Huynh *et al. IZA Journal of Labor Economics* (2017) 6:7
DOI 10.1186/s40172-017-0057-0

IZA Journal of Labor Economics

ORIGINAL ARTICLE Open Access

Industry shutdown rates and permanent layoffs: evidence from firm-worker matched data

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Abstract

Firm shutdown creates a turbulent situation for workers as it leads directly to layoffs for its workers. An additional consideration is whether a firm's shutdown within an industry creates turbulence for workers at other continuing firms. Using data drawn from the Longitudinal Worker File, a Canadian firm-worker matched employment database, we investigate the impact of industry shutdown rates on workers at continuing firm. This paper exploits variation in shutdown rates across industries and within an industry over time to explain the rate of permanent layoffs and the growth of workers' earnings. We find an increase in industry shutdown rates increases the probability of permanent layoffs and decreases earnings growth for workers at continuing firms.

JEL Classification: J24, J31, J63, C35

Keywords: Worker separation, Firm survival, Selection

1 Introduction

The fortunes of firms and workers are inextricably linked. Firm shutdown results in displacement of workers through layoffs. Firm turnover creates uncertainty for workers by affecting their employment status and wages. These first-round effects have negative consequences for the laid-off workers of the shutting down firms. When examining firm shutdown within an industry and its impact on workers, industry shutdown rates also provide an indication of the state of an industry. If industry shutdown rates capture industry wide shocks and fluctuations, then industry shutdown rates may also tell us something about the fortunes of workers at continuing firms. Negative shocks within an industry cause firm profits to fall, which results in rising shutdown rates. Further, the falling demand also causes layoffs at continuing firms to rise, as these firms must reduce production and shed costs. The issue becomes whether industry shutdown rates capture turbulence and fluctuations within an industry, which spill over to cause second-round layoffs at the continuing firms.

This paper empirically investigates the effect of industry shutdown rates on the probability of worker layoffs at continuing firms and, by extension, earnings growth of these laid-off workers. A firm's exit or shutdown results in separations as the firm must lay off its worker. The purpose of this paper is not to consider these direct effects of firm shutdown on worker outcomes. Rather, we look at whether industry shutdown rates contain

information indirectly relevant for layoff probabilities and earnings of workers at continuing firms. We focus on industry shutdown rates as its impact on workers receives little attention in the literature. This paper addresses the impact of industry shutdown rates by examining the questions: (i) does the industry shutdown rates affect workers at continuing firms; (ii) how does the industry shutdown rate affect workers at continuing firms; and (iii) what are the future earnings prospects of workers experiencing a permanent layoff from a continuing firm? Understanding the labor market interaction of firms and workers requires access to firm-worker matched datasets.[1] Our study utilizes one such Canadian administrative employer-employee dataset called the Longitudinal Worker File (LWF).[2]

Earnings growth allows us to look at the future prospects of laid-off workers. This analysis captures the intensive margin of associated with layoffs. Using administrative data on workers in the USA, von Wachter et al. (2009) find that the annual earnings of workers in relative stable jobs experiencing a surprise layoff during the 1982 recession are still 20% lower than their nondisplaced counterparts after more than 20 years. Using Canadian data, Morissette R et al. (2007) find that mass layoffs due to firm closure have a greater impact on more senior workers. Further, Song and von Wachter (2014) show that the long-term nonemployment rate increase is similar across recessions in the past 30 years. However, they find the long-term unemployment rate increase is higher in the 2008 recession than in previous recessions. These studies demonstrate that layoffs, especially mass layoffs typically occurring during recessions, have long-term consequences for the earnings and employment prospects of displaced workers.[3]

Our study is similar to Quintin and Stevens (2005a, b), who investigate the impact of industry exit rates on firm-worker separation rates using cross-sectional French data. However, three additional aspects of the LWF database allow us to build on these previous studies. First, the LWF database classifies separations as (i) voluntary separation when a worker quits or an involuntary separation as a result of a layoff and (ii) permanent or temporary. The data used in Quintin and Stevens (2005a, b) only identifies worker separations with no classification on type of separation. Due to these data limitations, Quintin and Stevens (2005a, b) focus on explanations for worker separations related to the workers choice to leave the firm. In contrast, the LWF database allows us to empirically analyze the firm's decision to separate from workers through permanent layoffs.

The second aspect is that the LWF is a longitudinal database, while the third aspect is that the LWF contains worker earnings information. Unlike the data in Quintin and Stevens (2005a, b), the longitudinal aspect of the LWF database allows us to exploit variation in industry shutdown rates both across industries and within an industry over time and also allows us to follow workers over time. As the empirical specifications includes industry dummy variables as controls, the analysis focuses on the within industry variation in shutdown rates. Using the longitudinal worker information, this paper provides further analysis of the growth rate of individual worker earnings following a permanent layoff.

The findings of our study are[4]:

1. Industry shutdown rates have a positive and significant effect on the probability of a permanent layoff at continuing firms. The impact of industry shutdown rates on the probability of a permanent layoff captures the extensive margin or the number

of affected workers. For men, a 1% increase in industry shutdown rates means approximately a 0.13% increase in the probability of a worker layoff. For women, the marginal effect can be negative or positive and ranges from −0.01% at extra small-sized (less than 5 employees) firms to 0.11% at small-sized firms (5 to 19 employees).

2. The effect of industry shutdown rates on earnings growth is generally negative for both laid-off men and women. The exceptions include men at medium-sized firms and women at small-sized firms. The impact of industry shutdown rates on individual workers through wage growth captures an intensive margin.
3. For workers experiencing a permanent layoff, their post-layoff wage prospects vary with the size of firm at which they eventually find employment. Most laid-off workers moving to a larger firm see their wages increase, while most laid-off workers moving to a smaller firm see their wages fall.

The first result extends the finding of Quintin and Stevens (2005b). Quintin and Stevens (2005a, b) are not able to distinguish between layoffs and quits. They focus on workers voluntarily leaving continuing firms to explain the positive relationship between worker separation rates and industry shutdown rates. Our first finding indicates that layoff rates at continuing firms also increase with industry shutdown rates. Therefore, models of worker turnover must capture both workers choosing to quit firms and firms choosing to lay off workers when investigating worker separations in the context of industry fluctuations. The second result also extends the previous work by demonstrating that rising industry shutdown rates also cause deterioration of the earnings prospects for laid-off workers. However, the final result shows that some workers do find "good" jobs after experiencing a layoff, which allows them to increase their earnings. Thus, a layoff need not necessarily result in a "bad" outcome for a displaced worker.

These results demonstrate the necessity of the joint analysis of firm shutdown with either permanent layoff or worker wages. Industry shutdown rates provide a measure of firm turnover or churn within an industry. Exogenous conditions within an industry, such things as cyclical movements or demand decline, cause profits of firms to change. The typical view of the firm in economics is that falling profits for firms within an industry lead to firm shutdown and possible exit. Thus, increasing shutdown rates indicate falling profits within an industry. For continuing firms, direct and indirect effects on employment result when moving to a new equilibrium. With these falling profits, output falls at continuing firms, which leads directly to worker layoffs. Indirect effects occur for continuing firms for two reasons. First, they now face less competition with greater shutdown of competitors. Second, more workers are available to hire with the shutdown of competitors. Continuing firms are now better able to substitute for current workers as new hires are cheaper (see Farber (1999)). Direct effects of falling profits result in increased layoffs at continuing firms and, by extension, lower earnings for laid-off workers. Indirect effects are ambiguous.

Recent research suggests that, in the case of involuntary separations, there are large differences in the income losses associated with differences in human capital. Kambourov and Manovskii (2009) argue that many skills acquired by workers during their working careers are job-specific. Job displacement is especially detrimental to those workers with job-specific skills not easily transferable. Davis and Wachter (2011) provide an extensive

review of the literature on the effects of large cyclical movements in job displacement and how worker anxieties about job loss, wage cuts, and job opportunities respond to contemporaneous economic conditions. They find that the job loss as a result of mass layoffs results in a loss of earnings results in roughly 1.4 to 2.8 years of pre-displacement earnings (depending on the current unemployment rate). This macroeffect is of first-order importance. However, there are spillover effects of mass layoffs.[5]

Gathmann et al. (2017) exploit regional variation to find spillover effects of mass layoffs are about 35% of local employment losses stem from spillover effects in plants not directly affected by the mass layoff (55% after a decade). In our analysis, we are not able to use regional variations but rather rely on the industry shutdown rate as a proxy for industry variation. Depending on the firm size class of a worker, we compute that there is an annual earnings loss of between 10 and 60% for laid-off men and 20 to 60% for laid-off women as a result of a 1% increase in the shutdown rate.

The rest of the paper is organized in the following fashion: the LWF (firm-worker matched) dataset is described in Section 2 while Section 3 provides an empirical model of permanent layoffs which discusses the issue of selection due to firm survival. Section 4 discusses the effect of firm shutdown rates on workers' earnings. Finally, Section 5 concludes.

2 The Longitudinal Worker File

Our data are from the Longitudinal Worker File (LWF). The LWF is an annual administrative dataset from 1983 onwards and contains a 10% random sample of Canadians who either filed a tax return (T1 form) or received a statement of remuneration (T4 form). Appendix A gives a brief description of the LWF data sources and its construction. The LWF has information on individuals' earnings, demographics, and occupation, as well as on the the firm of employment. LWF's matched employer-employed structure allows for examining workers' mobility, turnover, and earnings dynamics.

Our sample consists of individuals living in the 10 Canadian provinces who are between 25 and 64 years of age. The source of firm-level information is the Longitudinal Employment Analysis Program (LEAP) database. Given that the LWF and LEAP databases contain common firm identifiers, firm information from the LEAP database is linkable to the worker in the LWF database. LEAP contains annual employment information on firms with at least one dollar in payroll in a given year from 1991 to 2008. The LEAP payroll information allows the identification in year t of continuing firms with a positive payroll versus temporarily or permanently (exit) firm shutdown with a zero payroll. Industry j's shutdown rate in year t, SR_{jt}, is

$$SR_{jt} = SD_{j,t+1}/N_{jt} \tag{1}$$

where $\mathrm{SD}_{j,t+1}$ gives the total number of firms in industry j with a positive payroll in year t and a zero payroll in period $t+1$ and N_{jt} gives the total number of firms with in industry j positive payroll in period t. The structure of the LEAP database implies that firm shutdown is not due to merger or acquisition activity. Table 1 provides the list of the 39 industries in the data. LEAP assigns a NAICS code to each firm from 1992 onwards[6]. We restrict our sample of workers to the period from 1992 to 2007 since the analysis uses firm and NAICS information taken from the LEAP database.

Table 1 Industry classification by NAICS

Industry	NAICS
Crop and animal production	111, 112
Forestry and logging; fishing, hunting, and trapping	113–115
Oil and gas extraction	211
Mining (except oil and gas)	212
Support activities for mining and oil and gas extraction	213
Utilities	22
Construction	23
Food manufacturing; beverage and tobacco product manufacturing	311, 312
Textile mills; textile product mills	313, 314
Clothing manufacturing; leather and allied product manufacturing	315, 316
Wood product manufacturing	321
Paper manufacturing	322
Printing and related support activities	323
Chemical manufacturing	325
Plastic and rubber product manufacturing	326
Nonmetallic mineral product manufacturing	327
Primary metal manufacturing	331
Fabricated metal product manufacturing	332
Machinery manufacturing	333
Computer and electronic product manufacturing	334
Electrical equipment, appliance, and component manufacturing	335
Transportation equipment manufacturing	336
Furniture and related product manufacturing	337
Miscellaneous manufacturing	339
Wholesale trade	41
Retail trade	44–45
Air, rail, water, touristic, and support transportation	481–483, 487, 488
Truck transportation	484
Transit and ground passenger transportation	485
Warehousing and storage	493
Publishing; information services and data processing services	511, 516, 518, 519
Motion picture and sound recording industries	512
Broadcasting and telecommunication	515, 517
Finance and insurance; real estate and rental and leasing	52, 53
Professional, scientific, and technical services	54
Administrative and support services	561
Arts, entertainment, and recreation	71
Accommodation and food services	72
Other services (except public administration)	81

Note: The North American Industry Classification System (NAICS) is a standard classification used by Statistics Canada to classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data. More information is available at http://www.statcan.gc.ca/concepts/industry-industrie-eng.htm

A separation occurs in year t, if t is the last year of an individual's tenure in firm j (i.e., the end of a job spell). The LWF database allows for the categorization of employee-employer separations. Quits and layoffs are two such categories. Layoffs are further broken into temporary, worker subject to recall, and permanent, worker not subject to recall subcategories. These categories allow for the creation of dummy variables. The value of a given separation dummy variable is 1 for any type of the given separation, including, but not limited to, quits and layoffs. For example, the value of the layoff variable is 1 if the Record

of Employment (ROE) states that the shortage of work is the reason for the separation, i.e., layoff.

2.1 Summary statistics

Table 2 provides summary statistics across industries. There is industry heterogeneity in terms of (i) workers' characteristics of age, gender, tenure, and earnings and (ii) industry characteristics of shutdown rate, permanent layoff rate, number of firms, and number of workers. The age range of average worker varies from a low of 37.8 years in the motion picture and recording industry to a high of 44.0 years in the primary metal manufacturing industry. Women dominate clothing manufacturing and leather and allied manufacturing at 76% of workers but only constitute 10% of workers in mining. Tenure ranges from 3.81 years in administrative and support services to 11.45 years in primary metal manufacturing. Average earnings are the highest in oil and gas extraction at $107,090 per year while earnings in accommodation and food services are $18,800 per year on average. The shutdown rate is the highest in utilities at 16.1% and the lowest in fabricated metal product manufacturing at 7.4%. Forestry has the highest permanent layoff rate 12.4%, while oil extractions has the lowest at 1.5%.

Table 3 provides summary statistics on worker characteristics across five firm size classes. We define firm size groupings as (i) extra small (XS)—less than 5 employees; (ii) small (S)—5–19 employees; (iii) medium (M)—20–99 employees; (iv) large (L)—100–500 employees; and (v) extra large (XL)—greater than 500 employees. XS size class firms have workers with the lowest tenure and earnings relative to the other size classes, but these firms experience the highest shutdown rates. The permanent layoff rate is the highest for the firm size classes XS, S, and M at around 5%. L size class firms have a 3.7% layoff rate, while XL firms have a 2% layoff rate.

Table 4 provides summary statistics for worker characteristics across five regions: (1) Atlantic provinces—Newfoundland, New Brunswick Nova Scotia, and Prince Edward Island; (2) Quebec; (3) Ontario; (4) Prairie provinces—Alberta, Saskatchewan, and Manitoba; and (5) British Columbia. Across the regions, average age, proportion of men versus women, and exit rate are similar. The eastern Canadian regions of the Atlantic provinces, Quebec, and Ontario tend to have longer tenure rates compared to the Prairie provinces and British Columbia. Wage rates range from an average high of $45,780 in Ontario to a low of $29,710 in the Atlantic provinces. The opposite occurs for layoff rate as the Atlantic provinces have the highest permanent layoff rate of 6.7% and Ontario has lowest at 3%.

2.2 Comparison of continuing and shutting down firms

One issue to consider when investigating the impact of industry shutdown rates on worker layoff rate is that workers may choose to quit in anticipation of deteriorating industry conditions in order to avoid any negative consequences of being laid off. A worker may quit in anticipation of being laid off or firm shutdown. This may create a possible selection bias when investigating firm layoffs of workers. Given that a random sample of workers forms the basis of the LWF database, we observe separations for workers in the LWF sample but do not observe separations rates at the firm level. Therefore, we are unable to determine quit rates in the years prior to a firm's shutdown. However, the data contain a measure of firm employment which allows us to look at overall employment activity at firms.

Table 2 Summary statistics by industry

Industry	Age	Female	Tenure	Earnings	SR	PL	Firms	Workers
Crop and animal production	41.7	0.41	5.76	21,530	0.132	0.073	8610	13,530
Forestry and logging; fishing, hunting, and trapping	41.1	0.20	5.49	30,840	0.138	0.124	4485	9540
Oil and gas extraction	41.2	0.29	6.92	107,090	0.125	0.015	375	3560
Mining (except oil and gas)	43.9	0.10	9.92	66,030	0.115	0.026	400	6235
Support for mining, oil, and gas extraction	39.0	0.14	4.56	59,380	0.121	0.076	1295	6050
Utilities	43.4	0.26	10.46	69,290	0.161	0.015	365	11,330
Construction	41.0	0.15	5.25	39,610	0.136	0.114	30,530	64,965
Food; beverage and tobacco manufacturing	41.3	0.39	7.04	38,390	0.099	0.035	2855	26,970
Textile mills; textile product mills	41.7	0.42	7.14	34,090	0.111	0.039	755	3825
Clothing manufacturing; leather and allied manufacturing	43.0	0.76	6.29	22,950	0.160	0.055	1800	8095
Wood product manufacturing	41.1	0.15	7.67	46,720	0.118	0.036	1945	13,670
Paper manufacturing	43.2	0.18	9.66	58,110	0.087	0.017	405	10,230
Printing and related support activities	41.0	0.41	6.68	41,240	0.102	0.031	2135	7715
Chemical manufacturing	41.2	0.36	6.82	56,900	0.100	0.020	875	8170
Plastic and rubber product manufacturing	40.1	0.32	7.03	43,500	0.089	0.026	1320	12,310
Non-metallic mineral product manufacturing	42.3	0.16	7.85	47,050	0.091	0.041	930	5905
Primary metal manufacturing	44.0	0.11	11.45	62,970	0.095	0.015	340	8735
Fabricated metal product manufacturing	41.1	0.18	6.70	44,670	0.074	0.046	3950	15,360
Machinery manufacturing	40.6	0.18	6.67	51,500	0.081	0.034	2445	12,660
Computer and electronic product manufacturing	39.8	0.35	6.67	60,660	0.111	0.032	965	8415
Electrical, appliance, and component manufacturing	41.7	0.31	6.98	49,000	0.093	0.041	550	4855
Transportation equipment manufacturing	41.6	0.20	9.01	57,060	0.094	0.018	1070	23,765
Furniture and related product manufacturing	40.4	0.24	6.17	33,600	0.106	0.040	1975	7975
Miscellaneous manufacturing	40.5	0.42	6.25	36,360	0.096	0.041	1870	5620
Wholesale trade	40.9	0.35	6.34	47,120	0.110	0.032	19,720	66,045
Retail trade	40.4	0.56	6.02	29,950	0.126	0.022	35,605	117,410

Table 2 Summary statistics by industry *(Continued)*

Air, rail, water, touristic, and support transportation	42.0	0.28	8.75	52,860	0.146	0.021	2410	20,420
Truck transportation	41.6	0.16	5.06	37,810	0.144	0.037	6695	16,385
Transit and ground passenger transportation	44.9	0.33	7.92	34,530	0.125	0.026	1525	9550
Warehousing and storage	40.7	0.27	6.06	41,410	0.097	0.033	430	2485
Publishing information and data processing services	40.1	0.49	6.35	51,060	0.136	0.020	1690	12,220
Motion picture and sound recording industries	37.8	0.40	4.26	40,670	0.159	0.092	875	2995
Broadcasting and telecommunication	40.0	0.45	8.85	58,120	0.147	0.009	635	17,530
Finance, insurance, and real estate	41.1	0.61	7.18	51,840	0.118	0.017	16,340	81,690
Professional, scientific, and technical services	39.6	0.49	4.98	50,860	0.131	0.035	23,005	58,470
Administrative and support services	39.7	0.48	3.81	28,300	0.133	0.049	12,440	55,515
Arts, entertainment, and recreation	39.5	0.50	4.86	29,440	0.123	0.059	4895	14,865
Accommodation and food services	38.8	0.62	4.23	18,800	0.152	0.035	25,745	61,130
Other services (except public administration)	41.4	0.56	5.34	30,380	0.137	0.031	27,360	53,125

Note: SR is the shutdown rate while PL is the permanent layoff rate

Table 3 Summary statistics by size of firms

Firm size	Age	Gender	Tenure	Earnings	SR	PL	Firms	Workers
XS	41.8	0.47	4.83	25,710	0.130	0.050	110,540	125,795
S	40.4	0.42	5.17	32,100	0.128	0.054	83,935	136,195
M	40.1	0.39	5.34	37,960	0.124	0.049	47,845	176,875
L	40.3	0.39	5.83	43,330	0.120	0.037	7825	128,875
XL	40.9	0.41	7.77	51,040	0.121	0.020	1475	321,260

Note: The firm size classes are (1) less than 5 employees, (2) 5–19 employees, (3) 20–99 employees, and (4) greater than or equal to 100 employees. SR is the shutdown rate while PL is the permanent layoff rate

Figure 1 presents the median employment size and growth for firms in their last 3 years prior to shutdown. As a comparison, the figure also presents median employment size and growth for rival continuing firms over a similar 3-year window. Continuing firms tend to be larger and have higher growth than shutting down firms. The median employment size and growth both tend to be flat for continuing firms. Alternatively, shutting firms experience a drop in size and increasingly negative growth as shutdown approaches.

Tables 5 and 6 provide these comparisons between continuing and shutting down and firms across the industries. Similar results occur at the industry level. The shedding of workers, whether through layoffs or quits, appears to occur in the years leading to firm shutdown.

3 Permanent layoffs—extensive margin

Industry shutdown rates measure the short-run performance of firms within an industry. High shutdown rates indicate firms within an industry deem that shutdown is more profitable than continuing operations. The implication of shutdown is that a firm must become profitable or eventually exit. One method to reduce costs is worker layoffs. These layoffs can be temporary or permanent depending on circumstances. Temporary layoffs may lead to permanent layoffs in the long run if the firm eventually exits or workers are not recalled.

Thus, our analysis focuses on permanent layoffs by firms as a method to analyze the process of shedding workers. We consider the effects of industry shutdown rates along with the other controls to assess the qualitative and quantitative impacts of industry conditions on a firm's decision to permanently layoff workers.

We identify shutdowns in year t as those firms transitioning from a positive payroll in year t to a zero payroll in year $t + 1$.

A firm's shutdown does not imply an exit, as the firm may have a positive payroll in some future period. Our focus on anticipated separations motivates the choice of shutdown rates. The absence of a positive annual payroll in year t signals at least a year-long

Table 4 Summary statistics by region

Region	Age	Gender	Tenure	Earnings	SR	PL	Firms	Workers
Atlantic	40.7	0.42	6.47	29,710	0.127	0.067	19,535	61,775
Quebec	41.0	0.41	6.52	36,170	0.124	0.042	63,165	213,585
Ontario	40.7	0.43	6.30	45,780	0.122	0.030	86,550	350,570
Prairies	40.4	0.41	5.67	41,720	0.126	0.034	44,830	147,625
BC	40.9	0.42	5.79	41,070	0.127	0.043	37,520	115,445

Note: The five regions are (1) Atlantic provinces, (2) Quebec, (3) Ontario, (4) Prairie provinces, and (5) British Columbia. SR is the shutdown rate while PL is the permanent layoff rate

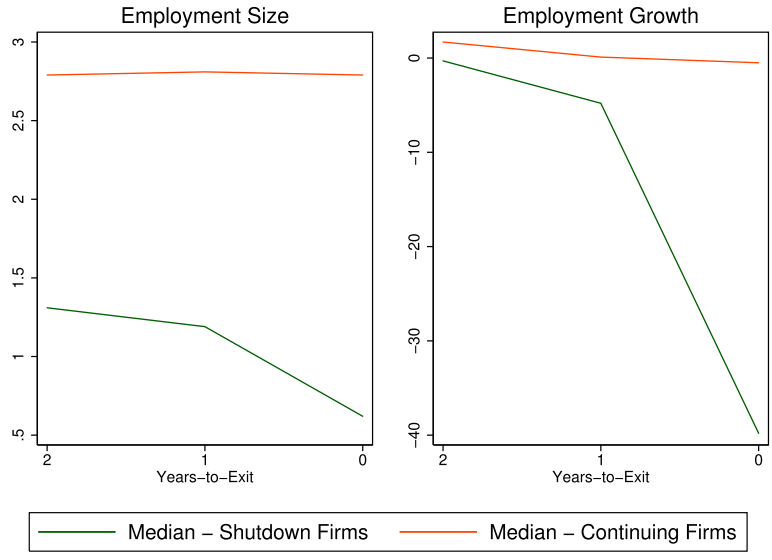


Fig. 1 Comparison of shutdown and continuing firms. *Note*: This graph provides a comparison between shutting down firms in year *t* with continuing firms. For these two groups of firms, the graph provides the median employment size and growth rate in 3 years prior to firm shutdown in the former group. For a full comparison by industry, see Tables 5 and 6

closure. From the worker's point of view, there is little difference whether or not his/her firm reopens in some future year following shutdown. In either case, the firm's workers anticipate prolonged separations and adjust their labor market decisions. Shutdowns are also more easily identified in the data than firm exits since they only require the knowledge of the firm's payroll in two consecutive periods. For the analysis, we perform separate analysis for men and women and across firms in different size classes. We analyzed the pooled data but found the assumption of homogeneity of effects across men and women is rejected statistically and economically.[7]

3.1 Selection issues and identification strategy

A selection issue arises as the permanent layoff decisions are only observable for continuing firms in year *t*. In the remainder of the paper, we will refer to *continuing* firms to indicate those firms not experiencing a shutdown at year *t*. To account for the selection bias, we consider two separate dichotomous variables and allow for correlated disturbances. For worker *i* at firm *k* in industry *j* at time *t*, we estimate a bivariate probit model. The continuing firm (*FS*) equation accounts for firm selection and the permanent layoff (*PL*) equation captures a worker's outcome or the probability of a permanent layoff, which gives the following bivariate probit worker selection (BPWS) model:

$$\begin{aligned}
\mathrm{FS}^{*}_{ikjt} &= \alpha^{\mathrm{FS}} + \beta^{\mathrm{FS}}\mathrm{SR}_{jt} + \gamma^{\mathrm{FS}}B_{it} + \sum_{j=1}^{J}\psi_{j}^{\mathrm{FS}}I_{j} + \sum_{t=1993}^{2002}\delta_{t}^{\mathrm{FS}}D_{t} + \lambda Z_{kjt} + \nu_{ikjt},\\
\mathrm{PL}^{*}_{ikjt} &= \alpha^{\mathrm{PL}} + \beta^{\mathrm{PL}}\mathrm{SR}_{jt} + \gamma^{\mathrm{PL}}B_{it} + \sum_{j=1}^{J}\psi_{j}^{\mathrm{PL}}I_{j} + \sum_{t=1993}^{2002}\delta_{t}^{\mathrm{PL}}D_{t} + u_{ikjt}. \qquad (2)
\end{aligned}$$

$$\nu_{ikjt}, u_{ikjt} \sim N(\mu, \Sigma), \mu = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

Table 5 Size comparison of shutting down and continuing firms

	Shutting down in t						Continuing in t					
Industry	Mean			Median			Mean			Median		
	t	$t-1$	$t-2$	t	$t-1$	$t-2$	t	$t-1$	$t-2$	t	$t-1$	$t-2$
Crops and animal prod.	0.9	1.3	1.5	0.4	0.6	0.7	3.4	3.5	3.5	1.3	1.3	1.3
Forestry, fishing, etc.	1.3	2.6	3.0	0.5	0.9	1.0	6.0	6.3	6.6	1.7	1.8	1.9
Oil and gas	5.7	7.7	7.6	0.8	1.4	1.5	45.8	42.9	40.1	1.6	1.6	1.6
Mining (except oil and gas)	6.1	10.5	11.0	0.8	2.3	2.6	102.7	98.6	95.5	10.3	10.3	10.0
Support for mining	2.5	6.0	6.1	0.5	1.0	1.1	21.2	20.1	18.3	1.7	1.8	1.7
Utilities	5.9	10.0	10.1	1.3	2.6	2.5	235.9	231.8	227.3	8.0	7.6	7.1
Construction	1.5	2.7	3.0	0.6	1.1	1.2	9.2	8.9	8.5	2.7	2.6	2.6
Food, beverage, etc.	3.7	8.7	9.6	0.8	2.0	2.2	58.5	58.6	58.7	6.0	6.0	6.0
Textile, etc.	4.6	12.7	15.2	0.9	2.1	2.5	25.8	27.6	29.1	6.1	6.4	6.5
Clothing, etc.	4.6	10.8	13.4	1.1	2.9	3.7	23.8	25.8	27.3	6.4	6.9	7.2
Wood	3.8	9.4	11.1	0.8	2.2	2.4	45.8	47.6	47.9	10.2	10.6	10.4
Paper	7.2	19.7	24.6	2.0	3.5	4.2	175.1	182.7	190.1	20.6	21.1	21.4
Printing, etc.	2.8	5.9	6.6	0.8	1.7	1.8	19.7	20.5	21.0	4.5	4.8	4.9
Petroleum and coal	2.2	5.0	5.8	1.2	1.7	1.4	316.6	299.1	288.2	8.8	8.3	7.7
Chemical prod.	3.7	8.3	8.4	0.8	1.8	2.1	64.5	64.4	63.4	8.7	8.7	8.7
Plastic and rubber	9.2	22.3	23.6	1.6	3.5	4.4	77.5	79.9	80.5	17.8	17.8	17.3
Non-metallic	2.6	5.5	6.3	0.7	1.6	2.2	39.0	39.1	38.8	7.4	7.4	7.2
Primary metals	9.0	22.9	33.1	1.3	3.8	4.4	156.4	161.1	163.5	19.9	20.5	20.5
Fabricated metal	3.6	8.0	9.3	0.9	2.0	2.3	25.8	25.8	25.6	8.7	8.5	8.3
Machinery	4.3	9.9	11.7	0.9	2.0	2.3	35.1	34.8	34.3	9.2	9.3	9.2
Computers, etc.	4.0	9.6	11.1	0.8	1.7	2.2	49.1	49.0	49.9	8.2	8.2	8.1
Electrical equipment, etc.	4.9	8.7	9.8	0.9	1.7	1.8	49.4	49.5	50.5	8.6	8.4	8.1
Vehicles	7.3	18.0	26.1	1.0	2.2	2.5	135.3	140.3	142.6	10.5	10.6	10.7
Furniture	4.5	9.6	10.8	1.0	2.1	2.4	24.6	25.2	25.3	6.9	6.9	6.8
Miscelleneous Manu	2.2	4.4	5.4	0.6	1.3	1.5	13.0	13.0	12.8	3.9	3.9	3.7

Table 5 Size comparison of shutting down and continuing firms *(Continued)*

Wholesale	2.1	4.3	4.8	0.7	1.3	1.5	18.7	18.7	18.6	4.3	4.4	4.3
Retail	2.3	4.6	5.1	0.9	1.9	2.1	23.1	22.4	21.7	4.4	4.4	4.3
Air transport, etc.	2.7	5.3	6.0	0.7	1.4	1.6	39.9	39.7	39.0	3.9	3.8	3.7
Truck	1.8	3.3	3.5	0.6	1.1	1.2	9.3	9.1	8.9	1.8	1.9	1.9
Transit	2.7	4.6	5.1	0.9	1.6	1.7	40.1	39.1	38.0	4.0	4.0	4.0
Pipeline	1.2	3.1	4.1	0.3	0.9	0.9	86.4	81.4	76.8	1.8	1.7	1.7
Warehousing	3.9	7.3	8.5	1.3	2.7	2.9	42.8	41.0	39.0	6.6	6.8	6.7
Information, etc.	3.1	6.0	6.7	0.8	1.6	1.8	38.4	37.8	38.2	4.1	4.1	4.1
Motion pics	1.8	3.3	4.5	0.5	0.9	1.0	11.1	11.0	11.0	1.4	1.4	1.4
Broadcasting	4.6	8.1	8.4	0.9	1.8	1.9	150.8	151.0	154.7	5.6	5.5	5.0
Finance, etc.	1.6	3.0	3.4	0.6	0.9	1.0	18.1	17.8	17.5	1.9	1.9	1.9
Professional, etc.	1.2	2.2	2.5	0.5	0.9	1.0	8.7	8.5	8.2	1.6	1.7	1.7
Admin, etc.	2.6	4.7	5.2	0.7	1.3	1.5	22.3	21.5	20.5	3.1	3.1	3.0
Waste management	2.3	4.3	5.2	0.7	1.5	1.7	17.2	16.6	16.0	4.0	3.9	3.9
Arts, etc.	2.4	4.2	4.6	0.7	1.3	1.4	17.4	17.1	16.7	3.2	3.2	3.1
Accommodations, etc.	3.8	7.0	7.8	1.5	3.3	3.7	20.9	20.7	20.4	6.8	6.9	7.0
Other services	1.0	1.8	1.9	0.4	0.7	0.7	6.3	6.3	6.2	1.8	1.9	1.9
All	2.1	3.9	4.4	0.6	1.2	1.3	20.5	20.2	19.9	2.8	2.8	2.8

Note: This table provides a comparison between shutting down firms in year *t* with continuing firms. For these two groups of firms, the table provides the median and average employment size in 3 years prior to firm shutdown in the former group

Table 6 Growth comparison of shutting down and continuing firms

	Shutting down in *t*						Continuing in *t*					
	Mean			Median			Mean			Median		
	$t/t-1$	$t-1/t-2$	$t-2/t-3$	$t/t-1$	$t-1/t-2$	$t-2/t-3$	$t/t-1$	$t-1/t-2$	$t-2/t-3$	$t/t-1$	$t-1/t-2$	$t-2/t-3$
Crops and animal prod.	−6.4	23.2	23.5	−22.3	−4.7	−3.0	11.0	12.2	33.4	−2.2	−2.3	−1.0
Forestry, fishing, etc.	−1.7	34.3	42.5	−37.7	−7.9	−3.8	12.3	13.7	29.3	−3.7	−3.3	−2.0
Oil and gas	8.9	39.6	126.5	−30.2	−2.1	4.3	25.4	33.3	63.8	−0.8	0.6	2.6
Mining (except oil and gas)	−21.0	17.3	55.0	−54.1	−4.8	−3.2	20.2	20.1	39.1	1.6	1.4	2.8
Support for mining	−13.6	59.2	156.1	−41.0	−5.3	3.4	32.4	32.6	68.3	−0.6	1.9	7.3
Utilities	−23.0	40.1	41.5	−33.7	−1.8	5.8	28.3	28.7	76.9	1.2	1.7	3.6
Construction	−1.9	46.5	94.2	−40.4	−4.4	3.5	26.6	26.2	131.7	1.7	2.9	5.3
Food, beverage, etc.	31.5	5.2	40.8	−47.6	−7.3	0.1	11.3	12.9	31.5	0.4	0.2	2.9
Textile, etc.	−35.4	170.4	34.2	−48.5	−11.7	−3.9	24.9	12.6	25.9	−4.1	−2.2	−0.2
Clothing, etc.	−33.5	4.4	44.3	−55.0	−13.2	−5.3	6.4	11.2	22.7	−5.8	−3.6	−2.4
Wood	309.6	24.0	175.0	−50.0	−9.2	−2.1	6.2	10.7	30.7	−1.5	0.9	3.1
Paper	−44.2	−0.4	23.2	−51.0	−8.9	1.8	3.3	3.3	28.9	−2.8	−1.3	2.8
Printing, etc.	−9.8	28.2	60.5	−45.7	−8.1	−4.3	10.4	12.9	23.6	−4.1	−1.7	−0.9
Petroleum and coal	−7.0	11.1	33.4	−44.5	4.3	5.8	13.0	12.9	20.4	2.5	1.8	2.1
Chemical prod.	−37.2	9.2	40.3	−48.6	−4.0	−2.8	6.7	12.1	29.9	−1.0	0.2	0.6
Plastic and rubber	−31.9	0.6	70.6	−51.6	−6.8	−0.3	31.1	8.3	28.8	−0.6	1.0	3.1
Non-metallic	−31.3	31.9	40.1	−45.4	−9.9	−4.6	18.7	19.6	26.8	0.8	1.5	3.1
Primary metals	−43.1	−1.2	70.8	−47.2	−9.6	1.6	10.2	12.0	29.3	−0.8	2.0	2.8
Fabricated metal	−24.6	1.2	38.8	−47.1	−7.4	−1.0	11.8	17.7	34.2	0.7	1.7	2.0
Machinery	−17.9	6.0	62.7	−49.6	−9.7	−3.5	12.8	15.0	33.6	−0.9	0.6	2.6
Computers, etc.	−30.8	−3.0	30.3	−47.3	−10.1	−6.1	9.1	14.5	60.8	0.1	−0.2	0.7
Electrical equipment, etc.	−31.5	4.3	23.7	−41.6	−7.6	2.9	658.5	659.1	675.7	2.4	1.9	4.0
Vehicles	−33.0	10.5	93.2	−47.9	−6.7	−1.9	7.6	11.6	143.0	−1.9	0.4	1.1
Furniture	−26.9	7.6	45.8	−48.8	−6.9	−1.3	9.6	12.9	32.7	−0.5	1.3	2.3
Miscelleneous manufacturing	−31.3	−7.5	52.2	−45.3	−6.9	−2.2	8.4	12.0	33.3	−0.1	1.1	1.8

Table 6 Growth comparison of shutting down and continuing firms *(Continued)*

Wholesale	−26.0	305.2	547.3	−44.1	−7.1	−1.9	34.3	17.0	31.4	−0.8	0.3	1.5
Retail	−7.6	7.6	49.9	−45.4	−4.4	0.4	54.6	57.2	89.3	0.6	1.4	2.7
Air transport, etc.	−19.9	20.8	54.0	−40.9	−5.9	0.9	22.8	24.2	49.9	1.2	2.5	3.9
Truck	−18.6	25.5	56.4	−42.6	−4.8	0.2	36.6	64.5	42.7	−0.1	0.4	2.1
Transit	−0.9	44.1	56.8	−37.3	−4.5	−1.1	21.3	25.1	44.3	0.6	−0.1	1.5
Pipeline	−38.8	21.3	29.2	−53.2	−13.0	−17.2	35.8	56.9	93.2	−1.3	1.5	5.9
Warehousing	−17.1	38.2	45.8	−38.1	−4.0	6.5	16.3	21.4	60.6	−2.7	2.6	7.2
Information, etc.	−25.6	10.0	55.1	−40.9	−7.8	0.6	17.1	14.4	49.1	−0.1	−1.0	2.6
Motion pics	−5.2	28.5	241.4	−35.1	−6.8	−3.9	28.6	44.3	48.9	0.0	−1.6	−1.8
Broadcasting	−24.9	31.2	176.5	−43.5	−3.0	4.1	19.4	27.8	62.8	0.1	2.9	4.4
Finance, etc.	123.2	25.1	52.9	−29.2	−4.2	−1.0	17.6	19.2	36.5	0.3	0.0	1.0
Professional, etc.	−12.9	105.1	55.8	−38.0	−5.1	0.1	122.8	121.5	130.7	−0.5	0.4	2.6
Admin, etc.	179.2	82.9	85.7	−37.7	−4.3	0.2	38.5	51.9	142.1	1.0	1.7	3.0
Waste management	−12.4	21.1	37.6	−45.6	−4.4	0.3	15.3	18.8	38.0	1.8	3.6	5.4
Arts, etc.	−17.5	17.4	68.8	−33.7	−5.0	−0.1	15.0	16.8	53.2	0.2	0.7	2.4
Accommodations, etc.	−24.6	10.3	64.9	−44.5	−6.3	−1.0	10.9	12.3	46.6	−0.9	−0.5	1.4
Other services	−27.4	10.2	65.7	−40.9	−3.7	0.7	8.4	10.3	41.9	−1.2	−1.0	0.5
All	58.6	52.8	84.8	−39.8	−4.8	−0.3	35.2	35.9	72.9	−0.5	0.1	1.7

Note: This table provides a comparison between shutting down firms in year *t* with continuing firms. For these two groups of firms, the table provides the median and average employment growth in 3 years prior to firm shutdown in the former group

The sample includes only continuing workers or workers experiencing a permanent layoff. Thus, the indicator variable, PL_{ikjt}, equals 1 if a worker experiences a permanent layoff with $\mathrm{PL}^{*}_{ikjt} \geq 0$ and 0 if a worker continues employment. A second indicator variable, FS_{ikjt}, equals 1 if a firm remains active with $\mathrm{FS}^{*}_{ikjt} \geq 0$ and 0 otherwise. SR_{jt} is the annual shutdown rate in industry j in period t. The PL equation includes individual-, firm-, and industry-specific control variables: (i) B_{it} is a set of worker including an age categories, marital status, job tenure and tenure squared, region of residence, union membership, and earnings in period year $t-1$; (ii) I_j is industry-specific dummy variables; and (iii) D_t is a set of year-specific dummy variables. We break the sample of workers into subsamples for estimation purposes based on their firm's employment size. The FS equation includes all the relevant variables from PL equation but with Z_{kjt} as the exclusion restrictions both at the firm (k) and industry (j) levels. For a technical discussion of this method, please refer to Maddala (1983).

3.2 Identification strategy

The BPWS model given in Eq. 2 identifies the impact of selection in two ways: (1) the correlation parameter (ρ) of the joint model and (2) using exclusion restrictions of variables (Z_{jt}). The correlation parameter achieves identification through functional form. Han and Vytlacil (2017) prove that identification is achievable in bivariate models without exclusion restrictions (i.e., instruments) if there are common exogenous regressors in both equations. They also show that having an exclusion restriction is necessary and sufficient for identification in these models without common exogenous variables but is sufficient only in models with common exogenous covariates.

The second method requires at least one variable that affects whether a firm continues or not but not whether a worker experiences a permanent layoff or not, contemporaneously. There are two exclusion restrictions. The first exclusion restriction is the use of industry-level US-Canada bilateral real exchange rate:

$$\mathrm{RER}_{jt} = P^{\mathrm{US}}_{jt} / P^{\mathrm{CDN}}_{jt} \times e_t, \tag{3}$$

where P^{US}_{jt} is the US industry gross output price index, P^{CDN}_{jt} is the Canada industry gross output price index and e_t is the nominal bilateral exchange rate between Canadian and USA in year t. The choice of RER_{jt} as the exclusion restriction is motivated by the fact that the USA is the major trading partner of Canada. The real exchange rate affects Canadian export and import propensities with the USA. Short-run profits of Canadian firms likely fluctuate with export/import propensities. Thus, real exchange rate movements likely affect the probability of whether a Canadian firm continues to operate or temporarily shutdown; see for example Huynh et al. (2010). For employment, the impact of exchange rates differs. Huang et al. (2014) provide empirical evidence that exchange rate movements have little effect on manufacturing employment and no effect on non-manufacturing employment in Canada for the period 1994 to 2010. Commodity prices and exchange rate movements are tied together. The authors show that commodity price movements are a main driver to employment changes in manufacturing resulting from exchange rate movements. Further, Campa and Goldberg (2001) show that the real exchange rate movements for the USA have effects on wages and hours worked but have negligible effects on total employment and number of jobs. Based on these empirical findings, we argue that fluctuations of the real exchange rate is correlated with firm exit

rates but are unlikely to affect the contemporaneous probability a worker experiences a permanent separation.

The second exclusion restriction is a relative firm-to-industry variable. We compute the logarithm of the ratio of the wage bill of firm k at time t relative to the average wage bill of firms in industry j and size class s at time t or:

$$\log \overline{\text{wage bill}}_{kjst} = \log \left(\frac{\text{wage bill}_{kjst}}{\overline{\text{wage bill}}_{jst}} \right). \tag{4}$$

This variable is strongly correlated with whether a firm continues operations, as it proxies for how competitive a firm is relative to its industry peers. Controlling for the employment size of a firm, the relative wage bill provides a measure of firm efficiency/productivity within an industry. More productive firms pay higher wages and, thus, have a higher wage bill as discussed in Abowd et al. (1999), Michelacci and Quadrini (2009) and Moscarini and Postel-Vinay (2012). More productive firms with higher wage bills should be more likely to continue operations. However, the contemporaneous relative wage bill of a firm is unlikely to contain information about worker layoff probabilities at continuing firms.

3.3 Results

The BPWS results provide estimates of the impact of industry shutdown rates on worker layoffs with an additional selection control for whether a firm is active or not. Table 7 presents estimation coefficients for the probability of a permanent layoff when controlling for firm shutdown selection effects for men while Table 8 provides estimation coefficients for women.

The descriptive statistics illustrate that there is substantial variation in the shutdown rates across industry and time. Therefore, the impact of industry shutdown rates on permanent layoffs should be well-identified. A likelihood ratio test reveals that selection is statistically significant in all cases for men and three out of five cases for women. The exceptional cases are women at large and extra large firms. Therefore, selection via the impact of firm shutdown affects the probability of permanent layoff on a worker. Most of the discussion emphasizes the variable of interest, industry shutdown rates.

With the exception of women at small-sized firms, the coefficient on the shutdown rate is positive for both men and women across the firm size classes. Thus, these estimates indicate that the impact of industry shutdown rates on worker layoff rates are positive. Figure 2 provides estimated marginal effects of an increase in industry shutdown rate on the probability of a worker layoff across the firm size classes. For comparison, this figure also provides the estimated marginal effect without accounting for selection.[8] For both men and women, these quantitative impacts of the industry shutdown rate on permanent layoff probability change when accounting for selection. After controlling for selection, the results for men indicate that a 1% increase in industry shutdown rate causes between 0.04 and 0.14% increase in the probability of a permanent layoff. For women, the marginal effects vary across the firm size classes; a 1% increase in industry shutdown rates implies (i) a 0.01% decrease in the probability of a permanent layoff at extra small-sized firms and (ii) a 0.11, 0.03, 0.01, and 0.05% increase in the probability of a permanent layoff at small-, medium-, large-, and extra large-sized firms, respectively.

Table 7 Bivariate probability of permanent layoff: men

	XS	S	M	L	XL	All firms
Shutdown rate	1.1319	1.1781	1.3252	1.0205	.9667	.7368
	(.6124)[a]	(.6890)[a]	(.5541)[b]	(.6317)	(.3721)[c]	(.3935)[a]
Lag of earnings	−.0892	−.1124	−.1181	−.1251	−.1192	−.1179
	(.0056)[c]	(.0058)[c]	(.0114)[c]	(.0163)[c]	(.0131)[c]	(.0102)[c]
Age 35–49	−.0488	.0717	.0905	.0880	.0658	
	(.0067)[c]	(.0127)[c]	(.0127)[c]	(.0181)[c]	(.0151)[c]	(.0110)[c]
Age 50+	.0393	.1765	.2456	.2804	.2712	.2292
	(.0196)[b]	(.0237)[c]	(.0293)[c]	(.0432)[c]	(.0366)[c]	(.0299)[c]
Married	−.1877	−.1368	−.1229	−.1112	−.0987	−.1270
	(.0058)[c]	(.0069)[c]	(.0078)[c]	(.0075)[c]	(.0095)[c]	(.0098)[c]
Tenure	−.1489	−.1362	−.1316	−.1237	−.1005	−.1320
	(.0104)[c]	(.0128)[c]	(.0176)[c]	(.0193)[c]	(.0101)[c]	(.0153)[c]
Tenure squared	.0045	.0039	.0039	.0038	.0028	.0039
	(.0004)[c]	(.0005)[c]	(.0006)[c]	(.0007)[c]	(.0003)[c]	(.0005)[c]
Union	.1571	.2080	.2045	.1980	.1548	.1551
	(.0247)[c]	(.0357)[c]	(.0440)[c]	(.0552)[c]	(.0536)[c]	(.0693)[b]
Atlantic	.3809	.3096	.2920	.3091	.2318	.3213
	(.0391)[c]	(.0268)[c]	(.0257)[c]	(.0340)[c]	(.0431)[c]	(.0249)[c]
Quebec	.1292	.0978	.0748	.0576	–.0432	.0831
	(.0322)[c]	(.0216)[c]	(.0153)[c]	(.0210)[c]	(.0215)[b]	(.0180)[c]
Prairie	−.1128	−.0512	−.0246	.0142	−.0050	−.0194
	(.0175)[c]	(.0089)[c]	(.0136)[a]	(.0195)	(.0315)	(.0118)
BC	.0600	.0701	.0643	.0238	.0190	.0630
	(.0341)[a]	(.0192)[c]	(.0195)[c]	(.0384)	(.0393)	(.0247)[b]
Constant	−.1237	.0308	.0824	.2450	.2227	.1455
	(.1161)	(.0823)	(.1102)	(.1658)	(.1542)	(.1158)
Firm active estimates—exclusion restrictions						
log RER_{jt}	−.1108	−.0573	.0657	−.1671	−.1428	−.0523
	(.0526)[b]	(.0800)	(.1665)	(.2014)	(.9003)	(.1162)
log $\overline{\text{wage bill}}_{ikjt}$	.4065	.1746	.1184	.1228	.3395	.2850
	(.0146)[c]	(.0296)[c]	(.0418)[c]	(.0361)[c]	(.0349)[c]	(.0167)[c]
ρ (correlation)	−.4272	−.4545	−.463	.8875	.9156	−.0583
	(.0638)[c]	(.1736)[c]	(.0474)[c]	(.0127)[c]	(.0239)[c]	(.1657)
LR test χ^2 (selection)	34.20	5.02	4.99	555.22	111.34	.1234
p value	0	.025	.025	0	0	.7254
Observation-censored	78,090	32,215	26,554	12,415	5864	155,138
Observations	856,229	1,046,321	1,464,844	1,095,370	2,733,141	7,195,905
log *L*	−385,676.8	−342,000.6	−385,265.8	−217,645.1	−264,097.3	−1,691,035

Note: The reference group is Ontario for region, 25–35 for age, 2005 for year, and Construction for industry. The firm size classes are (XS) less than 5 employees, (S) 5–19 employees, (M) 20–99 employees, (L) 100–500 employees and (XL) 500+ employees. Clustered standard errors, in parentheses, account for within industry correlation

[a, b, c] Statistical significance at the 10, 5, and 1% levels, respectively

Returning to Tables 7 and 8, coefficients on the other control variables remain fairly constant across the firm size classifications and qualitatively identical for men and women. The probability of a permanent layoff falls with a worker's income. Tenure effects are concave in shape. Married workers have a lower probability of permanent layoff separation, while unionized workers have a higher permanent separation probability. Across the regions, workers in the Atlantic provinces experience the highest probability of a permanent layoff, where the lowest permanent layoff separation probability occurs for

Table 8 Bivariate probability of permanent layoff: women

	XS	S	M	L	XL	All firms
Shutdown rate	−.1088	1.2718	.4622	.2457	1.3510	.9273
	(.6894)	(.5613)[b]	(.3462)	(.5169)	(.5141)[c]	(.3633)[b]
Lag of earnings	−.0642	−.0847	−.0927	−.0990	−.0893	−.0908
	(.0090)[c]	(.0074)[c]	(.0101)[c]	(.0148)[c]	(.0107)[c]	(.0089)[c]
Age 35–49	−.0572	.0154	.0270	.0434	.0662	.0343
	(.0080)[c]	(.0103)	(.0114)[b]	(.0132)[c]	(.0125)[c]	(.0093)[c]
Age 50+	−.0166	.1236	.1524	.1724	.1760	.1379
	(.0146)	(.0179)[c]	(.0208)[c]	(.0175)[c]	(.0212)[c]	(.0196)[c]
Married	−.1738	−.1159	−.0849	−.0637	−.0310	−.0852
	(.0358)[c]	(.0189)[c]	(.0112)[c]	(.0126)[c]	(.0100)[c]	(.0146)[c]
Tenure	−.1015	−.0944	−.0883	−.0806	−.0669	−.0928
	(.0080)[c]	(.0055)[c]	(.0046)[c]	(.0052)[c]	(.0056)[c]	(.0052)[c]
Tenure squared	.0026	.0025	.0025	.0025	.0020	.0028
	(.0003)[c]	(.0002)[c]	(.0002)[c]	(.0002)[c]	(.0002)[c]	(.0002)[c]
Union	.0775	.1065	.0532	.0199	.0285	.0126
	(.0150)[c]	(.0163)[c]	(.0206)[c]	(.0226)	(.0285)	(.0198)
Atlantic	.4349	.3257	.2766	.2587	.1274	.2942
	(.0361)[c]	(.0341)[c]	(.0306)[c]	(.0558)[c]	(.0422)[c]	(.0323)[c]
Quebec	.2284	.1508	.0845	.0595	−.0177	.1158
	(.0303)[c]	(.0157)[c]	(.0299)[c]	(.0238)[b]	(.0216)	(.0253)[c]
Prairie	−.1340	−.0910	−.0517	−.0329	−.0617	−.0764
	(.0437)[c]	(.0139)[c]	(.0164)[c]	(.0250)	(.0275)[b]	(.0164)[c]
BC	.1163	.1069	.1095	.0566	.0001	.0884
	(.0297)[c]	(.0290)[c]	(.0247)[c]	(.0350)	(.0337)	(.0221)[c]
Constant	−.7691	−.6926	−.4260	−.2235	−.6727	−.6289
	(.2024)[c]	(.1446)[c]	(.1328)[c]	(.1794)	(.1622)[c]	(.1471)[c]
Firm active estimates—exclusion restrictions						
log RER_{jt}	−.1165	.0167	−.0649	−.7401	.0052	−.2341
	(.0878)	(.1220)	(.1802)	(.2693)[c]	(.8326)	(.0948)[b]
log $\overline{\text{wage bill}}_{ikjt}$	.4257	.1833	.1428	.0722	.3200	.3363
	(.0201)[c]	(.0493)[c]	(.0411)[c]	(.0376)[a]	(.0511)[c]	(.0248)[c]
ρ (correlation)	−.2913	−.3842	.9171	.5114	.0937	−.0487
	(.0764)[c]	(.1698)[c]	(.0091)[c]	(.3475)	(.4337)	(.1713)
LR test χ^2 (selection)	12.89	4.13	739.38	1.44	.05	.0807
p value	0	.042	0	.230	.830	.7764
Observation-censored	80,672	27,214	18,571	8387	4449	139,293
Observations	791,138	806,543	979,833	718,374	1,904,505	5,200,393
log *L*	−339,866.5	−235,821.1	−225,177.8	−128,665.1	−174,849.7	−1,187,556

Note: The reference group is Ontario for region, 25–35 for age, 2005 for year, and construction for industry. The firm size classes are (XS) less than 5 employees, (S) 5–19 employees, (M) 20–99 employees, (L) 100–500 employees, and (XL) 500+ employees. Clustered standard errors, in parentheses, account for within industry correlation

[a, b, c] Statistical significance at the 10, 5, and 1% levels, respectively

workers in the Prairie provinces. Tables 7 and 8 also report the coefficients on the log of the firm's wage bill and the log of the real exchange rate, which are our exclusion restriction variables in the selection equation. The coefficient on the wage bill variable is always positive and significant. This result likely captures the effect of firm size on firm survival as larger firms tend to have higher survival rates. The coefficient on the log of the real exchange rate varies between negative and positive and is only statistically significant with a negative value for men at small-sized firms and women at large-sized firms. For

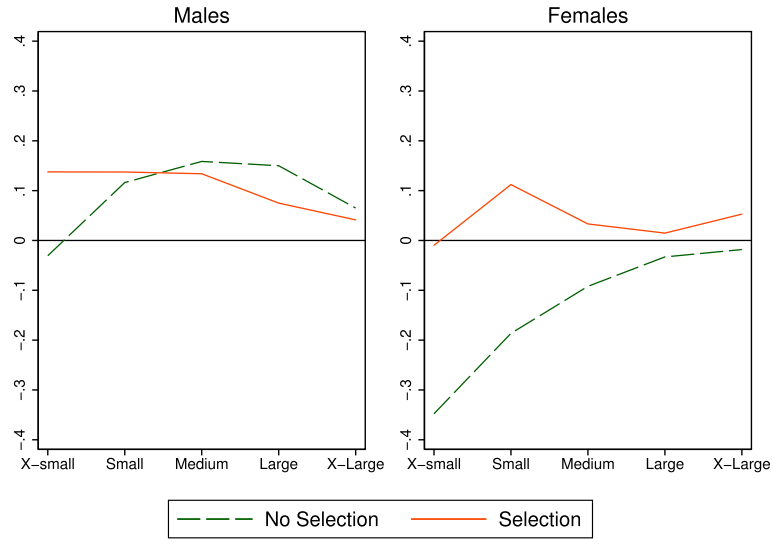


Fig. 2 Probability of permanent layoff and the effect of selection. *Note*: The figure provides the marginal effects of industry shutdown rates on the probability of a permanent layoff for a worker across various size classes of firms. Selection corresponds to estimates from Tables 7 and 8 for men and women, respectively. For comparison, no selection are estimates when not accounting for selection effects of continuing or shutdown of a firm

men, the correlation in the error terms between the two equations is approximately −0.45 in the extra small-, small-, medium-sized firm categories and approximately 0.9 in the large- and extra large-sized firm categories. A negative correlation implies that a positive shock to a firm remaining active has a negative impact on the probability of a male worker being permanently laid off. This correlatation also varies for women across firm size classes.

4 Earnings transitions—intensive margin

The previous section discusses permanent layoffs or the extensive margin of employment. In this section, we discuss workers earnings transitions or the intensive margins of permanent layoffs by looking at the earnings growth for those workers experiencing a permanent layoff. We do not use the identification strategy found in Abowd et al. (1999), where the worker and firm fixed effects enter additively. The LWF allows us to follow the worker transitions from a separation (layoff) to possible employment to a another firm. Eeckhout and Kircher (2011) provide motivation for using transitions. They show the estimated worker and firm fixed effects from the log-linear wage equation do not directly identify the underlying worker skill and firm productivity heterogeneity. In particular, the correlation between the estimated worker and firm fixed effects does not identify sorting in the matching between worker skill and firm productivity.

4.1 Earnings and selection

Similar to the previous selection problem, the estimated earnings growth model must account for selection effects due to firm shutdown. To deal with this selection problem, we estimate the effect of the transitions on the change in log wage using a Heckman-selection model. Again, the selection equation describes the probability of a firm continuing

$\left(\mathrm{FS}^{*}_{kjt}\right)$, while the outcome equation describes the log wage $\left(\ln w^{*}_{ikjt}\right)$ of a specific transition:

$$\begin{aligned}
\mathrm{FS}^{*}_{ikjt} &= \alpha^{\mathrm{FS}} + \beta^{\mathrm{FS}}\mathrm{SR}_{jt} + \gamma^{\mathrm{FS}}B_{it} + \sum_{j=1}^{J}\psi_{j}^{\mathrm{FS}}I_{j} + \sum_{t=1993}^{2002}\delta_{t}^{\mathrm{FS}}D_{t} + \lambda Z_{kjt} + \nu_{ikjt}, \\
\Delta \log w^{*}_{ikjt} &= \alpha^{w} + \beta^{w}\mathrm{SR}_{jt} + \gamma^{w}B_{it} + \sum_{j=1}^{J}\psi_{j}^{w}I_{j} + \sum_{t=1993}^{2002}\delta_{t}^{w}D_{t} + u_{ikjt}. \qquad (5)
\end{aligned}$$

where $\Delta \ln w_{ikjt}$ is wage growth of worker i from firm k in industry j at time t and the errors u_{ikjt} and ν_{ikjt} are normally distributed with zero means and correlation ρ. The other variables are defined as in the BPWS model from Eq. 2. The analysis examines wage growth as a way to control for potentially unobservable factors. For example, there may be wages differentials due to job risk, education, or occupations with higher layoff rates. The analysis includes industry, location, and firm size variables which partially capture some of these differentials. Further, these unobservable-time invariant worker or job characteristics are unlikely to affect wage growth. Dostie (2005) and Abowd et al. (2005) show unobserved heterogeneity affects the level of $\ln w_{ikjt}$. However, the analysis of wage growth, $\Delta \ln w_{ikjt}$, differences out time invariant factors and, thus, removes these unobservable variables. In contrast to the BPWS model, the exclusion restriction only includes the firm-to-industry relative wage ($\log \overline{\text{wage bill}}_{ikjt}$). The specification does not include the relative real exchange rate as an exclusion restriction. Campa and Goldberg (2001) show an impact of the real exchange rate on wages, which justifies this change from the previous worker separation analysis.

Tables 9 and 10 present the coefficient estimates for the earnings regression accounting for selection effects for men and women, respectively. The selection parameter (λ) is significant for all size classes except small- and large-sized firm categories for men and small- and extra large-sized firm categories for women.[9] This result is due to the small correlation (ρ) between the two equations. For comparison purposes, Fig. 3 provides coefficient estimates on the industry shutdown variable for the selection and non-selection models. For men, the coefficient on the industry shutdown rate variable becomes positive and statistically significant for workers at medium-sized firms, while the coefficients remain negative, statistically significant and increase slightly in magnitude for workers at other size classes when moving from the non-selection to the selection model. For women, there is no change in the qualitative findings and little change in the quantitative effects of the industry shutdown rate after accounting for selection. Thus, the impact of selection effects of firm shutdown is small when examining worker earnings growth. With the exception of men at medium-sized firms, the correlation between the error terms in the two equations, ρ, is positive. Positive correlation indicates that firms with unexplained increases in the probability of remaining active also have unexplained increases to wages paid.

The change in the logarithm of worker wages measures the wage growth for a worker. Thus, the coefficient on the industry shutdown rate variable gives the response of worker wage growth to changes in the industry shutdown rate. Equivalently, this coefficient gives an elasticity or the percentage change in worker earnings in response to a 1% change in the industry shutdown rate. The estimated coefficient values indicate economic significance in that worker wage growth is highly responsive to industry shutdown rates. For men,

Table 9 Earnings regression with selection: men

	XS	S	M	L	XL	All firms
Shutdown rate	−.9794	−1.3430	−3.0549	−.5340	−1.3538	
	(.7858)	(1.0124)[b]	(1.1623)	(1.0471)[c]	(1.0941)	(.7210)[a]
Age 35–49	−.0737	−.0742	−.0661	−.0904	−.0751	
	(.0195)[c]	(.0161)[c]	(.0202)[c]	(.0169)[c]	(.0168)[c]	(.0098)[c]
Age 50+	−.1820	−.1965	−.2107	−.2139	−.2429	−.2135
	(.0346)[c]	(.0207)[c]	(.0251)[c]	(.0304)[c]	(.0277)[c]	(.0187)[c]
Married	−.0065	.0414	.0917	.0033	.0390	.0221
	(.0172)	(.0179)[b]	(.0337)[c]	(.0139)	(.0260)	(.0126)[a]
Tenure	−.1236	−.1629	−.1200	−.1437	−.1270	−.1406
	(.0153)[c]	(.0121)[c]	(.0060)[c]	(.0172)[c]	(.0119)[c]	(.0107)[c]
Tenure squared	.0055	.0075	.0069	.0055	.0042	.0054
	(.0008)[c]	(.0006)[c]	(.0004)[c]	(.0008)[c]	(.0006)[c]	(.0005)[c]
Union	.1109	.1224	.0589	.1051	.0704	.0772
	(.0206)[c]	(.0256)[c]	(.0199)[c]	(.0277)[c]	(.0290)[b]	(.0130)[c]
Atlantic	.1431	.1096	−.1151	.0734	−.1065	
	(.0233)[c]	(.0155)[c]	(.0542)[b]	(.0443)[a]	(.0601)	(.0325)[c]
Quebec	.0231	.0058	−.0907	.0154	−.0046	.0220
	(.0253)	(.0202)	(.0285)[c]	(.0211)	(.0383)	(.0198)
Prairie	.0350	.0296	−.1011	.0276	.0432	
	(.0198)[a]	(.0186)	(.0348)	(.0210)[c]	(.0317)	(.0161)[c]
BC	−.0444	−.1370	−.0089	−.0461	−.0226	
	(.0257)[a]	(.0249)[a]	(.0547)[b]	(.0334)	(.0424)	(.0204)
Firm active estimates—exclusion restrictions						
$\log \overline{\text{wage bill}}_{ikjt}$	.4872	.2657	.1091	.1053	.4938	.3989
	(.0217)[c]	(.0435)[c]	(.0485)[b]	(.0721)	(.0698)[c]	(.0205)[c]
ρ (correlation)	.0956	.0052	−.6605	.0138	.0683	.0396
	(.0213)[c]	(.0346)	(.0753)[c]	(.0393)	(.0193)[c]	(.0120)[c]
σ (variance)	1.2316	1.2336	1.3537	1.197	1.2076	1.2191
	(.0182)[c]	(.0215)[c]	(.0932)[c]	(.0381)[c]	(.0439)[c]	(.0286)[c]
λ (selection)	1176	.0065	−.8942	.0165	.0824	.0483
	(.0263)[c]	(.0426)	(.1624)[c]	(.0354)	(.0219)[c]	(.0143)[c]
Observations	104,317	64,708	68,134	36,100	36,352	309,611
Observation-censored	81,178	31,112	25,081	11,738	5416	154,525
log *L*	−82,747.59	−107,003.9	−57,477.46	−59,985.37	−433,093.5	

Note: The reference group is Ontario for region, 25–35 for age, 2005 for year, and construction for industry. The firm size classes are (XS) less than 5 employees, (S) 5–19 employees, (M) 20–99 employees, (L) 100–500 employees, and (XL) 500+ employees. Clustered standard errors, in parentheses, account for within industry correlation

[a, b, c] Statistical significance at the 10, 5, and 1% levels, respectively

extra small-sized firms show the least response of wage growth to industry shutdown rates with a coefficient of −0.98, while men at large-sized firms have the most response with a coefficient of −3.05. For women, workers at the extra small-sized firms have the largest response as the coefficient estimate indicates a 1% increase in industry shutdown rate causes a 3% decrease in worker wage growth.

The coefficients on the other variables indicate similar patterns across firm size classes and genders. Earnings growth falls with age and rise with being married or part of a unionized firm. The effect of job tenure is nonlinear. Wage growth initially falls with tenure but begins to rise after approximately 11 years at a job. We investigate worker earnings while controlling for the possible association of the firm size class with the worker earning

Table 10 Earnings regression with selection: women

	XS	S	M	L	XL	All firms
Shutdown rate	−3.4041	.1620	−1.8604	−2.0460	−.9859	−1.3759
	(1.4500)[b]	(.8545)	(1.3127)	(1.8356)	(1.0292)	(.9488)
Age 35–49	−.0556	−.0321	−.0328	−.0728	−.0475	
	(.0343)	(.0257)	(.0235)[a]	(.0296)	(.0239)[c]	(.0101)[c]
Age 50+	−.2370	−.1923	−.3059	−.3178	−.3306	−.2710
	(.0328)[c]	(.0441)[c]	(.0392)[c]	(.0419)[c]	(.0555)[c]	(.0285)[c]
Married	−.0207	.0394	.0363	.0494	.0267	.0293
	(.0242)	(.0158)[b]	(.0270)	(.0248)[b]	(.0262)	(.0103)[c]
Tenure	−.1648	−.1966	−.2136	−.1722	−.1555	−.1747
	(.0204)[c]	(.0202)[c]	(.0131)[c]	(.0188)[c]	(.0129)[c]	(.0106)[c]
Tenure squared	.0068	.0088	.0095	.0061	.0054	.0067
	(.0009)[c]	(.0012)[c]	(.0008)[c]	(.0011)[c]	(.0006)[c]	(.0005)[c]
Union	.1523	.0486	.0450	.1302	.0540	.0719
	(.0552)[c]	(.0911)	(.0682)	(.0393)[c]	(.0334)	(.0383)[a]
Atlantic	.2317	.1793	.1750	.2020	.1494	.1805
	(.0392)[c]	(.0422)[c]	(.0647)[c]	(.0684)[c]	(.0552)[c]	(.0340)[c]
Quebec	.1129	.0569	.0349	.0904	.1160	.0698
	(.0338)[c]	(.0392)	(.0339)	(.0436)[b]	(.0343)[c]	(.0234)[c]
Prairie	.0328	−.0049	.0548	.0678	.0732	.0353
	(.0533)	(.0475)	(.0328)[a]	(.0628)	(.0453)	(.0268)
BC	.0372	.0312	−.0467	.00007	−.0238	−.0052
	(.0422)	(.0295)	(.0361)	(.0777)	(.0501)	(.0252)
Firm active estimates—exclusion restrictions						
$\log \overline{\text{wage bill}}_{ikjt}$	.4743	.2943	.1818	.1116	.5411	.4460
	(.0148)[c]	(.0460)[c]	(.0768)[c]	(.0736)	(.0635)[c]	(.0232)[c]
ρ (correlation)	.0762	.0167	.0563	.0876	0038	.0314
	(.0422)[a]	(.0532)	(.0441)	(.0354)[b]	(.0589)	(.0296)
σ (variance)	1.3042	1.3157	1.3280	1.3296	1.3249	1.3250
	(.0293)[c]	(.0329)[c]	(.0377)[c]	(.0170)[c]	(.0238)[c]	(.0222)[c]
λ (selection)	.0998	.0232	.0748	.1165	.0051	.0416
	(.0557)[a]	(.0699)	(.0581)[a]	(.0476)[b]	(.0781)	(.0394)
Observations	94,357	40,953	33,713	17,267	18,628	204,918
Observation-censored	82,961	26,855	17,872	8093	4117	139,898
log *L*	−48,767.82	−48,280.89	−48,160.96	−26,165.28	−30,879.39	−222,421.9

Note: The reference group is Ontario for region, 25–35 for age, 2005 for year, and construction for industry. The firm size classes are (XS) less than 5 employees, (S) 5–19 employees, (M) 20–99 employees, (L) 100–500 employees, and (XL) 500+ employees. Clustered standard errors, in parentheses, account for within industry correlation

[a, b, c] Statistical significance at the 10, 5, and 1% levels, respectively

changes. There are two potential reasons for a worker's firm size class to change. First, the worker moves to a different firm belonging to a different size class. Second, the worker stays at the same firm, but the firm moves to a different firm size class. Since we look at workers experiencing a permanent layoff, our analysis focuses on the group of workers moving to a different firm. This analysis demonstrates whether a layoff necessarily results in a worse situation for a worker. We examine the impact of firm size class switches on the earnings of laid-off workers since firm size provides a clear dimension for improvement in worker's earnings. Oi and Idson (1999) document that larger firms pay higher wages. Therefore, workers experiencing a layoff but moving to firms in larger size classes may actually see their wages increase.[10]

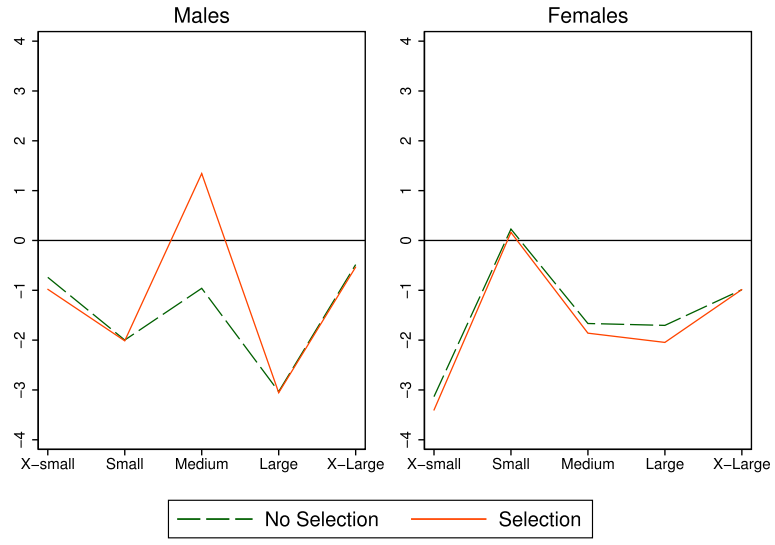
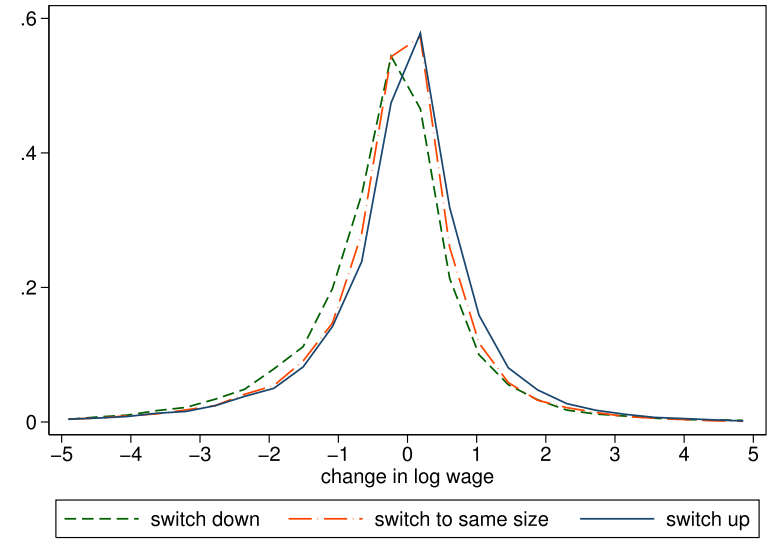


Fig. 3 $\Delta \log w_{ikjt}$ and the effect of selection. *Note*: The figure provides the marginal effects of industry shutdown rates on the probability of a permanent layoff for a worker across various size classes of firms. Selection corresponds to estimates from Tables 9 and 10 for men and women, respectively. For comparison, no selection are estimates when not accounting for selection effects of continuing or shutdown of a firm

Figure 4 presents the probability distribution function (PDF) for $\Delta\log(\text{wage}_{ikjt})$ for those men and women, respectively, who experience a permanent layoff but move to a different firm. Each figure shows CDFs for three subgroups: (i) switch down—worker moves to a firm in a smaller size class; (ii) switch to same size—worker moves to a firm in the same size class; and (iii) switch up—worker moves to a firm in a larger size class. For both men and women, the wage growth PDFs for the switch down, switch to the same size, and switch up are left, middle, and right, respectively. These figures indicate that workers who transition to larger sized firms do better than workers who move to a firm in the same size class, while workers who move to smaller sized firms do worse. An asymmetry results when comparing the distributions across the three groups. For negative values of wage growth, the lower tail for the switch down group of workers is much fatter than for the other two groups, while the lower tail looks similar for the switch to same size and switch up groups. For positive values of wage growth, the opposite occurs. The distribution switch down and switch to same size groups have similar upper tails while the switch up group has a fatter upper tail.

This unconditional analysis ignores the rich characteristics of firms and workers. So, we amend the wage model with selection (5) to include the firm size class switches. The switchers are treated as exogenous as we focus only on involuntary separations or permanent layoffs. The following specification combines workers experiencing a firm size class switch with the selection wage model:

$$\begin{aligned}
\text{FS}^{*}_{ikjt} &= \alpha^{\text{FS}} + \beta^{\text{FS}}\text{SR}_{jt} + \gamma^{\text{FS}}B_{it} + \sum_{j=1}^{J}\psi_j^{\text{FS}}I_j + \sum_{t=1993}^{2002}\delta_t^{\text{FS}}D_t + \lambda Z_{kjt} + \sum_{i\in m}\eta^{\text{FS}}\text{SW}_{it} + \nu_{ikjt}, \\
\Delta \log w^{*}_{ikjt} &= \alpha^{w} + \beta^{w}\text{SR}_{jt} + \gamma^{w}B_{it} + \sum_{j=1}^{J}\psi_j^{w}I_j + \sum_{t=1993}^{2002}\delta_t^{w}D_t + \sum_{i\in m}\eta^{w}\text{SW}_{it} + u_{ikjt}. \qquad (6)
\end{aligned}$$



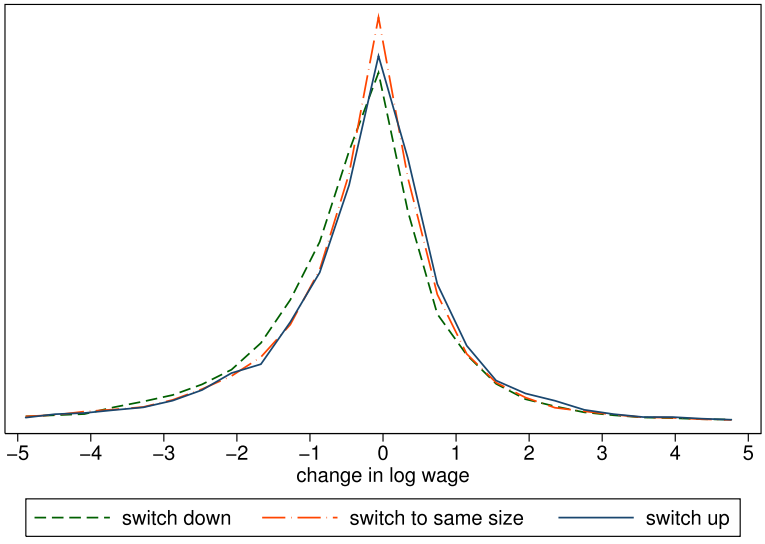


Fig. 4 Unconditional probability distribution of $\Delta \log w_{ikjt}$. *Note*: This graph illustrates the unconditional growth rate of wages ($\Delta \log w_{ikjt}$) for male (*top graph*) and female (*bottom graph*) workers who experienced a permanent layoff and found a new job. The following three lines are for groups of workers: (1) transition to a smaller size firm (*switch down*), (2) transition to a larger size firm (*switch up*), and (3) transition to a same size firm

where SW_{it} is a series of indicator variables for individuals across various firm size transitions between time $t-1$ and t and η^w is the corresponding coefficients on the indicator variables. Firm size transition classes, m, are: (i) extra small to small (XS–S); (ii) small to extra small (S–XS); (iii) small to small (S–S); (iv) small to medium (S–M); (v) medium to small (M–S); (vi) medium to medium (M–M); (vii) medium to large (M–L); (viii) large to medium (L–M); (ix) large to large (L–L); (x) large to extra large (L–XL); (xi) extra large to large (XL–L); and (xii) extra large to extra large (XL–XL). Table 11 provides estimates for the earnings regressions controlling for firm size class changes. Industry shutdown rate continues to have a negative impact on worker earnings even with the additional control for switching firm size class. The coefficients on the

Table 11 Earnings switcher regression with selection: pooled

	Male	Female
Shutdown rate	−1.2943	−.9074
	(.6875)[a]	(.9686)
XS–S	.2229	.1779
	(.0228)[c]	(.0224)[c]
S–XS	−.1983	−.1368
	(.0141)[c]	(.0399)[c]
S–S	.0311	.0496
	(.0241)	(.0329)
S–M	.1259	.0597
	(.0276)[c]	(.0354)[a]
M–S	−.0593	−.0292
	(.0227)[c]	(.0471)
M–M	.0529	.0370
	(.0153)[c]	(.0506)
M–L	.1111	.0912
	(.0247)[c]	(.0447)[b]
L–M	−.0615	−.0133
	(.0165)[c]	(.0577)
L–L	.0627	.0714
	(.0211)[c]	(.0442)
L–XL	.0832	.0478
	(.0276)[c]	(.0475)
XL–L	−.0348	.1104
	(.0242)	(.0685)
XL–XL	.0206	.0695
	(.0177)	(.0369)[a]
$\log \overline{\text{wage bill}}_{ikjt}$	.2795	.3215
	(.0180)[c]	(.0316)[c]
ρ (correlation)	.0208	.0314
	(.0155)	(.0420)
σ (variance)	1.1546	1.2967
	(.0313)[c]	(.0288)[c]
λ (selection)	.0240	.0408
	(.0180)[a]	(.0547)
Observations	164,659	89,450
Observations (Censored)	60,750	48,027
log *L*	−288,496.2	−139,451.6

Note: The reference group is Ontario for region, 25–35 for age, 2005 for year, and construction for industry. The firm size classes are (XS) less than 5 employees, (S) 5–19 employees, (M) 20–99 employees, (L) 100–500 employees, and (XL) 500+ employees. Clustered standard errors, in parentheses, account for within industry correlation

[a, b, c] Statistical significance at the 10, 5, and 1% levels, respectively

switching variables have the expected sign. An increase in the firm size class of a worker sees the worker's earnings increase, while a decrease in firm size class sees the worker's earnings fall.

Switching from extra small- to small-sized firm causes wages to increase by 0.22% for men and 0.18% for women. The magnitude is not as great in the reverse direction as switching from small- to an extra small-sized firms causes earnings for men to fall by 0.20% and women earnings to fall by 0.14%. A movement from medium- to large-sized firms causes earnings of men to increase by 0.11% and earnings of women to increase

by 0.09%, while a movement from large- to medium-sized firms causes the earnings of men and women to fall by 0.06 and 0.01%, respectively. Those workers not changing firm size class generally do not see changes in their earnings. The exceptions to this rule are men at medium- and large-sized firms who see a statistically significant increase in earnings of 6%.

Figure 5 present the PDFs of the residuals from the regressions in Table 11 for men and women. As in Fig. 4, these workers are broken into three categories based on pre-layoff to post-layoff size class transition of their firms. The conditioning removes a significant amount of the difference between the distributions across the three categories. Further, the asymmetries at the tails of the distributions across the three categories disappear after

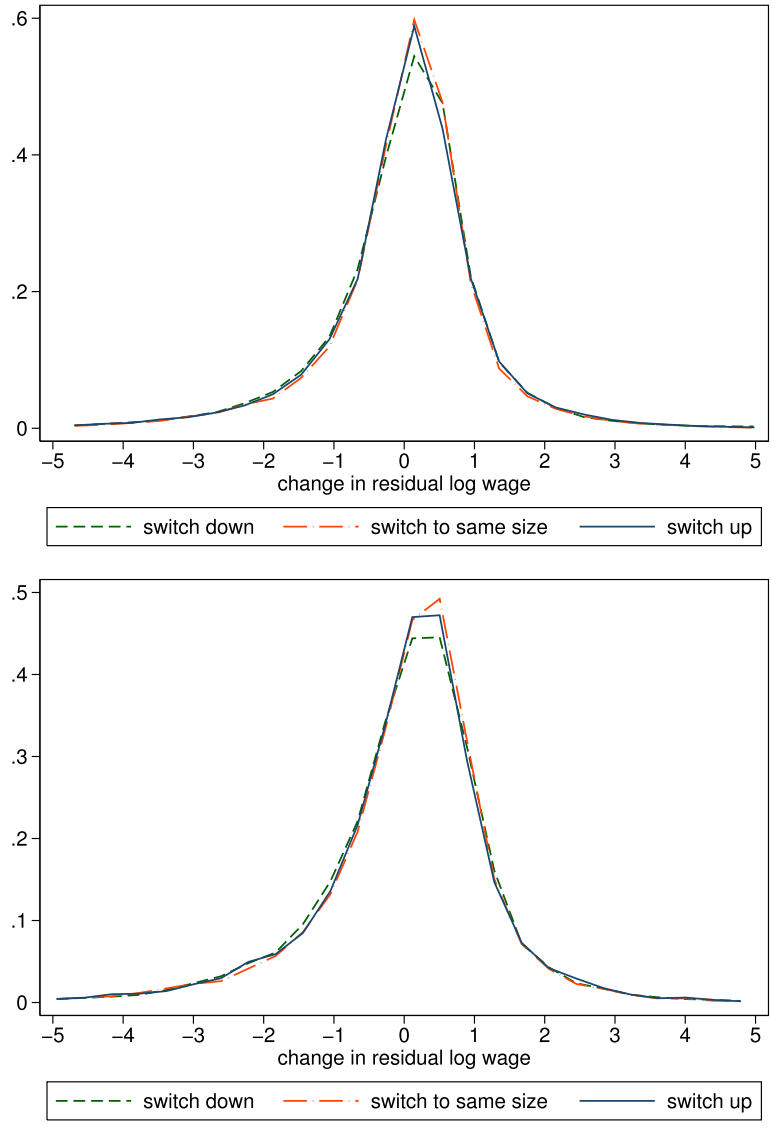


Fig. 5 Conditional probability distribution of $\Delta \log w_{ikjt}$. *Note*: This graph illustrates the conditional growth rate of wages ($\Delta \log w_{ikjt}$) for male (*top graph*) and female (*bottom graph*) workers who experienced a permanent layoff and found a new job. The following three lines are for groups of workers: (1) transition to a smaller size firm (*switch down*), (2) transition to a larger size firm (*switch up*), and (3) transition to a same size firm. The residual wage growth is generated by the Heckman selection model (6) and results in Table 11

the conditioning. A worker does not necessarily end up in a worse position with a lower earning job after being permanently laid off. However, almost 60% of those laid-off workers who move to smaller or similarly sized firms see a fall in wages. In contrast, less than 50% of laid-off workers eventually moving to a larger sized firm see their earnings fall. Thus, the type of firm a worker ends up at after being laid off explains a significant amount of the resulting wages.

5 Conclusions

We quantify the effect of industry shutdown rates on worker outcomes such as involuntary separations or permanent layoffs (extensive margin) and wage earnings (intensive margin). Our empirical work shows that when controlling for individual- and firm-specific characteristics, industry shutdown rates generally have a positive and significant effect on the probability of a permanent worker layoff. For wage growth, shutdown rates have a negative effect but the effects are amplified for workers in smaller firms. The unique structure of the LWF database allows us to differentiate among different industries in our analysis. We find substantial differences across industries in the roles of individual- and firm-level attributes on permanent layoff and wage growth. Our analysis controls for firm selection effects on worker outcomes due to firm shutdown. Accounting for selection effects does alter the estimated impact of industry shutdown rates on worker outcomes.

Determining the relative contribution of worker, firm, industry, and time factors to the overall employment instability is an essential step in developing training programs to counter the adverse effects of employment loss. If job instability is mostly determined by differences in individual human capital, then future policies may focus on providing opportunities for workers to improve their education or skills. If, on the other hand, job instability is mostly a reflection of industry conditions or, more specifically, firm shutdown within an industry, then education and skill development programs may not be as effective. Hence, understanding the relative impact of individual and firm characteristics on worker turnover is important in determining the effectiveness of specific training and skill-development programs provided both privately and publicly. In the light of the recent economic downturn that affected many Western countries including Canada, the costs and benefits associated with such programs are likely to remain subject to intense policy discussions in the foreseeable future. Our estimates of the impact of industry shutdown rates on earnings growth is line with other papers that focus on uncertainty and variability such as Gathmann et al. (2017).

These results demonstrate the necessity of the joint analysis of firm shutdown with either permanent layoff or worker wages. Industry shutdown rates provide a measure of turbulence and firm turnover within an industry. Without controlling for firm selection, the analysis ignores a major portion of workers and firms. Higher industry shutdown rates suggest more turbulence within an industry. Substantial hiring and firing costs lead to a desire by continuing firms to keep and not lay off their workers. These costs factor into a firm's choice to continue operations or shutdown. Higher hiring and firing costs within an industry also factor into a firm's choice between temporary shutdown or permanent exit.

Controlling for a firm's shutdown probability allows the industry shutdown rate to fully capture industry turnover which leads to the positive correlation between industry

shutdown and the permanent worker layoff rate. This finding complements the work by Moscarini and Postel-Vinay (2012) who document that the negative correlation between net job creation rates and the unemployment rate is larger for small firms versus large firms.

Job turnover has a rich set of dynamics that cannot necessarily be explored with reduced-form methods. As suggested by Postel-Vinay and Robin (2006), they highlight the role for modeling job turnover using frictional models of unemployment. In these models, job turnover is a dynamic process that involves explicitly laying out the microfoundations. However, there is an important opportunity for further research on voluntary separations or a worker quitting their job to find a new one. Recent work by Lise et al. (2016) allows for matched agents to undertake on-the-job search and illustrates the complexity of labor outcomes in terms employment prospects and earnings. A fruitful extension would consider both involuntary and voluntary quits.

Endnotes

[1] Work in this literature is driven by collection of administrative data, which usually have restricted access. For example, a recent study by Song et al. (2015) shows that rising labor earnings dispersion in the USA is driven by increasing wage dispersion across firms and not by changes to within firm wage dispersion. Haltiwanger et al. (2006) provide a broad overview.

[2] Morissette (2004), Morissette R et al. (2007) and Morissette et al. (2013) use the LWF database to investigate permanent layoffs and worker reallocation.

[3] Job instability has wide ranging financial and other consequences for individuals and families (Jacobson et al. (1993); Gottschalk and Moffitt (1994) Gottschalk and Moffitt (2009); Beach et al. (2003); Morissette and Ostrovsky (2005)). Often, it signals high earnings uncertainty, which may, in turn, lead to lower consumption Browning and Lusardi (1996) and alter family savings and labor supply decisions (Pistaferri (2003)). It may also affect families' schooling and occupational choices (Guiso et al. (2002)) and even their fertility behavior (Fraser (2001)).

[4] We perform separate analysis on men and women as labor market decisions and outcomes are likely to differ; see Killingsworth and Heckman (1987), Loprest (1992), and Altonji and Blank (1999), inter alia.

[5] We thank an anonymous referee for pointing out this salient feature.

[6] This NAICS coding is partially due to retro-coding by Statistics Canada.

[7] Results are available upon request.

[8] The coefficients on the other variables are quite similar for the models with and without a firm selection control. A complete set of estimates for the model with no control for selection are available from the authors upon request.

[9] In a full-information maximum likelihood estimation, the selection parameter is a function of correlation and variance (σ) or $\lambda = \rho \times \sigma$.

[10] Other dimensions to look at when investigating worker earnings following layoffs include workers moving to new occupations or industries. Our dataset does not include information regarding worker occupation. Further, there is no clear direction to the change in worker earnings when moving to a new industry or occupation unlike moving to larger firms.

[11] A T4 form closely resembles a W-2 form in the USA.

Appendix

Construction of Longitudinal Worker File

Statistics Canada constructs the LWF database from four data sources. The first data source in the LWF is the T4 Supplementary Tax File, which is a random sample of all individuals who received a T4 supplementary tax form and filed a tax return. A T4 supplementary tax form is issued by an employer to each employee for any earnings that either exceed a certain threshold or trigger income tax, Canada/Quebec Pension Plan (C/QPP), or unemployment insurance premiums. It contains information about the earnings received from an employer in a given year, tax deducted, pension contributions, union dues, and other information.

The second data source is the Record of Employment (ROE), which includes employer provided information on separations and their reasons. Canadian employers are by law required to provide such information for any separation. A detailed list of reasons for separations includes voluntary and involuntary separations such as the shortage of work, labor dispute, injury or illness, quit, pregnancy and parental leaves, retirement, and other reasons. The third data source is the Longitudinal Employment Analysis Program (LEAP). Statistics Canada constructs and maintains the LEAP database. This database includes information about the size of the employee's firm and tracks employees who move from one firm to another. The LEAP database covers the entire Canadian economy and includes firms (but not establishments) with at least one dollar in annual payroll. The key information that comes from the LEAP is the firm's employment derived from its payroll using average labor units (ALU). LEAP tracks employees who move from one firm to another. Statistics Canada constructs LEAP, and by extension the LWF database, to handle mergers and acquisitions in a retrospective manner. Suppose two firms, A and B, merge in year t to create firm C. Within the database prior to year t, a synthetic history for firm C is created by aggregating information from firms A and B, so that only firm C's information appears in the database. Thus, identification of a firm's exit or shutdown imply these are not due to merger activity. The final data source is personal income tax files (T1), which add demographic variables such as age, sex, family status, and area of residence. They also provide information about individuals' income sources other than T4 earnings.

Our data was constructed by using information from the LEAP to classify firm entries and shutdowns and to compute industry-specific shutdown rates. Identification of firm entries and shutdowns is based on firm payroll transitions from 1 year to the next one. A firm's entry year is the first year; the firm has a positive payroll. We identify firm shutdown in year t when a firm has zero payroll in year t but positive payroll in year $t-1$. Thus, entry year is not identifiable for firms existing in 1991 or the first year of the LEAP database, while firm shutdown is not identifiable in 2008 or the last year of the database. Further, LEAP includes NAICS codes for firms from 1992 and onwards. Consequently, NAICS industry-specific shutdown rates can be computed only from 1992 to 2007.

We proceed by extracting individual data from the LWF. Since NAICS codes in the LWF are available only from 1992, we used the LWF data from 1992 to 2008. We kept men and women aged 24 to 64. Total earnings in year $4t$ were defined as individual's total annual paid employment income (wages and salaries) computed from all T4 forms issued to the individual in year t. All earnings are adjusted to 2007 constant dollars using the Consumer Price Index for Canada. For individuals who held multiple jobs in a given year,

we then retained only the characteristics of main jobs defined as jobs with the highest T4 amount in that year.[11] To each individual record in the LWF, we added industry-specific shutdown rates by matching firm identifiers in the LWF to those in the LEAP. We excluded individuals who died and whose employer's industry classification was unknown.

Next, individual employer-employee records from the LWF are matched to industry price information available for the period from 1987 to 2007. US industry prices are taken from Industry Economic Accounts tables available from the Bureau of Economic Analysis, US Department of Commerce (Chain-Type Price Indexes for Gross Output by Industry series). Canadian industry price indexes are computed from the information on gross output and real gross output, by industry (Statistics Canada CANSIM series 383-0022). Although both the US and Canadian industry price indexes are based on the North American Industry Classification System (NAICS) codes, there are some differences between the industries available in each series. We identified 42 industries for which a direct correspondence between the two series could be established. Excluded are primarily industries that are most likely to be represented by the public sector, such as, for instance, public administration, education and healthcare. Three industries ("petroleum and coal product manufacturing," "pipeline transportation," and "waste management") had to be excluded because of insufficient sample size. Therefore, our final sample includes 39 industry categories. The list of included industries is given in Table 1. Finally, the LWF records are also matched to annual Canada/US nominal exchange rates necessary to produce real exchange rates used in the study. The rates used in the study are from the G.5 Foreign Exchange Rates series provided by the Board of Governors of the Federal Reserve System (Series ID: *EXCAUS*).

Acknowledgements
The assistance and hospitality of Statistics Canada is gratefully acknowledged. Comments and suggestions from the participants at various conferences and seminars are greatly appreciated. The authors thank Kathryn Shaw, Michael Veall, Gueorgui Kambourov, John Stevens, Joni Hersch, and anonymous referees for the valuable comments. The views in this paper represent those of the authors alone and are not those of the Bank of Canada or Statistics Canada. All errors and opinions are our own.
Responsible editor: Joni Hersch

Funding
No funding was received for this paper.

Competing interests
The IZA Journal of Labor Economics is committed to the IZA Guiding Principles of Research Integrity. The authors declare that they have observed these principles.

Publisher's Note

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Received: 12 January 2017 Accepted: 10 May 2017
Published online: 13 June 2017

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