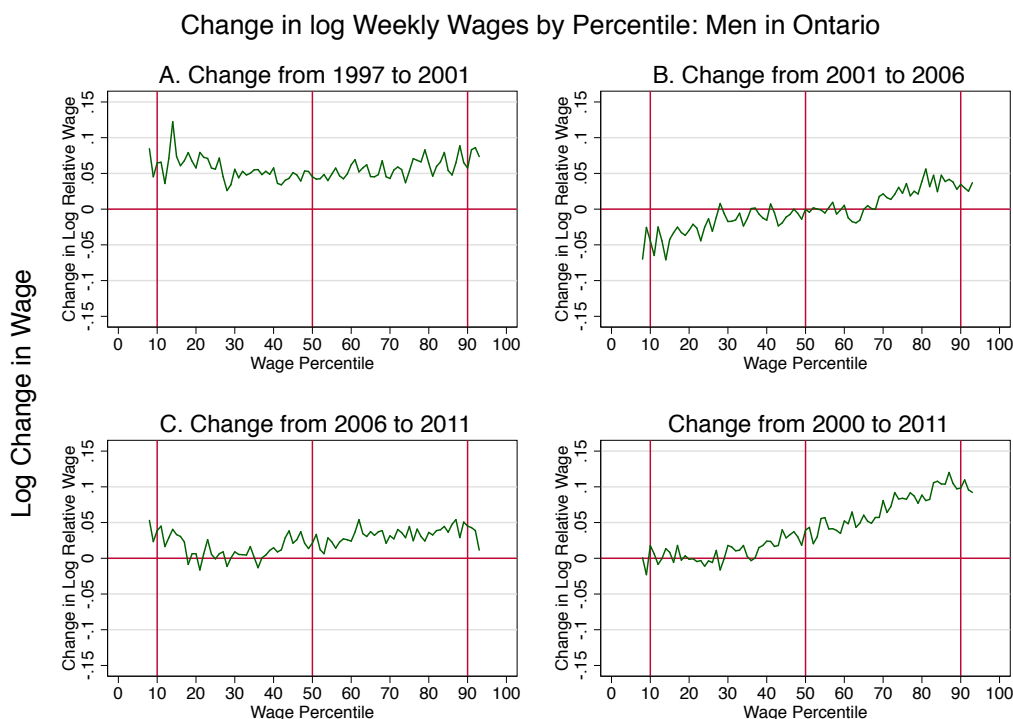
FIGURE 6.— Changes in log wages by percentile: Canada, LFS



Changes in Men's log weekly wage percentiles. Data comes from the Canadian Labour Force Survey. Wages are weekly wages in 2000 dollars for full-time men and correspond to the survey week.

difficulty finding workers during the resource boom in Alberta. In the second half of the decade, wage changes are essentially flat across percentiles in Ontario but reveal increasing inequality in Alberta. Overall, the patterns suggest that Ontario behaved more like the U.S. after 2000 and, putting the LFS patterns together with those for earlier Census years, would not be characterized as having polarized wages in any decade. Alberta seemed to follow a similar pattern in the 1990s but after 2000 did experience wage polarization. That polarization, though, is likely related to the Western resource boom rather than being driven by technological change in the sense emphasized in models of the U.S.. This is the conclusion reached in [Fortin and Lemieux \(2014\)](#) who provide convincing evidence that the effects of the resource boom have had broad effects on the wage distribution in the provinces most directly affected by it.

FIGURE 7.— Changes in log wages by percentile: Ontario, LFS



Changes in Men's log weekly wage percentiles. Data comes from the Canadian Labour Force Survey. Wages are weekly wages in 2000 dollars for full-time men and correspond to the survey week.

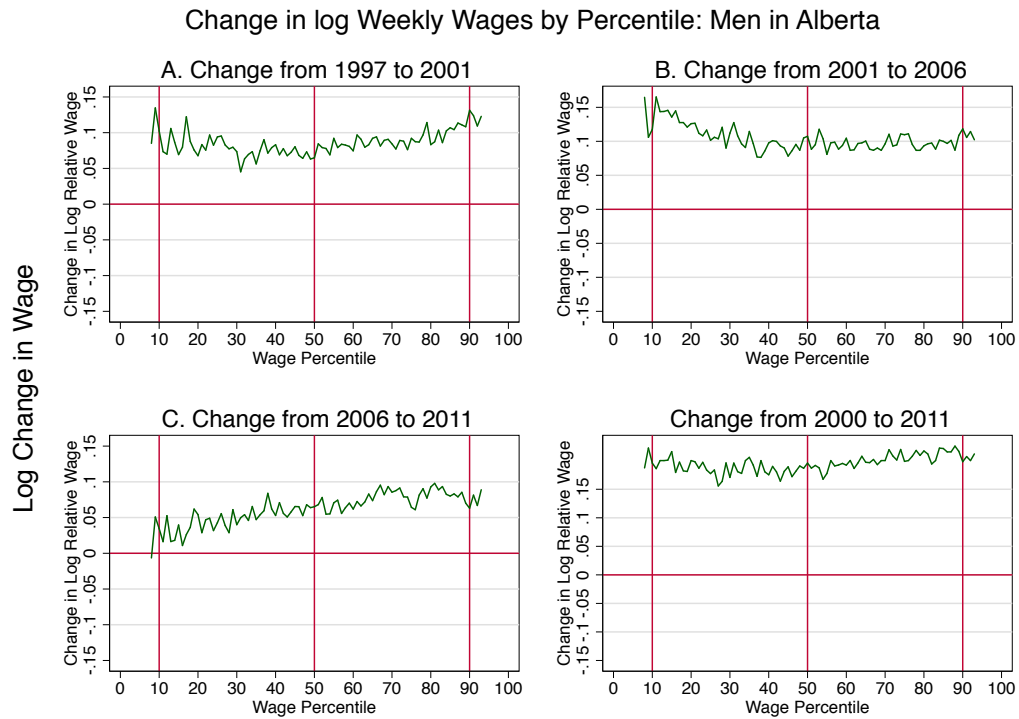
4.2. Occupational Polarization Patterns

We now turn to examining the question of whether there has been a polarization in employment across occupations and in wages by occupation. Wage polarization by occupation will differ from the movements in inequality discussed in the previous section to the extent that there are strong movements in inequality within occupations. Since we want to work with narrowly defined occupations, the main patterns in this section will pertain to males and females combined. We return to the issue of gender differences in section 4.2.4.

4.2.1. Occupational Employment

We begin our examination of changes in the structure of occupational employment in Canada by setting out the employment trends by broad occupation categories. Table I looks at occupation average education and relative wages in

FIGURE 8.— Changes in log wages by percentile: Alberta, LFS



Changes in Men's log weekly wage percentiles. Data comes from the Canadian Labour Force Survey. Wages are weekly wages in 2000 dollars for full-time men and correspond to the survey week.

1991, employment in 1981 and 2006 as well as employment growth over that period for aggregated occupation groups for all workers. The occupation groups aggregate the detailed 1991 SOC occupations into broad occupation groups offered in the 1991 SOC Census public-use files. To the right of the occupation title is a skill ranking in parenthesis from (A) to (D), where (A) denotes the highest level of skill based on the level of education required to enter the job as well as the type of work performed.⁹ In addition, the first column shows the average years of education among workers within each occupation and the second column shows the relative weekly wage in 1991. A first key point from the table is that the three ways of ranking occupations by skill are roughly in accord. The high-skilled A category by and large contains occupations with the highest

⁹These skill levels are defined by Human Resources and Development Canada. More information can be found at: <http://www5.hrsdc.gc.ca/noc/english/noc/2006/Tutorial.aspx#8>

associated education and wages. In what follows, we will follow the literature in using a ranking of occupations by wage in a base year as a skill ranking. This table indicates that our conclusions are unlikely to change substantially if we rank occupations by other measures of skill instead.

TABLE I
EDUCATION, WAGES AND EMPLOYMENT GROWTH

	(1) Ave. Education	(2) Wages	(3) Emp. 1981	(4) Emp. 2006	(5) Growth
Senior Managers (A)	14.7	2.18	1.12	1.50	0.29
Middle Managers (A)	13.9	1.25	9.19	9.98	0.082
Professionals (A)	16.6	1.23	12.8	18.7	0.38
Technicians (B)	14.3	0.96	5.56	6.47	0.15
Supervisors (B)	12.8	0.88	1.67	1.48	-0.12
Foremen/Women (B)	11.6	0.99	5.56	2.85	-0.67
Admin/Senior Clerical (B)	13.2	0.79	6.38	5.43	-0.16
Sales and Service (B)	12.7	0.96	5.53	5.23	-0.057
Skilled Craft and Trades (B)	11.9	1.04	9.55	8.06	-0.17
Clerical workers (C)	12.9	0.74	10.9	9.97	-0.093
Intermediate Sales and Service (C)	12.5	0.64	7.26	9.32	0.25
Semi-skilled manual (C)	10.9	0.87	14.1	11.2	-0.23
Other Sales and Service (D)	11.3	0.63	6.25	6.55	0.047
Other Manual Workers (D)	10.9	0.84	4.03	3.25	-0.22

Notes: Data comes from the Canadian Census Master Files for the years 1981, 1991, and 2006. The first column shows the average number of years of education of workers in the indicated occupation in 1991. The second column shows mean wage of an occupation relative to the average in 1991. Columns 3 and 4 show the share of employment in each occupation calculated as the share of total hours worked in the economy as a whole. The last column shows the growth in occupational employment calculated as the change in log share from 1981 to 2006.

Here, and elsewhere in this paper, we measure the share of employment in each occupation as the share of total hours worked in the economy.¹⁰ Since we measure employment shares rather than employment, all analysis below is in relative terms when discussing wage and employment growth. Columns 3 and 4 contain the share of employment of each occupation in 1981 and 2006 and the last column reports employment growth. As can be seen from the table, employment growth is heavily concentrated among occupations with higher levels of skill, defined by the skill requirements, average years of education, or relative wage in 1991. Occupations in the middle of the skill distribution had negative growth over this period, with the notable exception of Technicians. For jobs with the lowest skill requirements, employment growth was mixed. Among the two lowest

¹⁰Measuring employment by the share of hours worked is common in the literature. However, we have replicated all of our results using simple counts of workers as well, and the main features of the occupation structure we document below are not significantly different using this measure. Measuring employment by the number of hours worked may be preferable to simple head counts if part-time employment is significant in, for example, low wage employment, since counts of workers will tend to over estimate employment in these occupations (Goos and Manning, 2007).

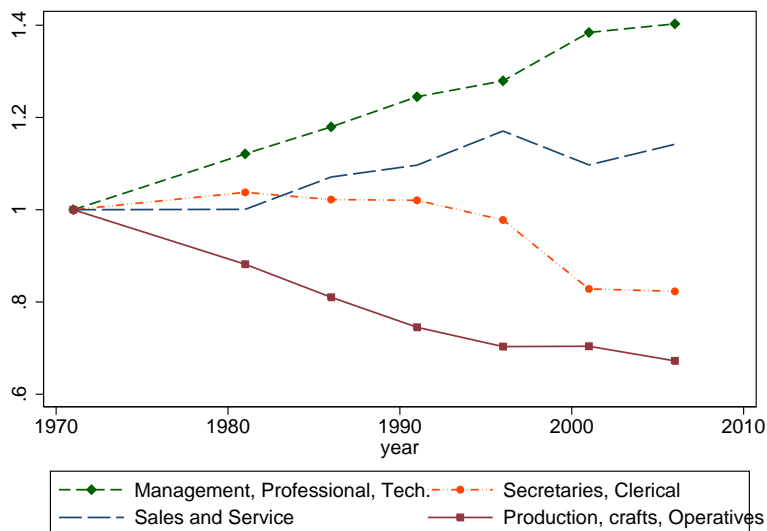
paid occupation groups, Other Sales and Service and Intermediate Sales and Service, employment growth is positive. These patterns - growth in high-paying, high-skill jobs and jobs in the service sector - are similar to employment trends over this period in a number of advanced economies (Goos and Manning, 2007; Dustmann, Ludsteck, and Schoenberg, 2009; Acemoglu and Autor, 2010).

Figure 9 shows the broad trends in Canadian occupational employment over time. In this figure, we aggregate occupations into four broad categories: (1) Management, Professional, and Technical; (2) Secretaries and Clerical Occupations; (3) Sales and Service Occupations; and (4) Production, Crafts and Operatives, including labourers. We calculate the share of employment in each occupation category in each year, and construct an employment index that equals one in 1971. As can be seen in this figure, the trend towards high-skill management and professional jobs and away from production type jobs is apparent in all periods, starting with the 1970s. The trend toward sales jobs and away from clerical work began approximately in 1980 and accelerated in the 1990s. Overall, employment in Management, Professional, and Technical occupations grew by about 40 percent since 1970, while Production jobs declined by nearly 35 percent. One impression that this figure imparts is that the shift toward high-skill Management and Professional jobs and away from middling jobs in Production and Crafts began in the 1970s and has been a fairly smooth and continuous development throughout the sample period. In contrast, the growth in sales and service occupation doesn't begin until 1980. It is noteworthy that both the the increase in the share of employment in sales and service and the decline in the share in production occupations roughly stall after the mid-1990s. Figure 10 contains an analogous plot to Figure 9 for the U.S.. Here, too, we see that the pattern of ongoing decline in the production occupations share and increase in the management and professional share dates back at least to the 1970s. Also similar to what we observed for Canada, the rise of the share in the service sector begins in the 1980s.¹¹ The largest differences between the two countries occur after 2000, when the share in service occupations spikes up further in the U.S. but is essentially flat in Canada. It is not clear why the two countries differ in this dimension, though a possible candidate is the resource sector boom in Canada implying that low-skill workers have not been pushed into service sector jobs to the same degree.

While the previous figures are useful in setting out broad trends, it is also useful to look at more disaggregated occupational categories in order to get more detail on the changes we are studying and to insure that how occupations are aggregated is not driving our results. In Figure 11 we use occupations grouped according to the 1991 SOC (with 443 occupations) to plot the change in the log share of employment in the occupation against its rank based on the average weekly occupational wage in 1991. The size of each circle in the figure denotes

¹¹Mishel et al(2013) also points out that while the main polarization literature for the U.S. emphasizes changes in the 1990s, it arises as a pattern much earlier.

FIGURE 9.— Employment by Aggregated Occupation Category: Canada 1970-2006



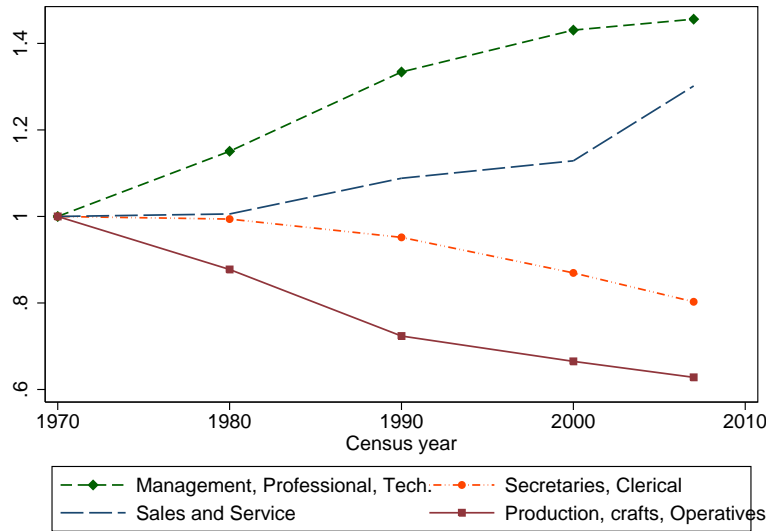
Data comes from the Canadian Census Master Files from 1971-2006. The figure represents the share of hours worked among four broad occupation classifications, indexed to 1 in 1971.

the relative size of the occupation in 1991. The dark line in the figure, labelled “smoothed fit”, represents a kernel regression of employment growth on log average wage in 1991.¹² Along with the dark line, the gray shaded area displays the 95% confidence interval of the predicted kernel smooth. In each panel, we also plot nine vertical lines that split the figure into 10 employment bins, where each bin represents 10% of occupational employment in 1991. For example, occupations to the left of the left-most vertical line represent the first decile of employment, containing the 10% of the labour force with the lowest log average occupational weekly wages. We follow [Goos and Manning \(2007\)](#)’s terminology and sometimes refer to these as job-quality deciles.

The figure contains four panels, each denoting a different time period. The upper left quadrant contains the results from 1971-1981. As can be seen from the figure, several occupations in the first decile of employment had positive growth over this period. From the second to the sixth decile, average employment growth was roughly zero, and, finally, the top three deciles of employment - those with the highest average log weekly wage in 1991 - had employment growth. This

¹²The Kernel estimates give the conditional (on log wage in 1991) mean predictions of changes in employment growth across Censuses. We estimate the local regressions with STATA’s `lpolys` command and choose the bandwidth as two-thirds of STATA’s rule-of-thumb default method.

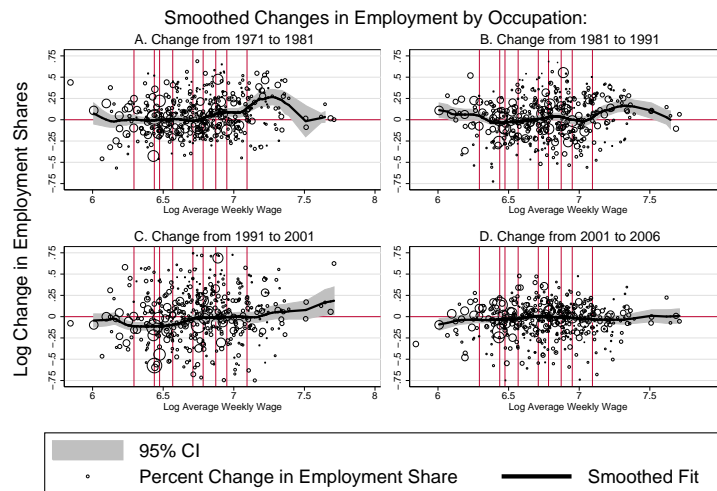
FIGURE 10.— Aggregate Occupation Employment Index: U.S.



pattern continued in the 1980s, with stronger employment declines in the 2nd, 3rd, and 4th job-quality deciles and growth in the bottom 10% and the top 10% of employment. The most notable feature of the 1990s is the continued decline in jobs in the 2nd-4th quality deciles. Thus, the patterns in both the 1980s and 1990s indicate a polarization of jobs in Canada. After 2000, the smoothed line implies virtually no change in the overall employment structure by skill. The fact that the share in top-paying occupations is on average unchanging after 2000 is in strong contrast to the previous three decades when these occupations consistently gained share. This result fits with [Beaudry, Green, and Sand \(2013\)](#)'s findings for the U.S., which they argue implies a reversal in the demand trend for skills after 2000.

In Figure 12, we replicate Figure 11 using U.S. Census data from 1970-2000 and American Community Survey data for 2007. The occupation categories we use are based on the 1980 Census Occupation Classifications, of which there are 495 categories. Details on how we obtain consistent occupation codes from 1970-2007 are given in [Lefter and Sand \(2010\)](#), but the method is similar to that used here for the Canadian data. Again, we rank occupations based on the log of the average occupation weekly wage in 1990, and plot occupation growth along the y -axis. Overall, changes in employment in the U.S. data are relatively similar to the Canadian data. In all 4 panels, the lowest paying occupations employing 10 percent of workers show employment growth or stability relative to jobs in the 2nd-4th deciles of employment. As in the Canadian data, and replicating

FIGURE 11.— Occupational Employment Changes by Decade: Canada

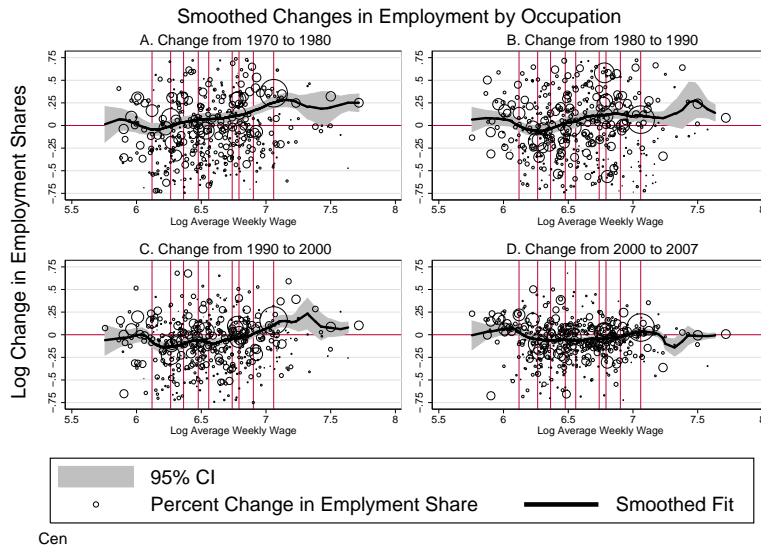


Data comes from the Canadian Census Master Files from 1971-2006. The x -axis denotes the average wage of an occupation in 1991. The y -axis displays employment growth of an occupation calculated as the change in log share of employment. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 1991.

the results in [Beaudry, Green, and Sand \(2013\)](#), the top deciles show growth in the 1970s, 1980s and 1990s, but that growth stops in the 2000s. In addition, the timing of the employment changes appears similar to Canada, with noticeable polarization occurring in the 1970s and increasing throughout the time period. In particular, falling employment is noticeable in the 2-4th deciles of employment beginning in the 1980s in both countries. This contrasts with standard claims in the U.S. literature that polarization in that country began in the 1990s. As discussed earlier, [Lefter and Sand, 2010](#) find the same result and show that the differences are based on how the cross-walk between occupation codings in the 1990 and 2000 U.S. Censuses are performed. Recall that a finding of polarization reaching back into the 1980s fits with patterns observed in European and U.K. data.¹³

¹³In particular, in the approach used in previous papers, if workers in one occupation in the 2000 coding (call it Occ2000A) are observed in several occupations under the 1990 coding in a Census year where both codings are present then all the workers in Occ2000A are assigned to the 1990 category where the largest proportion of Occ2000A workers are observed. [Lefter and Sand, 2010](#) note that since all estimation is being done at the occupation level, one can split the number of workers from Occ2000A among the various 1990 coding occupations according to the proportions in those occupations in the cross-walk year. They show that doing this has

FIGURE 12.— Occupational Employment Changes by Decade: U.S.



Data comes from the U.S. Censuses from 1970-2000 and the 2007 ACS. The x -axis denotes the average wage of an occupation in 1990. The y -axis displays employment growth of an occupation calculated as the change in log share of employment. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1990. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 1990.

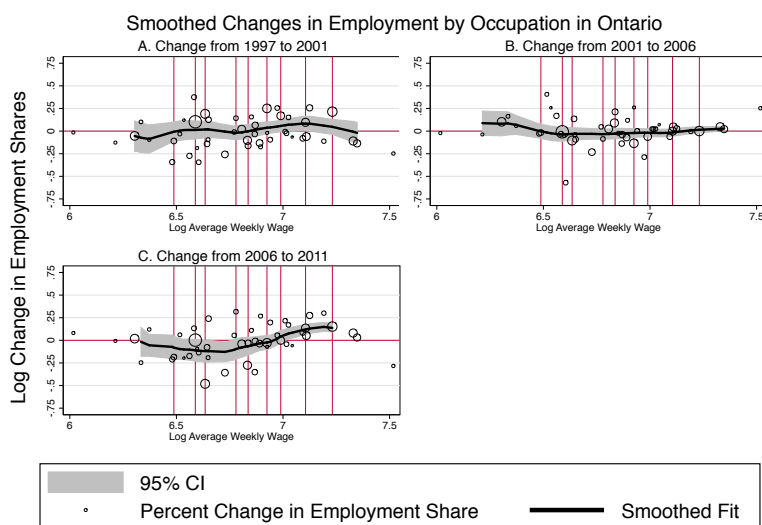
Finally, in Figures 13 and 14, we present similar plots using LFS data. Given the evidence on wage dispersion earlier, we present separate figures for Ontario and Alberta. Because of sample size restrictions, we use only 43 occupations. We rank occupations according to the average weekly wage in 2000. The sample sizes make precise statements difficult but the pattern for Ontario in the early part of the 2000s looks much like that in the U.S. in the same period: little or no change in employment share for high-wage occupations but some growth in the bottom end occupations. The plot for 2006-2011 for Ontario looks somewhat like polarization but it may simply reflect higher wage occupations doing relatively better in a recession. In comparison, Alberta shows growth in top-end occupations and declines below the median in the first half of the 2000s, and a pattern in the second half of the 2000s that looks more like the U.S. pattern. The lines are particularly poorly defined for Alberta, however.

In summary, for both Canada and the U.S., we see employment polarization

substantive effects on movements in both tails of the occupational distribution and that using this method implies polarization in both the 1980s and 1990s. We adopt the same approach for both the U.S. and Canadian data here.

in the 1980s and 1990s. After 2000, though, the polarization pattern comes to an end. The growth in employment share in top-paying occupations that had been going on for the previous three decades stops. In the U.S. (and Ontario in the first part of the 2000s), employment in low-end occupations continue to grow after 2000 while for Canada as a whole this is not the case.

FIGURE 13.— Occupational Employment Changes: Ontario



Data comes from the Canadian Labour Force Survey from 1997-2011. The x -axis denotes the average wage of an occupation in 2000. The y -axis displays employment growth of an occupation calculated as the change in log share of employment. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 2000. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 2000.

4.2.2. Occupational Wages

In this section, we examine the change in occupational wages in the same way as the employment changes. One limitation of this exercise is that the numbers we report below are actual changes in occupational wages and do not account for any compositional changes within occupations (for example, skill upgrading or the changing fraction of women and non-Canadian born workers). Nevertheless, these raw changes in occupational wages are informative, particularly when compared to the U.S. situation.

Figure 15 replicates Figure 11, but plots the log change in average weekly wage for each occupation against the log average weekly wage in 1991. Again, we use the 1991 SOC occupation categories with the size of each circle denoting

FIGURE 14.— Occupational Employment Changes: Alberta

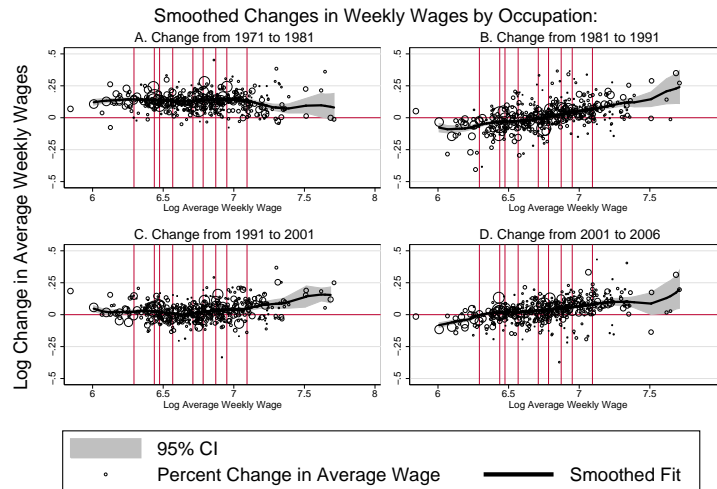


Data comes from the Canadian Labour Force Survey from 1997-2011. The x -axis denotes the average wage of an occupation in 2000. The y -axis displays employment growth of an occupation calculated as the change in log share of employment. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 2000. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 2000.

the relative size of the occupation in 1991, and the vertical lines split each panel into 10 deciles of employment according to their job-quality measured by the log average wage in 1991. The main conclusion from comparing the two figures is that the growth in occupational employment does not correspond to the growth in occupational wages. For both the 1980s and the 2000s, wage changes are monotonically increasing in the occupation rank while employment changes are U-shaped in the 1980s and flat in the 2000s. In the 1990s, one might read both employment changes and wage changes as U-shaped, but the wage changes have much less curvature and the low point of the wage changes is in the 5th decile for the wage changes but the 2nd or 3rd decile for the employment changes. In fact, wage growth is slightly positive in deciles 2 through 4 in the 1990s - corresponding to the same occupations that had employment declines in this decade. Our view is that the between-occupation wage growth in Canada in the 1990s does not display wage polarization since wages for middling occupations (in job-quality deciles 2-4) increase as much or more than the wages of low-paying occupations in the first job-quality decile.

The flatness of the wage growth profile below the 5th job-quality decile in the

FIGURE 15.— Occupational Wage Changes by Decade: Canada



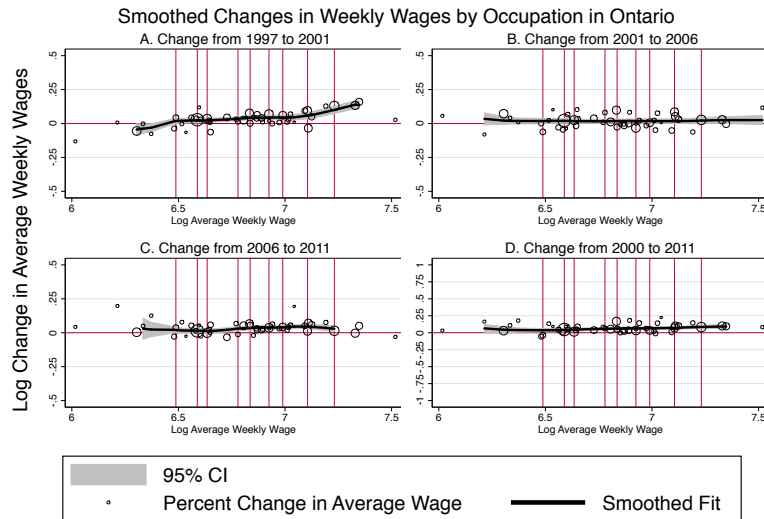
Data comes from the Canadian Census Master Files from 1971-2006. The x -axis denotes the average wage of an occupation in 1991. The y -axis displays the growth in the average wage of an occupation calculated as the change in log wages. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 1991.

1990s represents a difference relative to what we see in Figures 1 and 4 where wage inequality grows throughout the wage distribution. This implies that that within-occupation dispersion increased in the 1990s. [Firpo, Fortin, and Lemieux \(2011\)](#) argue that such a pattern could be accounted for through increased offshoring of jobs. As we show in the next section, women are more heavily concentrated in occupations below the 5th decile than men. This, in combination with the strong growth in women's wages over the 1990s is consistent with the between-occupational wage changes shown in this panel.

In Figures 16 and 17, we present the occupational wage change plots using LFS data for Ontario and Alberta, respectively. Both provinces show similar increases in inequality across the whole range of occupations in the late 1990s. In the early 2000s, Ontario experienced a continued, though much flatter increase in occupational inequality while in Alberta wages actually grew more in low end occupations. For both provinces, the 2000s decade was characterized by a small increase in cross-occupation inequality with no evidence of wage polarization.

Figure 18 replicates Figure 15 using U.S. Census data. Occupational wage growth in the U.S. shows considerable differences compared to the Canadian data, similar to the wage patterns for all workers presented above. In particular,

FIGURE 16.— Occupational Wage Changes: Ontario



Data comes from the Canadian Labour Force Survey from 1997-2011. The x -axis denotes the average wage of an occupation in 2000. The y -axis displays wage growth of an occupation calculated as the change in the log of the average weekly wage. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 2000. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 2000.

in the 1980s, occupations in the bottom half of the distribution experienced wage declines in Canada but no real change in the U.S.. During the 1990s, wages in the U.S. showed strong polarization, with wage growth occurring at the bottom and the top of the occupational wage distribution, compared to occupations in the middle. Overall, the 1990s were a period of strong wage growth for the U.S.. The last panel, which shows the wage growth by base period occupational wage for the 2000s, indicates that wage polarization ended in this decade, with the U.S. pattern being the same as that for Canada: wage changes that are strongly linear in the base period wage and are negative for low-wage occupations.

In Figure 19, we display the results from the post-1980 period for both Canada and the U.S. side-by-side. This provides a means of summarizing the main patterns. We present the post-1980 data and exclude the 1970s since most of the literature on polarization focuses on this period as an era that was impacted by computer technology. In this figure, the results for employment changes are shown in the left column and the results for wage changes are shown in the right column. As can be seen from the figure, while the results for employment changes are very similar between Canada and the U.S., changes in occupation wages over

FIGURE 17.— Occupational Wage Changes: Alberta

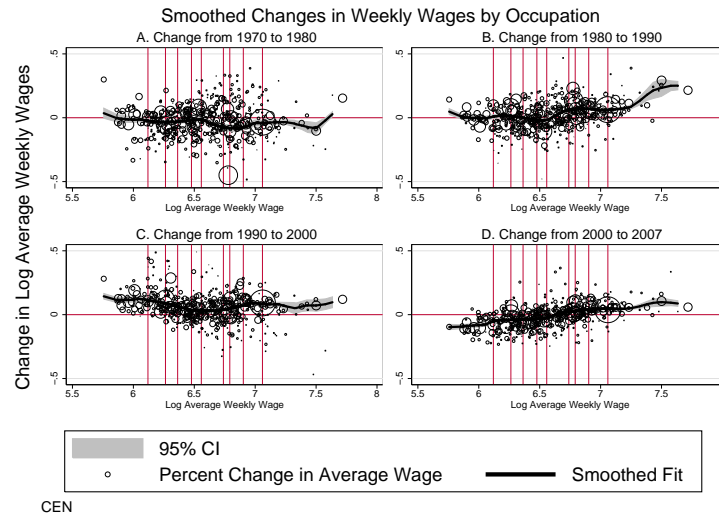


Data comes from the Canadian Labour Force Survey from 1997-2011. The x -axis denotes the average wage of an occupation in 2000. The y -axis displays wage growth of an occupation calculated as the change in the log of the average weekly wage. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 2000. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 2000.

this period are much more strongly linearly related to the base year wages for Canada compared to the U.S.. This reflects the fact that the U.S. had real wage polarization in the 1990s and possibly even the 1980s while Canada did not.

Several observations are worth noting about this figure. First, in both Canada and the U.S., the job-quality deciles that mainly suffer employment declines since 1980 are heavily concentrated in deciles 2 to 4, and include many of the same occupations. This is suggestive evidence that the factors responsible for these patterns are similar between each country. Second, employment gains for low-skill workers are concentrated in the first job-quality decile, and include service and home care-type jobs. Interestingly, since 1980, Canadian workers in this decile suffered wage declines while U.S. workers' wages were relatively stable. Since Canada is often thought to have labour market features and institutions that favour low-skill workers (Card, Kramarz, and Lemieux, 1999), this is perhaps a surprising result. Thirdly, a close inspection of the wage and employment patterns reveals that, in both Canada and the U.S., the most negatively impacted occupations in job-quality deciles 2-4 did not have corresponding wage declines. In fact, in the U.S. data, wage growth was positive for job-quality deciles 2-4, and

FIGURE 18.— Occupational Employment Wage by Decade: US



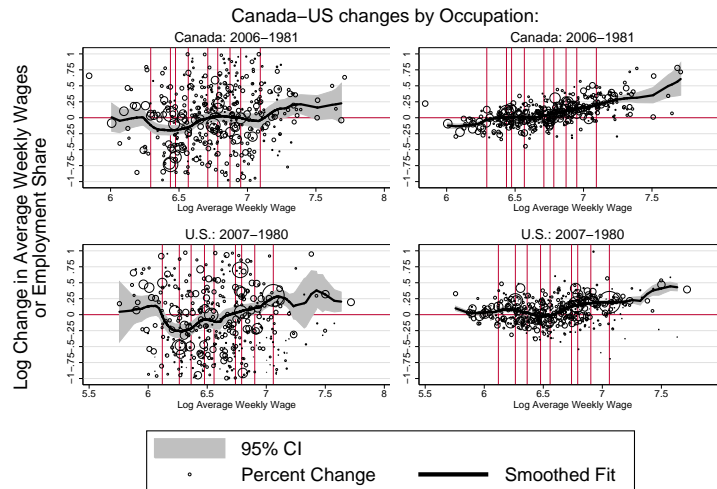
Data comes from the U.S. Censuses from 1970-2000 and the 2007 ACS. The x -axis denotes the average wage of an occupation in 1990. The y -axis displays the growth in the average wage of an occupation calculated as the change in log wages. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1990. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 1990.

greater than wage growth in the first decile, since 1980. Lastly, in both Canada and the U.S., only in the 9th and 10th deciles did employment and wage changes move in the same direction, which is evidence of demand shifts that favour these workers.

4.2.3. Detailed Occupations

The employment and wage changes by occupation in the previous section provide a disaggregated picture of movements in the employment and wage structure but it is potentially informative to know which specific occupations are responsible for the main patterns. The first three columns of Table II contain the difference between the log wage in a given occupation-year cell and the log of the overall average wage in 1991 at the two digit occupational level. Thus, all of the reported values are log differences relative to the 1991 mean and the difference between any two values in the table corresponds to the difference in log wages between those occupation-year cells. The occupations are listed in their ordering from the highest- to lowest-wage occupations in 1991. Following across the columns, it is clear that by far the largest gains (and the highest wage levels) are for 'Senior Management', a category that refers to the business sector.

FIGURE 19.— Occupation Employment and Wage Changes: Canada vs US



Data comes from the Canadian Census Master Files for the years 1981 and 2006 and the U.S. Census for 1980 and the ACS for 2007. The x -axis denotes the average wage of an occupation in 1991 for Canada and 1990 for the U.S.. In column 1, the y -axis displays the employment growth of an occupation calculated as the change in log employment shares. In column 2, the y -axis displays the growth in the average wage of an occupation calculated as the change in log wages. Vertical lines denote employment deciles. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in the base year. The dark line represents kernel regression estimates of the mean employment or wage growth conditional on occupational mean wages in 1991.

Health professionals join them near the top of the rankings. At the other end, sales and service occupations related to the food industry and child care are at the bottom of the list. Some of these occupations had relative wage gains after 1990s, though their wages still remain well below those in mid-range occupations - including mid-range occupations that suffered strong wage losses.

The second set of columns in Table II show employment shares in each occupation in 1981, 1991 and 2006 for Canada. Here we see declines in manufacturing occupations such as 'Labourer in Processing, Manufacturing and Utilities' but we also see offsetting increases in primary production labourer occupations and construction trades. Thus, the decline in the manufacturing sector has been partly offset by improvements in construction and the resource sector. Polarization is evident in the increases in employment shares in several occupations at the bottom of Table II. In summary, occupational changes in Canada since 1980 can be broadly described as declines in manufacturing related jobs, jobs in agriculture and farming, and a fall in secretarial and clerical work. Employment gains were made by high-skill occupations in management, jobs in the financial sector, ad-

TABLE II
RELATIVE WAGES AND EMPLOYMENT: CANADA

	Relative Wages			Employment Share		
	1981	1991	2006	1981	1991	2006
A0 Senior Management Occupations	0.57	0.82	1.20	1.12	1.20	1.50
D0 Professional Occupations in Health	0.60	0.62	0.70	0.82	0.98	1.23
A1 Specialist Managers	0.30	0.44	0.61	2.19	2.72	3.06
A3 Other Managers n.e.c.	0.32	0.40	0.62	3.46	3.95	3.63
I1 Occupations Unique to Forestry Operations, Mini	0.25	0.32	0.44	1.03	0.77	0.64
E1 Teachers and Professors	0.23	0.27	0.25	4.35	4.21	4.24
C0 Professional Occupations in Natural and Applied	0.24	0.26	0.42	2.43	3.21	5.04
E0 Judges, Lawyers, Psychologists, Social Workers,	0.17	0.26	0.42	1.49	1.89	2.38
B0 Professional Occupations in Business and Finan	0.20	0.24	0.50	1.41	1.73	2.92
H0 Contractors and Supervisors in Trades and Trans	0.20	0.22	0.36	2.05	1.71	0.87
H2 Stationary Engineers, Power Station Operators a	0.16	0.20	0.29	1.49	1.40	1.23
J0 Supervisors in Manufacturing	0.20	0.20	0.32	0.89	0.67	0.56
G1 Wholesale, Technical, Insurance, Real Estate Sa	0.090	0.17	0.29	2.87	2.91	2.34
H6 Heavy Equipment and Crane Operators Including D	0.16	0.16	0.20	0.91	0.74	0.71
G6 Occupations in Protective Services	0.11	0.13	0.20	1.50	1.53	1.46
C1 Technical Occupations Related to Natural and Ap	0.12	0.13	0.21	2.61	2.59	2.54
H3 Machinists, Metal Forming, Shaping and Erecting	0.051	0.090	0.16	1.09	0.86	0.81
F0 Professional Occupations in Art and Culture	0.040	0.072	0.100	0.83	0.96	1.20
D1 Nurse Supervisors and Registered Nurses	0.00060	0.061	0.29	1.50	1.74	1.73
H4 Mechanics	0.030	0.042	0.11	3.25	2.78	2.60
B3 Administrative and Regulatory Occupations	0.12	0.041	0.12	1.23	1.54	2.34
H1 Construction Trades	0.050	0.032	-0.047	2.23	2.14	2.57
B4 Clerical Supervisors	0.025	0.0022	0.100	1.02	0.92	0.66
H7 Transportation Equipment Operators and Related	-0.0010	-0.024	-0.045	3.67	3.16	3.47
A2 Managers in Retail Trade, Food and Accommodati	0.037	-0.044	0.046	3.54	3.91	3.29
D2 Technical and Related Occupations In Health	-0.15	-0.063	0.012	1.12	1.24	1.34
H8 Trades Helpers, Construction, and Transportatio	-0.042	-0.065	-0.12	2.66	2.29	2.18
J1 Machine Operators in Manufacturing	-0.13	-0.093	-0.030	5.52	4.16	3.35
J2 Assemblers in Manufacturing	-0.100	-0.11	-0.055	1.67	1.52	1.71
F1 Technical Occupations in Art, Culture, Recreati	-0.12	-0.12	-0.095	1.14	1.18	1.44
E2 Paralegals, Social Services Workers and Occupat	-0.037	-0.12	-0.12	0.69	0.84	1.15
I2 Primary Production Labourers	-0.10	-0.15	-0.24	0.61	0.57	0.62
B1 Finance and Insurance Administrative Occupatio	-0.15	-0.15	-0.0086	1.37	1.26	1.24
G0 Sales and Service Supervisors	-0.079	-0.19	-0.28	0.65	0.68	0.82
J3 Labourers in Processing, Manufacturing and Util	-0.19	-0.20	-0.23	1.96	1.70	1.56
H5 Other Trades n.e.c.	-0.22	-0.25	-0.23	0.94	0.83	0.65
B5 Clerical Occupations	-0.26	-0.26	-0.19	10.9	10.7	9.97
G7 Occupations in Travel and Accommodation Includi	-0.22	-0.27	-0.25	0.52	0.59	0.77
B2 Secretaries	-0.34	-0.30	-0.24	3.77	3.84	1.85
G2 Retail Salespersons and Sales Clerks	-0.25	-0.31	-0.23	3.26	3.40	3.46
I0 Occupations Unique to Agriculture Excluding Lab	-0.22	-0.34	-0.25	3.28	2.78	1.82
D3 Assisting Occupations in Support of Health Serv	-0.27	-0.36	-0.32	1.02	1.10	1.47
G9 Sales and Service Occupations n.e.c.	-0.36	-0.40	-0.47	5.74	5.93	5.91
G4 Chefs and Cooks	-0.43	-0.44	-0.52	0.91	1.17	1.25
G8 Childcare and Home Support Workers	-0.36	-0.64	-0.48	0.92	1.49	2.15
G3 Cashiers	-0.50	-0.65	-0.73	1.02	1.10	1.13
G5 Occupations in Food and Beverage Service	-0.67	-0.71	-0.78	1.29	1.41	1.15

ministration, and computer and information systems; and by sales and personal service-type jobs on the low-end of the skill distribution.

4.2.4. *Gender*

In this section, we break down the changes in occupational employment and wages in Canada between men and women. Since, at this level of disaggregation, occupation cells sizes can become quite small, we use the 1991 SOC aggregated up into the two-digit level, where there are 47 occupations. This also allows a cleaner presentation of changes in employment and wages of particular occupation groups. We focus on employment changes over the period since 1980.

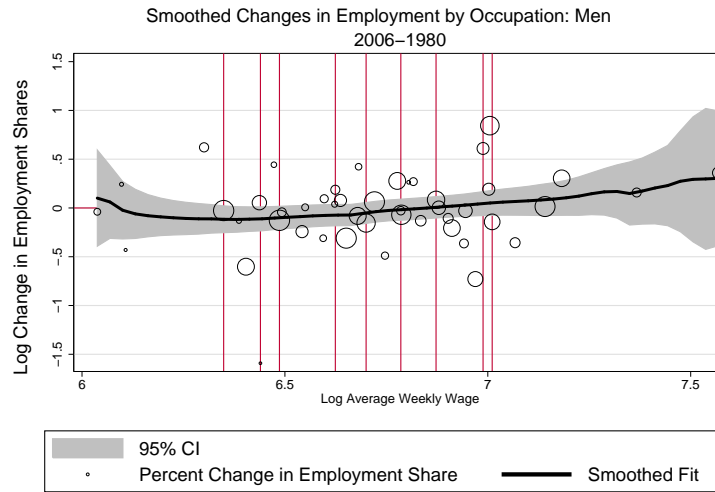
Figures 20 and 21 show the changes in employment for men and women, respectively. When constructing this figure, we continue to rank occupations by their overall (men and women) wages, in order to preserve comparability between the gender-specific figures and the overall (men and women) figures. Therefore, the wage along the x -axis refers to the overall occupational wage, but the size of the circles refer to the relative size of the gender-specific employment. The vertical lines split each panel into deciles of employment based on the overall, combined employment of both genders. Otherwise, these figure are similar to Figure 11.

Figure 20 displays the results for mens' employment changes. As can be seen from the figure, men are more heavily concentrated in occupations above the 5th decile of job-quality in the overall distribution of employment as indicated by the size and clustering of the circles. Mens' employment growth over this period is concentrated among the highest-paying jobs, while employment shares in the 2nd-4th deciles show slight declines. Otherwise, it is apparent that, since men are concentrated in jobs above the 5th job-quality decile, shifts in their occupation structure are unlikely to be causing the U-shape observed in panel 1 of Figure 19, except for the impact of agricultural employment.

Figure 21 contains the results for women. Compared to men, women are much more heavily concentrated in the bottom 5 deciles of job-quality. Like men, women have increased their employment shares mainly in high-paying jobs. The first job-decile also shows a considerable increase in one occupation, which turns out to be "Home Support Workers." Employment growth in this occupation is particularly apparent over the 1990s (not seen from this figure). Women also show strong declines in employment in occupations in the 2nd-4th job-quality deciles. Overall, female employment shows a trend of much stronger job polarization compared to men over the 1980-2006 period.

Figures 22 and 23 show comparable figures which examine the relationship between wage growth and the base wage in 1991. In these figures, the wage changes are gender specific. For example, wages for Clerical workers fell slightly for men over this period, but grew for women. Similar to what is presented above, the changes in occupational wages over this period are strongly monotonic in base period wage for both genders. In addition, several occupations with

FIGURE 20.— Occupational Employment Changes: Canadian Men



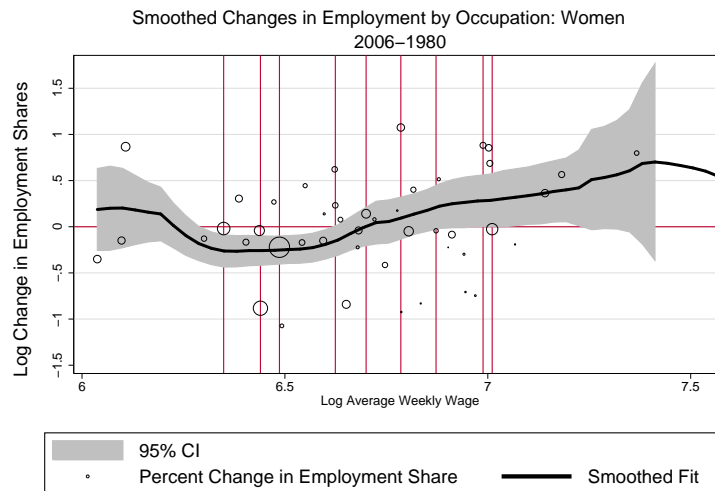
Data comes from the Canadian Census Master Files from 1981, 1991 and 2006. The x -axis denotes the average wage of an occupation in 1991 among all workers. The y -axis displays employment growth of an occupation for men, calculated as the change in log share of male employment. Vertical lines denote employment deciles for all workers. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991 in terms of male employment. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 1991.

strong employment declines, such as Secretaries, experienced wage growth. This observation is not consistent with a fall in the demand for secretarial work unless there were strong compositional changes.

5. DISCUSSION

Having set out the main patterns in polarization and movements in wage inequality for Canada, it is interesting to consider how they relate to the results in other countries and the models developed to explain them. We have seen from direct comparison that Canadian employment patterns are similar to those in the U.S.. The occupational structure in both countries underwent a polarization through the 1980s and 1990s with the strongest employment growth in the highest paying occupations and better employment outcomes in the first decile of the distribution of occupations ranked by skill than in the second through fourth deciles. In both countries, as well, the polarization trend appeared to stop around 2000, with a cessation in the growth of employment in the top occupations. The finding that polarization in the U.S. started in the 1980s rather than the 1990s does not reflect the consensus in the U.S. literature but it fits with findings in

FIGURE 21.— Occupational Employment Changes: Canadian Women

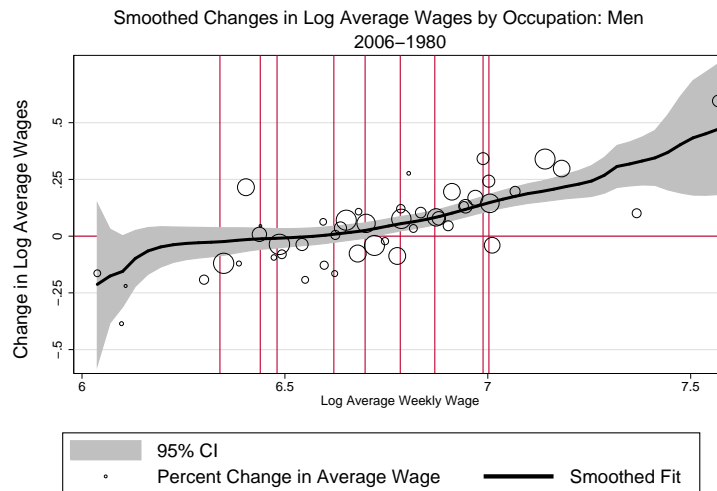


Data comes from the Canadian Census Master Files from 1981, 1991 and 2006. The x -axis denotes the average wage of an occupation in 1991 among all workers. The y -axis displays employment growth of an occupation for women, calculated as the change in log share of female employment. Vertical lines denote employment deciles for all workers. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991 in terms of female employment. The dark line represents kernel regression estimates of the mean employment growth conditional on occupational mean wages in 1991.

Lefter and Sand (2010) and Mishel, Shierholz, and Schmitt (2013). The pattern of polarization in the 1980s and 1990s also fits with results from the U.K. ((Goos and Manning, 2007)), Germany ((Dustmann, Ludsteck, and Schoenberg, 2009)), and other European economies ((Goos, Manning, and Salomons, 2009)). The lack of polarization after 2000 fits with results for the U.S. in Beaudry, Green, and Sand (2013).

The most widely hypothesized explanation for this employment growth pattern is a nuanced version of skill-biased technological change based on the “routinization” model developed by Autor, Levy, and Murnane (2003) (ALM). A central example of the type of model used to explain polarization is the one set out in Autor and Dorn (2010). In their model, unskilled workers can work either in service jobs (what they call unskilled manual occupations) or in routine tasks in goods producing sectors. The latter type of tasks can be replaced with computer capital and an aggregate of computer capital and routine task labour is combined with skilled labour to produce goods. If the price of computer capital falls, several implications arise in their model. First, since computer capital is a complement to skilled labour, employment and wages for skilled workers rise.

FIGURE 22.— Occupational Wage Changes: Canadian Men



Data comes from the Canadian Census Master Files from 1981, 1991 and 2006. The x -axis denotes the average wage of an occupation in 1991 among all workers. The y -axis displays wage growth of an occupation for men, calculated as the change in log share of the average male wage in an occupation. Vertical lines denote employment deciles for all workers. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991 in terms of male employment. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 1991.

Second, since computer capital is a substitute for routine task labour, wages and employment for unskilled routine tasks fall. Third, goods become cheaper to produce and, to the extent that goods and services are complements, that will imply some increase in demand for service sector labour which will raise service sector employment and wages. That is, their model predicts polarization in wages and employment.

Does this model fit with Canadian data patterns? First, it is worth pointing out that it is not clear it fits well with any country's patterns. The model was built to explain U.S. patterns in the 1990s and is based on a simple but powerful piece of identification reasoning: if wages and employment move in the same direction in a sector of the economy then the proximate cause must be a shift in demand. For the U.S. in the 1990s, as we have seen, there was a polarization in both wages and employment which is the basis for the argument that there was increased demand for both high- and low-skilled labour relative to middle-skilled labour. However, as the earlier figures show, the occupations where employment fell (in the second through fourth deciles) correspond to occupations with wage increases. The wage and employment movements, even in the U.S. in the 1990s,

FIGURE 23.— Occupational Wage Changes: Canadian Women



Data comes from the Canadian Census Master Files from 1981, 1991 and 2006. The x -axis denotes the average wage of an occupation in 1991 among all workers. The y -axis displays wage growth of an occupation for women, calculated as the change in log share of the average female wage in an occupation. Vertical lines denote employment deciles for all workers. Each circle shows an occupation's outcome and the relative size of the circles denote the size of the occupation in 1991 in terms of female employment. The dark line represents kernel regression estimates of the mean wage growth conditional on occupational mean wages in 1991.

match up only in the broadest of senses. [Autor and Dorn \(2010\)](#) argue that changes in composition could generate differences along the line in employment and wage changes but no study has really addressed this point and it remains speculation.

For the U.K., Germany and the rest of Europe, employment polarization is matched with a growth in wages at the top end and a decline at the bottom. ([Goos and Manning, 2007](#)) note this mismatch but still argue for an ALM type model as an explanation. They provide several possibilities for why wages fall at the bottom end in contradiction to the prediction of an ALM model but reach no conclusions. ([Antonczyk, DeLeire, and Fitzenberger, 2010](#)) argue that the weakening of labour market institutions in Germany in the 1990s could account for falling wages at the bottom of the distribution in that country.

As we have seen, Canada is another country where employment polarization is matched against rising wages in top end occupations and declining wages at the bottom. The ([Antonczyk, DeLeire, and Fitzenberger, 2010](#)) explanation of weakening institutions is unlikely to apply in Canada in this decade as, for example, minimum wages increased across most provinces. Instead, appealing to the

basic identification logic that is typically used in this literature, declining wages matched against increasing employment would point toward a supply increase in bottom-end occupations. This is not to say that demand shifts have not occurred or are unimportant, only that (in the absence of institutional changes or the very substantial shifts in composition that would be needed to reverse the observed wage changes) there must have been a larger supply shift. Such a shift could arise as a consequence of declining demand for middle-skilled jobs, with workers who would formerly have been in, say, manufacturing jobs now supplying their labour to the service sector. This is the type of model argued for by (Juhn, 1999) and (Juhn and Murphy, 1995), among others. One complication with such a model is that the fact that wages fell more at the bottom than in the middle occupations, implying that workers were not choosing to switch sectors. This type of pattern would fit with a demand decrease in sectors such as manufacturing interacting with downward wage rigidities in those sectors that would effectively lead to workers being pushed out of manufacturing and into service jobs. For example, to the extent that older cohorts of union workers manage to maintain high wages in their bargaining through holding up capital, the result could be fewer of these jobs for younger generations.¹⁴ A demand decrease in middle-skill occupations (and a corresponding increase in demand for high-end occupations before 2000) might well stem from technological change. In that sense, the common model of technological change could still fit part of the Canadian experience. However, something else is needed to understand the wage and employment patterns in the lower tail. The only remaining question is why the U.S. in the 1990s stood out as so different from other developed countries and from the U.S. itself in other decades. Answering that question is beyond the realm of this paper. But it seems clear that applying models that were developed to explain patterns in the U.S. labour market in the 1990s to Canada should be done with caution.

6. CONCLUSION

In this paper, we use Canadian Census and LFS data covering the period from 1971 to 2011 to portray movements in wage inequality, and employment and wage polarization across occupations in the last four decades. We use US Census data to provide a benchmark for the Canadian patterns since much of the discussion of polarization has been built around U.S. patterns. One of our goals is to assess whether the broad Canadian patterns fits with common models used to explain polarization in the U.S. and other countries.

Our main findings are that the Canadian labour market did undergo a polarization of employment in the 1980s and 1990s with employment growth in high

¹⁴ Green and Townsend (2010) show that when wages for high school or less educated men are organized by job cohort (defined by when they started their job), the starting wages for cohorts entering jobs in the early 1980s are on the order of 20% above those for cohorts entering in the 1990s or later. Moreover, the real wages of the older cohorts are maintained even while those of the new cohorts are declining.

and low paying occupations relative to those in the middle. After 2000, however, the employment growth at the top end appears to have stalled. For wages, both overall inequality and wages by occupation show a pattern of increased inequality across the distribution. That is, wages fell for low-end occupations relative to middle-paying occupations and for middle-paying occupations relative to high-paying occupations. This pattern is present for our data period as a whole and for most sub-periods. One main exception relates to inequality in the 2000s. After the onset of the resource boom in the West, Ontario continues to follow this pattern while the Alberta wage distribution polarized. In the latter case, though, the wage polarization is unlikely to have been caused by technological change. Instead, it likely arose from difficulties in getting a sufficient supply of low skilled workers to resource boom areas.

A comparison of these patterns with those in the U.S. data reveal that employment patterns are very similar in the two countries. Both experience polarization in the 1980s and 1990s and a stalling of that pattern after 2000. The polarization before 2000 fits with results from papers on the U.K. and Europe. But the countries differ considerably in wage patterns. Both countries experienced wage growth in high-paying occupations but Canada shows more consistent declines in wages at the low end. The strongest difference in this regard emerge in the 1990s, when the U.S. appears to be the only country with substantial wage polarization. Overall, both the wage and employment patterns in Canada are in strong accord with what has been documented for Europe and the U.K.. Given these patterns, we argue, in the end, that the common model of technologically driven demand shifts in both tails of the skill distribution driving polarization does not fit with the Canadian data. Technology may well be behind what has happened to jobs in the middle and upper parts of the skill distribution but something more is needed to understand outcomes in lower skilled occupations. In Canada's case, as well, one must overlay a discussion of the effects of the resource boom after 2000 over any technological determinants story.

APPENDIX A: DATA

A.1. *Canadian Census Data*

We use Canadian Census data from the 1971, 1981, 1986, 1991, 1996, 2001, and 2006 master files. We focus on adults between the ages of 18 and 64 at the time of the Census and we eliminate unpaid family workers. Following the literature, we use two samples in our analysis. The first sample is used to construct employment counts. Since our goal is to measure the total number of hours supplied to a particular occupation, we use all individuals who report positive weeks worked, regardless of whether or not they are self employed or work for wages. The Census data contains information on the occupation an individual worked in the prior year as well as the number of weeks worked. As in [Card and Lemieux \(2001\)](#), we impute a measure of annual hours worked in an occupation by multiplying the number of weeks worked last year by 40 for full-time workers and 20 for part-time workers. We use this imputation procedure because the Census does not contain information on the number of hours worked in the year prior to the Census. In the 1971 Census, weeks worked last year is reported as a categorical variable. We impute a continuous number of weeks worked variable for this Census year by assigning the mid-point within each category.

Our wage data is obtained from a more restricted sample of workers. We begin with the employment count sample and eliminate individuals who do not work for wages and salary, as well as observations without positive income. We construct a weekly wage measure by dividing wage and salary income by the number of weeks worked for individuals who report working full-time. Weekly wages are deflated to 2000 dollars using the CPI. We set to missing the wages of any individuals with a weekly wage less than \$75 in 2000 dollars. Income and weeks worked refer to the year prior to the Census. The Census does not contain information on the usual number of hours worked per week in the reference year, and therefore the annual number of hours worked. This information is required to construct an hourly wage measure. One alternative is to use the number of hours worked in the Census reference week to proxy for usual hours worked per week. However, the number of hours worked in a given week may vary considerably for individuals in certain occupations. Given the focus on occupations in this paper, we instead chose to follow [Boudarbat, Lemieux, and Riddell \(2010b\)](#); [Card and Lemieux \(2001\)](#) and focus on the wages of individuals who report working full-time in the year prior to the Census. It is common in the literature to further restrict attention to those working full-year (usually defined by a weeks worked cut-off). As in [Boudarbat, Lemieux, and Riddell \(2010b\)](#), we chose not to follow this practice. In 2006, respondents were able to provide income tax data instead of self-reporting income. As [Boudarbat, Lemieux, and Riddell \(2010b\)](#) suggest, another benefit of focusing on workers with a relatively strong attachment to the labour force (ie. full-time workers), is that it mitigates potential problems comparing the 2006 Census data on income with data from earlier years.

A central data issue that must be overcome in our analysis is the comparability of occupational classification across Census years. We focus on the 1991 Standard Occupational Classification (SOC) as our basis for constructing a consistent occupational classification. This classification has been recorded in all Censuses beginning with the 1991 Census, with only minor changes. Therefore, in the the 1991 to 2006 Census data, we are able to construct a slightly aggregated occupational code that is directly comparable across years. For years prior to 1991, we construct a crosswalk across occupational classifications. To implement this, we use the fact that the 1971 occupational classification was recorded in all Censuses from 1971 to 1991. We construct the cross-walk by using the 1991 Census to map the 1971 classifications to the 1991 classification described above. Details of this procedure are provided in the text. For Censuses prior to 1991, the data is aggregated at the 1971 occupation classification level; we calculate the number of hours worked as well as average wage measures for each 1971 classification. These are translated into the 1991 (SOC) level by using the cross-walk that we construct. If an 1971 occupation is split into more than one 1991 classification, we use the cross-walk to allocate the number of hours worked in the 1971 occupation among the 1991 codes, according to the fraction of workers in the 1991 Census with the same 1971 occupation. Similarly, when constructing wage measures at the 1991 SOC level, we take the weighted average of the wages in the 1971 occupations where the weights are given by cross-walk proportions.

Several assumptions are required for this procedure to be valid. In particular, we assume that the relationship between the 1971 occupational classification and the 1991 classification is stable across time. This allows us to use the 1991 Census to calculate the proportions that we apply to the 1971 data. Second, we assume that the head counts we use to calculate the proportions in the cross-walks are proportional to the annual hours worked in each occupation. Finally, when we construct the crosswalks we do not condition on other variables (for example, gender or education). Therefore we assume that the proportions in the cross-walks we calculate are stable across demographic groups. This assumption could be relaxed, for example, by calculating the cross-walks separately by gender. In practice, this resulted in cell sizes that violated restrictions in place at the Research Data Center.

A.2. *U.S Census and American Community Survey*

The Census data was obtained with extractions done using the IPUMS system (see [Ruggles, Sobek, Alexander, Fitch, Goeken, Hall, King, and Ronnander \(2008\)](#)). The files used are the 1980 5% State (A Sample), 1990 State, 2000 5% CensusPUMS, and the 2007 American Community

Survey. For 1970, Forms 1 and 2 were used for the Metro sample, and we adjust the weights for the fact that we use two samples. Our extracts contain information on individuals 18 through 65 who are currently employed in the civilian labor force, not living in group quarters or performing unpaid family work. We follow the literature in constructing labor supply weights by multiplying the Census weight by annual hours worked. In 1970, weeks worked last year are only available in categories. We impute a continuous weeks worked last year variable by assigning means of the IPUMs variable `wkswork1` by the categorical variable `wkswork2` by gender and race using the 1980 Census. Our measure for hours worked is ‘usual hours worked last year’ (`uhrswork`). This variable is not available in 1970, and we impute it for that using 1980 Census information on hours worked last week by gender and race.

For wage calculations, we further restrict the data to those (1) working for wages and salary, (2) with positive income from wages and salary, (3) with positive weeks worked last year. Top codes differ by Census year. For 1970 and 1980 Census data, we use a top code on wage and salary income of 50,000 and 75,000, respectively. In later Census years, top codes vary by state. We impose a uniform top code of 140,000 in 1990 and 200,000 for the 2000 Census and 2007 ACS. We adjust top code observations by 1.5. Hourly wages are calculated by dividing annual wage and salary income by annual hours worked, and set to missing hourly wages less than 1 or greater than 100 in 1979 dollars using the CPI-U deflator. We form weekly wages analogously for those with valid hourly wage observations.

Occupation codes differ by Census year. We use occupation categories that are consistent between 1980 and 1990 in the Census that are produced by code that can be found here: <http://www.unionstats.com/>. For the Census years 2000 and 2007, we use BLS cross-walks to convert aggregated data at the occupation level into the 1980-1990 Census occupation classification. These cross-walks can be found here: http://usa.ipums.org/usa/volii/occ_ind.shtml.

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