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IZA DP No. 11598

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ABSTRACT

Estimating the Impacts of Payroll Taxes: Evidence from Canadian Employer-Employee Tax Data

In this paper, we use linked employer-employee administrative tax data from Canada to estimate the impact of payroll taxes on a variety of firms and workers outcomes. At the firm level, we use geographic and time variations in tax rates to identify the effect of payroll taxes on wage growth at the worker level. For one province, we exploit a clean overtime change in the payroll tax rate to estimate its impact on the firm's level of employment, average wage and productivity, with difference-in-differences models, taking into account firm-level unobserved heterogeneity. Additionally, taking advantage of the nature of linked data, we estimate wage equations with both fixed worker and firm fixed effects. We find no impact on employment, productivity and profits, but significant impacts on wages, implying that payroll taxes are passed almost entirely to workers in the form of lower wages.*

JEL Classification: E62, J21, L25

Keywords: payroll taxes, wages, productivity, employment, linked employer-employee data

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1. Introduction

Payroll taxes are taxes levied on employers based on their aggregate payroll. They are paid directly from the employer's fund and directly tied to employing a worker. Hence, these taxes are different from other payroll taxes such as social contributions to employment insurance, health and safety at work, disability and contributions to the pension plan. Social contributions' costs are generally shared between the firm and the worker, vary according to the employee's salary but can also be paid only by the employer.[1]

Payroll taxes, including social contributions, collect approximately 25% of total tax revenue in OECD countries (Saez, Schoefer, and Seim (2017)). In Canada, pure payroll taxes levied directly on employers for general revenue purpose continue to be a significant component of corporate taxation in many provinces, including the two largest, namely, Manitoba, Québec, Ontario and Newfoundland, as illustrated in Figure 1.[2] Although nominally earmarked for certain expenses, they are best thought as contributing to general revenues.

In theory, the impact of a tax imposed on firms is uncertain. It can be passed on to consumers, paid by employees or borne by shareholders. A tax passed on to consumers could make the firm's products less competitive in the marketplace. A tax paid by employees may have a negative impact on the quality of the workforce hired by the firm as well as on its employment level. A tax shielded by shareholders through lower profits may have a downward impact on future investment opportunities. Therefore, the impact of payroll taxes is an important empirical question.

The consensus is that those taxes are partially to completely shifted to workers, at least in the long run (e.g., Anderson and Meyer (1997)). This shifting is often rationalized by the fact many of these taxes are used to fund services to workers, creating a so-called tax/benefit linkage (Summers (1989)). If workers attach value to these offsetting benefits, they could accept a lower wage in return without the tax having a significant impact on the level of employment of the company.[3]

However, the link between potential benefits and taxes is particularly fuzzy in the case of employer-specific payroll taxes compared to social contributions whose cost

[1]Other commonly used terms for the later include withholding tax, pay-as-you-earn tax (PAYE), or pay-as-you-go tax (PAYG).
[2]See also Di Matteo and Shannon (1995), Lin, Picot, and Beach (1996), Lin (2000a) and Lin (2000b).
[3]Complete tax shifting could also be prevented due to firms facing different tax rates based on their different payrolls and competing to hire the same workers. Anderson and Meyer (2000) show that this is the case for unemployment insurance based on experience ratings.

are shared between firms and workers; the former would be expected to have a possibly larger impact on employment decisions at the firm level. This underlines the importance of empirical studies to estimate the actual impact of these types of taxes separately.

Depending on who is the ultimate payer, such payroll taxes might have employment in addition to wage effects. In fact, possible benefits in terms of employment are the rationale often used for lowering payroll taxes (as part of wider packages of reduction in the level of employment protection). Insights into the employment effect of payroll taxes depend on the amount of shifting (partial or complete) to workers.

Unfortunately, the empirical literature on the impact of payroll taxes is limited (Saez, Matsaganis, and Tsakloglou (2012)). This is mostly due to the lack of relevant data at the firm level and the lack of clear identification strategies, because these taxes do not vary much within a country or across time in general. We review the literature in detail in Section 2.

This paper therefore aims to estimate the impact of payroll taxes in the Canadian context where this type of tax is still widely used and where empirical evidence is still scarce. Estimating this impact for Canada is even more interesting because the identification of the impact can be obtained by changes in the level of these taxes both over time and between provinces.

We use the Canadian Employer-Employee Dynamic Database (CEEDD) from 2001 to 2011 to analyze the impact of payroll taxes on firms' wages, employment levels, productivity and profits. The CEEDD is a longitudinally linked employer-employee data set based on the worker and firm tax records. As is the case with most administrative data, the CEEDD has a paucity of demographic variables, but the longitudinal and linked nature of the data allows us to take into account unobserved worker and firm heterogeneity, addressing some endogeneity concerns.

We start by estimating a very general wage growth equation, attempting to identify the impact of payroll taxes by exploiting geographical and time variations in tax rates as well as variations in how the tax applies based on the firm's payroll. We move on by examining more closely a natural experiment in how the payroll tax applies in Manitoba. This allows us to widen our analysis to firm-level outcomes including productivity, profits and employment levels. Finally, we take advantage of the fact that we have longitudinal linked employer-employee data to return to wage regressions in a natural experiment framework, allowing for heterogeneous treatment effects.[4] Hence,

[4]Not much work has been done on estimating the heterogeneous effects of payroll taxes. Vermaeten, Gillespie, and Vermaeten (1995), who analyze the impact of payroll taxes and social contributions

we are the first study to look at the impact of payroll taxes exploiting a natural experiment with administrative linked employer-employee tax data.

In virtually all specifications, we find no impact of payroll taxes on firms' levels of employment, productivity and profits, but we find significant and meaningful impacts on average wages (payroll divided by the number of employees). The results from worker-level regressions, including both firm and worker fixed effects, yield similar conclusions, implying that payroll taxes are passed almost entirely to workers in the form of lower wages.

2. Literature

The earlier literature attempting to estimate the impact of payroll taxes or social contributions obtained mostly mixed results by focusing on temporal variations within country or comparisons between countries. These mixed results are not entirely convincing because of the presence of country-specific factors that may have an impact on both taxation policies and the labor market outcomes. Moreover, analysis focusing only on one country only do so at an aggregate level and do not allow for microeconomic differences between firms to be taken into account. These difficulties led Hamermesh (1993) to summarize this literature by concluding, "It is impossible to draw any firm conclusions about the incidence of payroll tax from these studies."[5]

Hamermesh (1979) is the only author of this period to use worker-level data (adult white males) from the PSID in the United States for the period 1968-1974, finding that a small part of any payroll tax increase is shifted to labor, implying much stronger employment effects than those obtained in the previous literature.

A more convincing set of more recent studies uses changes in tax rates within a country or variations in how payroll taxes apply depending on the types of firm, worker or region, allowing the use of double- or triple-differences estimation methods. Most of this literature focuses on firm-level variables, using average payroll as a measure of average wage. Most find partial to full shifting of payroll taxes to wages and limited to nil effects on employment.

Early examples in this category are Gruber (1997) for Chile and Kugler and Kugler (2009) for Columbia. Similar natural experiment empirical methods are used even more convincingly in a series of recent studies that can rely on even more detailed data

jointly, show that they are progressive in the low end of the income distribution but become regressive in the high end, exhibiting an inverted-U shape in terms of tax incidence.

[5]Notable examples include Brittain (1971) for a multi-countries study, Vroman (1974) for the American manufacturing sector, Beach and Balfour (1983) for the United Kingdom and Holmlund (1983) for Sweden

and changes in geographically targeted tax rates. Bennmarker, Mellander, and Öckert (2009) use a reform of payroll tax rates in northern Sweden in 2002, whereby rates were lowered by 10 percentage points. They find no impact on employment levels in existing firms but a 2.5% increase in wages, implying that employers pay a larger share of the tax. However, these findings are not robust to explicitly taking into account firm exit and entry. When they do so, they find positive effects on employment.

Korkeamaki and Uusitalo (2008) use matching methods to study the impacts of a regional payroll tax decrease in Sweden. They find that half the reduction is passed to workers in the form of higher wages and no employment effect. Cruces, Galiani, and Kidyba (2010) exploit regional and time variations in statutory payroll tax rates in Argentina from 1995 to 2001. A particularity of their study is the use of detailed administrative data to obtain tax rates rather than relying on an implicit calculation based on firm-level characteristics. They also find no impact of payroll taxes on employment levels and a 50% partial shifting to workers through changes in wages.

In a meta-analysis of 52 empirical studies, Melguizo and González-Páramo (2012) find that payroll taxes and social security contributions are mostly paid by workers (66%) in Anglo-Saxon countries, implying that employers do pay some residual share (33%). They do note that the degree of tax shifting seems to be higher in Nordic countries. With respect to the impacts on employment, they conclude that there are no statistically or economically significant effects.

It is worth mentioning that Saez and coauthors obtain results that slightly depart from the literature consensus. However, these results are found using two unusual reforms in Greece and Sweden, so it is not clear how generalizable their results are. For Greece, Saez, Matsaganis, and Tsakloglou (2012) use a discontinuity in the marginal payroll tax rates (mostly social insurance) induced by the 1993 reform. Their results, exploiting administrative social security data, show no labor supply effect of the reform but show that employers absorb the extra employer payroll taxes and employees do the same for the extra employee part.[6] In Sweden, Saez, Schoefer, and Seim (2017) uncover mechanisms used by Swedish firms adjusting to a payroll tax cut for younger workers. They found strong employment effects for younger workers and that the cut was in part redistributed to workers. Workers from all age groups benefit from higher wages, this last pattern being consistent with rent sharing, or pay equity concerns.

[6]This seems to be likely due to the peculiarity of the reform and the fact that employers cannot wage discriminate between similar employees on either side of the discontinuity. The results could well be different from an across the board change in payroll taxes such as the one we examined in this paper.

Cervini-Plá, Ramos, and Silva (2014) use data from Spain and a policy that introduced lower payroll taxes contribution rates and lower firing costs for the unemployed aged less than 30 and over 45 years who find themselves in a new permanent job. They exploit variations in payroll tax rates and firing costs between age groups and across time. Their difference-in-difference estimates show positive effects of both reductions on wages and employment, with the reduction in payroll taxes having a bigger effect on wages.[7] Finally, Neumann (2017) examines discontinuities induced by earning caps for social security contributions in Germany and finds that they are paid equally by employers and employees.

In Canada, despite their widespread use, empirical estimates of the impact of payroll taxes are rare. One study to mention is Vaillancourt and Marceau (1990), who use longitudinal data on 780 collective agreements signed in Quebec between 1975 and 1984. They find that the impact on wages can be positive or negative, depending on the type of payroll taxes or the type of social security contributions. Di Matteo and Shannon (1995), using an aggregate labor market model, find non-negligible impacts of payroll taxes and social contributions on employment and that workers pay 50% of those taxes.

The most recent and comprehensive study for Canada is Abbott and Beach (1997). They use annual time-series data by province over 1966-1993, controlling for macro factors such as unemployment and inflation. Focusing on the employer portion of the tax, they find large unambiguous negative impacts of payroll taxes and social security contributions on both wages and employment.

3. Business taxation in Canada

In Canada, governments primarily use three forms of tax tools to collect income from businesses: business income tax, social security contributions and payroll taxes. Figure 1 illustrates how those three forms of taxes contribute to revenues in each province.

Corporate income tax Deducted from business income, corporate income tax accounts for 37% to 71% of provincial and federal government revenues from Canadian businesses. Provincial tax rates vary by province. The federal rate applies uniformly across Canada.

Social contributions Based on the salary of each employee and capped at maximum annual income, social contributions make up 29% to 63% of provincial and federal

[7]Antón (2014) evaluates the impact of a big payroll tax cut in Columbia, using a dynamic general equilibrium model that takes into account the presence of an informal labor market. He finds non-negligible impacts on employment levels.

government revenues from Canadian businesses. Social security contributions are used to finance programs designed specifically for workers in predetermined situations such as loss of employment or work-related accidents. Programs such as the Employment Insurance Plan or the Québec Parental Insurance Plan are part of the social contributions paid by the employer.

Payroll taxes Based on the company's payroll, that is, the sum of salaries and other benefits paid by the employer to employees: the payroll tax is levied by four provinces (Newfoundland and Labrador, Québec, Ontario, Manitoba). Payroll taxes represent 7% to 21% of provincial and federal government revenues from Canadian businesses.

Note that, as a general rule, studies consider payroll taxes and social contributions as a single business revenue category (usually simply called *payroll taxes*). The main reason for doing so is the fact that both social contributions and payroll taxes are based on wages paid.

In the context of this paper, however, we focus only on payroll taxes. The important distinction in our context is that social contributions are used to fund labor market programs that serve the interests of workers, while revenues from the payroll tax are counted as general government revenues and are used to finance various - not necessarily worker-related - expenditures. In addition, social contributions are levied on the basis of the individual salary of employees and are capped by an annual maximum insurable income, while the payroll tax is deducted from the total remuneration paid to employees (the firm's payroll).

4. Payroll taxes in Canada

In Canada, four provinces impose a tax on the payroll of businesses, namely, Québec, Ontario, Manitoba, and Newfoundland and Labrador. The structure and purpose of payroll taxes vary from province to province, but in all cases, the tax is levied on the total wage bill, or payroll, rather than on the salary of each employee (as is the case for social security contributions) and varies according to the total wage bills.[8]

Québec: Health Service Fund In Québec, firms must contribute to the Health Services Fund (*Fonds des services de santé*), which is used to partly fund the province's health system. The contribution of firms is determined by the size of the wage bill of enterprises:

[8]Anderson and Meyer (1997) examine the theoretical case of a tax that varies across firms in the same labor market. They show this can lead to labor reallocation and large deadweight losses.

- The maximum contribution rate is 4.26% and applies to firms with payrolls of more than 5 million dollars. There is no contribution limit.
- The minimum contribution rate is 2.7% and applies to firms with payrolls of 1 million dollars or less.
- The contribution rate for firms with payroll between 1 and 5 million dollars is progressive and ranges from 2.7% to 4.26% according to the following formula:

$$\text{Contribution rate} = 2.31 + (0.39 * \frac{\text{Payroll}}{1000000})$$

  Under these circumstances, the statutory rate is the same as the actual rate, i.e. the actual tax rate paid by the firm.

Table 1 summarizes the payroll-tax rates faced by firms from 2001-2011. In 2013, employers in Quebec contributed 6,559 million dollars as contributions to the Health Services Fund. Data from 2011 allow us to estimate the contribution of private firms at approximately 60% of the total payments made to the Health Services Fund. The balance is paid by the government and the entire public sector, as an employer, as well as by sole proprietorships and partnerships.

Ontario: Employer Heath Tax In Ontario, businesses are subject to the Employer Health Tax, a tax based on the corporate wage bill that is used to fund health care services in the province. The tax payable by a firm is determined by the size of its payroll as follows.

- The statutory rate is 1.95% of the payroll.
- Firms with payroll of less than 5 million dollars benefit from an exemption on the first $450,000. A firm with a payroll of less than $450,000 is therefore exempt from the Employer Health Tax. The effective rate for firms with payrolls of less than 5 million dollars thus varies from 0% to 1.77%.
- The exemption does not apply to private firms with a payroll higher than $5 million. The effective rate is then 1.95%, the same as the legal rate.

This information is summarized in Table 2

Newfoundland and Labrador: Health and Post Secondary Education Tax Firms in Newfoundland and Labrador are subject to payroll taxes to finance health and education services according to the following schedule.

- Firms with a payroll of less than $1.2 million are exempted from this tax.
- Firms with payrolls of more than $1.2 million are taxed on the portion of their payroll that exceeds this threshold at a statutory rate of 2%. The effective rate

ranges from 0% for firms with a payroll of just over $1.2 million, to 2% as their payrolls increase.

The evolution of these rates from 2001 to 2011 is shown in Table 3.

Manitoba: Health and Post Secondary Education Tax In Manitoba, firms are subject to payroll taxes used to finance health and education services:

- Firms with a payroll of less than $1.25 million are not subject to this tax.
- When the payroll of a firm moves between $1.25 and $2.5 million, it pays a legal contribution rate of 4.3% on the portion of its payroll that exceeds $1.25 million. Given the exemption, the effective rate does not exceed 2.15%.
- Firms with payrolls in excess of $2.5 million do not qualify for the exemption and are taxed on their total payroll at the statutory rate of 2.15%.

The evolution of these rates from 2001 to 2011 is shown in Table 4.

5. Data

This research uses data from the CEEDD, officially described by Statistics Canada as follows:

> The CEEDD is a linked employer-employee database which includes both firm-level and individual-level characteristics. It is a link between various tax files including the T1 personal, family and business declaration files, the T2 files (corporate tax return and owner files) and the T4 supplementary and summary files.

Access to data is restricted but not exclusive to the authors. Our access to the data covers the years 2001 to 2011. In the classification of Abowd and Kramarz (1999), this is a data set that would be described as a representative matched worker-firm panels of administrative origin.

At the firm-level, the data contain detailed data on its payroll, sales, number of employees and industry classification. At the worker level, we have detailed information of its yearly earnings. Ideally, we would like to have information on hours/weeks worked but this information is not available in this data set.

One advantage of using administrative fiscal data is in avoiding as much as possible potential spurious correlation (for example due to measurement error) between the various dependent variables used in our econometric specifications and independent variables linked to payroll taxes.

As is usually the case with administrative data, there is a paucity of information about the demographic characteristics of the workers, but we do have information on age and gender. However, taking advantage of the longitudinal nature of the data, we are able to explicitly model unobserved heterogeneity in most of our econometric specifications.

6. The impact of payroll taxes on wage growth

Because there are only four provinces using that type of tax instrument and because there is not that much variation over time within the provinces in payroll tax rates, as a first attempt to estimate the causal impact of payroll taxes on wages, we use a wage growth model. Our estimate of the impact of payroll taxes on wages thus relies on limited geographic and time variations as plausible sources of identification.

By choosing this particular econometric specification, we implicitly take into account time-invariant determinants of wage, while still allowing for second-order dynamic effects for the limited number of firm and worker characteristics at our disposition. Our model is defined as:

$$\Delta \ln w_{ijt+1} = \beta_1 + \beta_2 payrolltaxes_{ijt} + \beta_3 male_{ijt} + \beta_4 age_{ijt} + \beta_5 X_{ijt} + \varepsilon_{ijt}, \tag{6.1}$$

where the dependent variable is the percentage growth in w_{ijt}, the income of worker i in firm j at time t as extracted from its T4 tax form.[9] This income is, as described the Canada Revenue Agency, the sum of:

> salary, wages (including pay in lieu of termination notice), tips or gratuities, bonuses, vacation pay, employment commissions, gross and insurable earnings of self-employed fishers, and all other remuneration

Our main coefficient of interest is β_2, which indicates the impact of the amount of payroll taxes paid by firm j employing worker i at time t on its wage growth. It is identified by variation over time and between provinces in tax rates but also by variations within province in tax rate by the size of the firm's total payroll.

Since we have no information on actual payroll-tax payments made by the firm, we impute those based on the firm's payroll using the statutory tax schedules as described in Table 1 to 4.

Our econometric model also takes into account the age (age) and gender ($male$) of the worker. Additional control variables included in X_{ijt} are industry controls (4-digits

[9] Vaillancourt and Marceau (1990) and Neubig (1981) used similar wage growth models.

NAICS), firm-size indicator variables (with categories based on levels of employment) and controls for year and province.

In estimating equation 6.1, we exclude from our sample:

(1) firms in the Public Administration sector,
(2) non-incorporated firms,
(3) firms in the Territories (Northwest, Yukon and Nunavut).

Firms in the public sector were excluded because they invariably pay the top payroll tax rate. Rules applying to non-incorporated firms are different.

At the worker level, we also excluded:

(1) Workers aged below 20 and above 64.
(2) Workers occupying more than two jobs in a tax year.[10]
(3) Workers with total yearly income above 1 million dollars.
(4) Workers with total yearly income below what they would earn if working full time at the minimum wage.

These selection rules were used to minimize possible problems due to the fact the we have no information on hours worked, or part-time versus full-time status. Finally, we also excluded workers with wage growth above 100%.[11]

The results from estimating equation 6.1 with the above restrictions are presented in Table 5. It shows a negative impact of payroll taxes on wage growth, implying that a 1 percentage point increase in the tax rate would diminish wage growth by approximately 0.5 percentage point. This result means that workers are paying an important share of the tax through lower wages[12].

Other estimated coefficients mostly come out as expected. Wage growth is higher in larger firms, compared to firms with 1 to 10 employees. Wage growth slows down with age. Additionally, wage growth is higher in the resource-intensive provinces of Newfoundland and Labrador and Saskatchewan, which experienced a resource boom in the 1990s. Many provinces have lower wage growth than the province of Québec. It is true that average incomes are lower in Québec, but Québec has been playing catch up during that period.

[10]Because of the way our dependent variable is constructed, only workers staying in the same firm two years in a row are included in the sample used for our estimation.
[11]Results are robust to using 50% or 75% as a threshold.
[12]On the one hand, Roy-César and Vaillancourt (2010) use a similar methodology and focusing also on social contributions, obtain a similar amount of backward shifting to workers' wages using data from collective bargaining agreements in Québec and Ontario. On the other hand, Ebrahimi and Vaillancourt (2016) use data from Statistics Canada Labor Force Surveys from 1998 to 2013 and find much lower pass-through to workers (3% to 14%)

One has to remember that most wage growth comes from switching jobs. While men overall have higher wage growth, in our subsample of stayers, we observe slightly slower wage growth for men within job.

7. The Manitoba natural experiment: firm-level DD estimates

As a robustness check to our previous result and to use a different hopefully more convincing identification strategy, we take advantage of a natural experiment that occured in the province of Manitoba between 2007 and 2008. During that period, Manitoba effectively lowered the payroll tax rate for medium-sized firms by changing the threshold at which firms start to pay the payroll tax (see Table 4).[13]

The payroll tax in Manitoba celebrated its 25th anniversary in 2007. The *celebration* brought renewed calls for lowering it.[14] The payroll tax is hated by businesses in Manitoba.[15] A recurring concern in the press is that Manitoba is the only western province with such a tax.

The increase in the payroll tax exemption is illustrated in Figure 2 in which we can observe that firms with total payrolls between 1 and 1.25 million dollars no longer had to pay the payroll tax in 2008, and those with total payrolls between 1.25 and 2.5 million experienced a small decrease in the rate they faced. We thus define the treatment group as firms with payrolls between 1 and 2.5 million dollars.

To identify the impact of this change in the payroll tax rate on wages, we use a double-differences model at the firm level. Our main dependent variable, y_{jt} is the average wage of the firm j at time t, i.e., the firm's payroll divided by its total number of employees. All variables are measured in real terms using the Consumer Price Index for Manitoba provided by Statistics Canada.

Our measure of average wage, *avgwage* utilizes the total payroll of the firm divided by the number of individual labor units. Statistics Canada's definition of individual labor units that takes into account workers who were not working only for one firm. For example, for those cases where an individual was not with one firm for an entire year, a ratio is assigned to that individual based on their total earnings for a year. For example, if an individual worked in Firm A for six months of the year and earned

[13]The increase in the exemption was noted in the media, e.g., "*The increase in the payroll exemption, on this its 25th anniversary, is appreciated and will modestly reduce its burden ....*", Winnipeg Free Press April 5, 2007, p. A13

[14]*The Canadian Federation of Business bought a birthday cake and lit the candles to mark the 25th anniversary of the Manitoba payroll tax but not in celebration.*, Winnipeg Free Press, March 22, 2007, p a4

[15]"Business call it a tax on jobs", Winnipeg Free Press, February 14, 2007, p. b3

$40,000 and worked in Firm B for the rest of the year earning $60,000, Firm A will be assigned an ILU of 0.40 for that employee.

Summary statistics at the firm level for Manitoba in years 2006-2009 are presented in Table 6. Each column refers to a payroll category. Category 1 comprises firms with payrolls of less than $1,000,000, category 3 includes firms with payrolls of more than $2,500,000, and category 2 those in between (the treatment group).

In summary, the identification strategy relies on changes in the payroll thresholds that occurred between 2007 and 2008. The control group comprises firms that did not experience a change in their payroll tax rate, firms with a payroll of less than $1,000,000 and firms with a payroll of more than $2,500,000.

The estimated equation is:

$$\ln y_{jt} = \beta + \gamma D_{2t} + \pi T_j + \delta(T_j \cdot D_{2t}) + \psi_j + \epsilon_{jt} \tag{7.1}$$

with

$$D_{2t} = \begin{cases} 1 & \text{if } t > 2007 \\ 0 & \text{or else} \end{cases}$$

and

$$T_j = \begin{cases} 1 & \text{if } j \in \text{treatment group} \\ 0 & \text{or else} \end{cases}$$

Note that all estimated specifications include a fixed time-invariant effect for firm j denoted ψ_j. This effect is identified by the longitudinal nature of the data used and allows for taking into account all the unobserved characteristics of the firm (which are fixed over time) such as the firm?s working conditions, benefits package, average worker characteristics, and unobserved managerial ability.

The results of estimating equation 7.1 are presented in Table 7 using 2007 and 2008 as the pre- and post-reform periods respectively. The first column shows estimated coefficients using average wages as a dependent variable, and other columns show estimated coefficients for employment levels, average productivity and average profits.

The estimated results for the coefficient of interest (δ) can be found in the 'Treatment * Post' row. This coefficient shows a positive and statistically significant effect of the decline in payroll tax rate on average wages, no matter the employment measure that is used. The coefficient indicates that the wages of firms with a payroll between 1 and 2.5 million dollars have increased on average from 4.2% faster compared to other firms.

If the error term does not contain a factor that affects firms in the treatment and control groups differently over time, we can interpret this effect as being directly caused by the decline in the payroll tax rate. Based on our review of newspaper articles in

that time period, we cannot find any other policy change that would have affected firms differently (these are defined as having taxable income of less than 300K). Our results are robust to taking away those very small business from the control group.[16]

Since we also have information on the firm's employment level and sales, we also estimated our double-difference model with average sales, which can be interpreted as productivity, and employment as dependent variables. This allows us to examine a common concern with payroll taxes, namely, that it encourages firms to substitute labor for capital by making employing workers more expensive.

The second column of Table 7 shows that the lower payroll tax rates did not seem to have any impact on the firm's level of employment. This finding is in accordance with our previous findings showing that payroll taxes are passed on to workers through lower wages. When this is the case, one should not expect the levels of employment to be affected by those taxes.

However, the third column of Table 7 shows lower payroll tax rates seemed to have a positive impact on the firm's productivity, measured as sales per employee. This is to our knowledge a new and interesting finding. Comparing estimates from the impact on wages, the impact on productivity appears to be even higher. This last result is somewhat counterintuitive. One could think that the previously found positive impact of the payroll tax cut on wages would increase returns to human capital investments (through lower investments in firm-sponsored training, for example). Given the well-known positive impact of firm-sponsored training on productivity (see Dostie (2013)), one could expect a negative link between levels of payroll taxes and productivity.

Finally, the fourth column shows the impact of the decline in the payroll tax on profits. Saez, Matsaganis, and Tsakloglou (2012) show that if wages were sticky in the short run, reducing payroll tax would increase profits while not affecting net wages. However, coherent with our findings on wages, we find no statistically significant impact on firms' levels of profits. This is a particularly interesting and novel result, as data on profits are very rarely available in the payroll tax literature.

Before reaching a conclusion about the impact of payroll taxes, note that the above results could still be affected by a number of possible biases. First, there is the well-known issue of time-varying shocks that affect the treatment and control groups differently. Second, there is a possible labor turnover bias. Labor turnover, driven by changes in relative effective wages, might affect the quality of labor employed by the

[16]A new statutory February holiday "Family Day" was announced in 2007 and started in 2008. The small business tax rate and general corporate income tax were both cut by 1% and the general corporate capital tax was cut by 20%.

firm. Finally, there is a possible labor intensity bias. Because of the source of our data, we do not observe hourly wages and do not know whether the hours of work changed before and after the reform. We tackle each of those possible biases in the next sections.

8. Manitoba triple differences estimates

Remember that the causal interpretation of the results depends on the assumption that no factor influencing the dependent variable affects firms from the treatment and control groups differently. In the presence of such factors, it is still possible to identify the impact of the change in the tax assuming that these factors also occur in another location and to use that other geographic area to identify them in a triple differences model.

In our context, it seems natural to use the neighbouring province of Manitoba in the Prairie region, Saskatchewan. Both provinces have had weak population growth from 2001-11 and similar industrial structures, with a large agricultural sector, except that the size of the energy sector is larger and growing more rapidly in Saskatchewan (mostly due to uranium, potash and shale oil).

The estimated model is:

$$\begin{aligned} \ln y_{jpt} &= \beta + \gamma_1 D_{2t} + \gamma_2 T_j + \gamma_3 P_p + \\ &+ \pi_1 (T_j \cdot D_{2t}) + \pi_2 (T_j \cdot P_p) + \pi_3 (D_{2t} \cdot P_p) \\ &+ \delta (T_j \cdot D_{2t} \cdot P_p) \\ &+ \psi_j + \epsilon_{jt} \end{aligned}$$

where the p index now indicates the province, the dichotomous variable P_p is one for Manitoba firms and the impact of the δ reform is identified by the triple interaction.

Coefficient estimates from estimating equation (8.1) are presented in Table 8 for three firm-level outcomes, levels of employment, average wages and productivity using 2007 and 2008 as the pre- and post-reform years, respectively. All columns show treatment effects ('Manitoba * Post * Treatment' row) of a similar magnitude as previously found, albeit non-statistically significant at standard levels.

To see whether we obtain more statistical power with a larger sample, we re-estimate equation (8.1) using 2006 and 2007 as the pre-reform years and 2008 and 2009 as the post-reform period. As we move away from the year of the reform, we run a higher risk of confounding factors contaminating our estimates, but coefficients again remain much in line with what has been previously found. Only the impact on average wages revert

to being statistically different than zero, albeit at the 10% level, implying that wages increase by 3.5% in the treatment group compared to the control groups, implying again that the decrease in the payroll tax rates reverted to workers in the form of higher wages. Those results also show that the wage increase is not temporary.

9. Worker-level regressions

Estimates obtained from firm-level regressions confirmed and even reinforced our main finding that firms bear little if any of the burden of payroll taxes. However, the method used to obtain the previous double- and triple-differences estimates focus only on one side of the market, the demand side. Moreover, as mentioned before, the previous estimates are possibly biased due to firm-level labor turnover. However, we can use the fact that we have linked employer-employee data to examine the impact of the lower payroll tax rate on workers' wages using similar natural experiment methods.

We use the same definition of wages as in Section 6 with the structure of the double-differences model from Section 7. We take advantage of the fact that we longitudinally linked employer-employee data by estimating a wage model with fixed effects both at the worker and firm levels, taking into account unobserved heterogeneity at both levels. We define the model as:

$$\ln y_{ijt} = \beta + \gamma D_{2t} + \pi T_j + \delta(T_j \cdot D_{2t}) + \theta_i + \psi_j + \epsilon_{jit}, \tag{9.1}$$

in which the equation now includes a worker fixed effect (θ_i) in a addition to the firm fixed effect (ψ_j) (see Abowd, Kramarz, and Margolis (1999)).

Summary statistics at the worker level for Manitoba in the years 2006-2009 are presented in Table 10. Each column refers to the same payroll categories as defined earlier. Table 10 shows that earning increases with firm size. There is not much variation in age although workers in medium-sized firms (payroll category 2) appear to be slightly younger. The largest firms employ a more feminized workforce, as do the smallest firms, but to a lesser degree.

The results from estimating equation 9.1 are presented in Table 11 with either worker or firm fixed effects. Results with both fixed effects simultaneously are presented in the next section. Both sets of results show that taking into account unobserved heterogeneity lowers our previous estimate, with unobserved worker heterogeneity being more important. But we still conclude that workers bear the full extent of the payroll tax.

10. Heterogeneous effects

In the last set of estimates, we investigate whether we can find heterogeneous impacts, depending on the earnings of the worker, and estimate equation 9.1 taking into account both worker and firm unobserved heterogeneity. We divide our sample into three subsamples based on the worker's location in the distribution of earnings and estimate equation 9.1 on each subsample.

Remember that we found earlier that firms that benefited from a reduction in their payroll tax rates gave back their saving almost entirely on average to their workers. However, it is possible that those savings are not distributed equally among all workers. One could imagine for example that workers with lower wage bargaining power bear a higher proportion of the cost of the tax and then reap most of the savings (e.g., Dolado, Jansen, and Jimeno Serrano (2007)), or labor markets might differ in terms of the firm's monopsony power. Finally, Lehmann, Marical, and Rioux (2013) find that lower-wage workers are shielded from payroll tax increases due to nominal wage rigidity.

Heterogeneous effects are estimated by interacting the variable that acts as a proxy for the bargaining position of workers, i.e., his/her position in the earnings distribution, with the interaction variable that identifies the effect of the reform. Table 12 shows the estimated coefficient for all three earnings groups.

Even in this very detailed model that takes into account many possible sources of possible biases, we still conclude that workers pay most if not almost all of the payroll taxes. Workers in firms that no longer had to pay the payroll tax saw their wage increase by 1.1 to 1.5 percentage point on average. The effect is small but approximately corresponds to the decrease in the effective payroll tax rate faced by the treated firms. The small size of the effect underscores the necessity of having access to detailed wage and payroll information from the universe of workers in Manitoba.

Taken at face value, the coefficients seem to indicate that workers at the low and high end of the distribution pay a higher fraction of the payroll tax. However, we cannot reject the null hypothesis that all three coefficients are equal. Thus, we cannot reject the null hypothesis that all workers pay the tax equally (based on their earnings).[17]

11. Conclusion

In this paper, we are the first to use linked employer-employee administrative tax data from Canada to estimate the impact of payroll taxes on a variety of firms' and

[17]Cervini-Plá, Ramos, and Silva (2014) found an increasingly large wage impact of payroll taxes as workers moved up the wage distribution, but for a much larger reduction in the payroll tax.

workers' outcomes. At the firm-level, we use geographic and time variations in tax rates to identify the effect of payroll taxes on workers' wage growth.

For one province, we can exploit a clean overtime changes in the payroll tax rates to estimate its impact on the firm's level of employment, average wage and productivity. To do so we use double- and triple differences models, taking into account firm-level unobserved heterogeneity. Additionally, exploiting the fact that we have linked employer-employee data, we can also estimate a worker's wage model with both fixed worker and firm effect.

We find no impact on employment and productivity but significant impacts on wages, implying that payroll taxes are passed almost entirely to workers in the form of lower wages. Hence, our results show that lowering payroll taxes should not be expected to yield gains in employment levels or that conversely, unemployment problems cannot be blamed on those taxes and that those taxes do not lead to major labor market inefficiencies. However, payroll taxes should certainly be taken into account in determining the amount of fiscal charges shouldered by workers.

These results are coherent with a model in which labor demand is considerably more elastic than labor supply, which would predict that the burden of payroll taxes is completely shifted to employees.

One limit of our data is that we do not observe work intensity and are not able to compute an hourly wage. If hours of work adjusted differently between our treatment and control groups before and after the reform, this would have an impact on our estimated effect. This is a common limitation with administrative tax data of the type we are using here.

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Appendix A. Figures

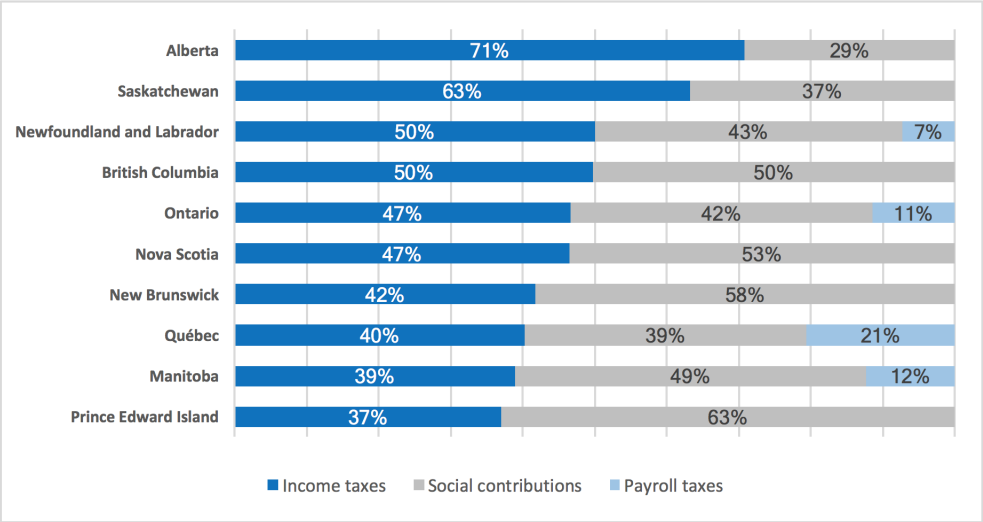

FIGURE 1. Distribution of sources of income by tax type in 2009

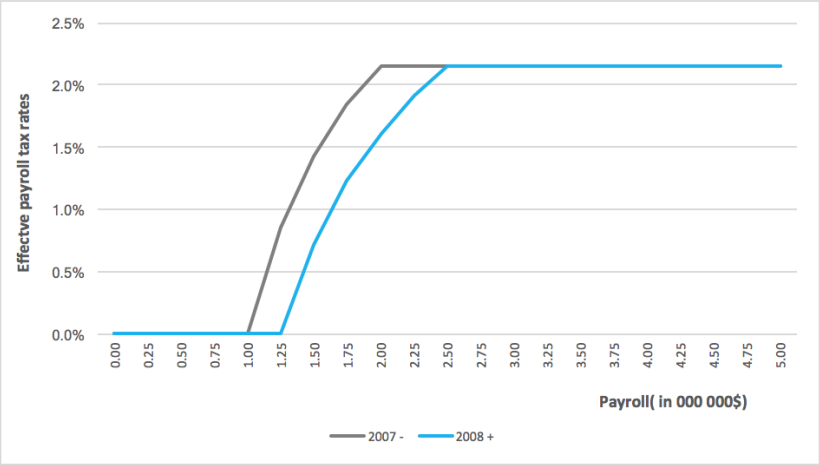

FIGURE 2. The Manitoba natural experiment

Appendix B. Tables

TABLE 1. Payroll tax rates 2001-2011 in the Province of Québec

Effective rates (%)	Payroll ($)	Computation of effective rates
2.7	< 1000000	2.7
2.7 to 4.26	(1 000 000 $, 5 000 000$)	$(2.31\% + 0.39\% \cdot \text{payroll})/1000000$
4.26	> 5000000 $	4.26

TABLE 2. Payroll tax rates 2001-2011 in the Province of Ontario

Effective rates (%)	Payroll ($)	Computation of effective rates
0	< 400000 \$	0
0 to 1.95	> 400000	$(\text{payroll} - 400000) * 1.95\%$

TABLE 3. Payroll tax rates 2001-2011 in the Province of Newfoundland and Labrador

Year	Effective rates (%)	Payroll	Computation of effective rates
2001	0	≤ 475000	0
	0 to 2	> 475000	$(\text{payroll} - 475000) \cdot 2\%$
2002	0	≤ 500000	0
	0 to 2	> 500000	$(\text{payroll} - 500000) \cdot 2\%$
2003	0	≤ 600000	0
	0.6	$]600000, 700000]$	$(\text{payroll} - (1200000 - \text{payroll}) \cdot 2\%$
	0.6 to 2	> 700000	$(\text{payroll} - 500000) \cdot 2\%$
2004-06	0	≤ 700000	0
	0 to 2	> 700000	$(\text{payroll} - 700000) \cdot 2\%$
2007	0	≤ 600000	0
	0 to 2	> 600000	$(\text{payroll} - 600000) \cdot 2\%$
2008-09	0	≤ 1000000	0
	0 to 2	> 1000000	$(\text{payroll} - 1000000) \cdot 2\%$
2010-11	0	≤ 1200000	0
	0 to 2	> 1200000	$(\text{payroll} - 1200000) \cdot 2\%$

TABLE 4. Payroll tax rates 2001-2011 in the Province of Manitoba

Year	Effective rates (%)	Payroll ($)	Computation of effective rates
2001-2007	0	< 1000000	0
	0 to 2.15	$[1000000, 2000000]$	$(\text{payroll} - 1000000) \cdot 4.3\%$
	2.15	> 2000000	2.15
2008-2011	0	< 1250000	0
	0 to 2.15	$[1250000, 2500000]$	$(\text{payroll} - 1250000) \cdot 4.3\%$
	2.15	> 2500000	2.15

TABLE 5. Coefficient estimates: wage growth model

	Coefficient	Std. Err.
Payroll tax rate	-0.4675	0.0001
Demographic characteristics		
Age	-0.0024	0.0000
Male	-0.0009	0.0001
Firm Size		
1-10 empl.	-	-
10-99 empl.	0.0042	0.001
100-499 empl.	0.0055	0.0001
500-1999 empl.	0.0040	0.0002
2000 empl. +	0.0035	0.0002
Province		
Quebec	-	-
Alberta	-0.0029	0.0003
British Columbia	-0.0136	0.0003
Manitoba	-0.0007	0.0002
New-Brunswick	-0.0117	0.0004
Newfoundland and Labrador	0.0087	0.0004
Nova Scotia	-0.0117	0.0003
Ontario	-0.0128	0.0002
Prince-Edward Island	-0.0099	0.0007
Saskatchewan	0.0052	0.0004
# observations	44 970 891	

Note. Source: CEEDD 2001-2011. All coefficients are statistically significant at the 1% level. Includes industry at the 4-digit NAICS level and year controls.

TABLE 6. Manitoba: summary statistics at the firm-level, 2006-2009

2006	Cat = 1	= 2	= 3
Payroll	156,189	1,546,562	1.43E+07
Revenue	...	...	...
Empl.	6.85	53.86	375.18
#	19814	764	481

2007	Cat = 1	= 2	= 3
Payroll	158,929	1,536,045	1.40E+07
Revenue	...	...	...
Empl.	6.81	52.71	350.72
#	20344	808	568

2008	Cat = 1	= 2	= 3
Payroll	157,934	1,542,383	1.42E+07
Revenue	908,335	9,081,755	7.54E+07
Empl.	6.68	50.65	356.13
#	20923	857	568

2009	Cat = 1	= 2	= 3
Payroll	158,500	1,525,487	1.37E+07
Revenue	829,954	9,121,952	6.98E+07
Empl.	6.67	50.2	343.78
#	21251	878	592

Note. Summary statistics for *Revenue* in 2006 and 2007 not shown because mean revenue of the firms in sub-sample (= 3) was dominated by a small group

TABLE 7. Manitoba: Firm-level FE double-differences estimates

	2007/2008			
	ln(avgwage)	ln(empl)	ln(avgprod)	ln(avgprof)
Treatment	0.082***	0.177***	-0.097**	-0.046
	(0.026)	(0.032)	(0.039)	(0.042)
Post	0.010***	0.013***	-0.025***	0.012**
	(0.003)	(0.004)	(0.005)	(0.005)
Treatment * Post	0.042**	-0.015	0.059**	0.020
	(0.017)	(0.020)	(0.025)	(0.027)
Constant	10.081***	1.363***	11.474***	10.882***
	(0.002)	(0.003)	(0.004)	(0.004)
# firms	24289	24289	24003	18819
# observations	44008	44008	43428	33856

Note. Source: CEEDD 2001-2011. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 8. Manitoba: Firm-level FE triple-differences estimates 2007-2008

	(1) ln(empl)	(2) ln(avgwage)	(3) ln(avgprod)
Treatment	0.307***	0.275***	-0.080*
	(0.038)	(0.032)	(0.045)
Post	0.014***	0.028***	0.008***
	(0.004)	(0.003)	(0.005)
Treatment * Post	-0.002	-0.007	0.039
	(0.024)	(0.020)	(0.028)
Manitoba * Post	-0.002	-0.018***	-0.036***
	(0.006)	(0.005)	(0.007)
Manitoba * Post * Treatment	-0.020	0.042	0.021
	(0.031)	(0.027)	(0.038)
Constant	1.207***	10.076***	11.612***
	(0.059)	(0.050)	(0.069)
# firms	47262	47262	46801
# observations	84436	84436	83523

Note. Source: CEEDD 2001-2011. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 9. Manitoba: Firm-level FE triple-differences estimates 2006-2009

	(1) ln(empl)	(2) ln(avgwage)	(3) ln(avgprod)
	0.412***	0.260***	-0.017
	(0.024)	(0.021)	(0.029)
Post	0.025***	0.038***	-0.012***
	(0.003)	(0.003)	(0.005)
Treatment * Post	-0.028	-0.005	0.065***
	(0.019)	(0.016)	(0.023)
Manitoba * Post	-0.007	-0.019***	-0.028***
	(0.005)	(0.005)	(0.006)
Manitoba * Post * Treatment	-0.018	0.035*	0.003
	(0.026)	(0.022)	(0.030)
Constant	1.197***	10.080***	11.606***
	(0.034)	(0.029)	(0.040)
# firms	55160	55160	54607
# observations	168249	168249	166385

Note. Source: CEEDD 2001-2011. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 10. Manitoba: summary statistics at the worker-level, 2006-2009

2006	Cat = 1	= 2	= 3
Earnings	42,923	45,187	49580
Age	43.0	41.8	43.0
Male	0.63	0.68	0.61
#	42,671	17,517	109,168

2007	Cat = 1	= 2	= 3
Earnings	43,498	45,885	50720
Age	43.2	41.9	43.3
Male	0.63	0.68	0.59
#	42,580	17,868	123,485

2008	Cat = 1	= 2	= 3
Earnings	44,651	47,803	51304
Age	43.3	42.0	43.4
Male	0.63	0.67	0.58
#	41,800	18,347	125,396

2009	Cat = 1	= 2	= 3
Earnings	45,929	48,394	51881
Age	43.5	42.1	43.6
Male	0.63	0.68	0.58
#	41,181	18,950	122,772

TABLE 11. Manitoba: double-difference estimates at the worker level, 2007/2008

ln(wage)	F FE	W FE
Treatment * Post	0.019***	0.016***
	(0.002)	(0.005)
Fixed effects		
#workers	210841	...
#firms	...	16510
#observations	369747	369747

Note. Source: CEEDD 2001-2011. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

TABLE 12. Manitoba: heterogeneous double-difference estimates at the worker level with worker and firm fixed effects 2007/2008

	W+F FE		
ln(wage)	Bottom third	Middle	Uppder third
Treatment * Post	0.014***	0.011***	0.015***
	(0.002)	(0.002)	(0.003)
# observations	123250	123250	123250

Note. Source: CEEDD 2001-2011. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.