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Work Sharing and Productivity : Evidence from a Natural Experiment*

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Résumé / Abstract

Cet article examine empiriquement l'impact du partage du travail sur la productivité des travailleurs d'une grande firme canadienne. L'application de la semaine réduite de travail pendant un an au sein de cette entreprise nous permet de comparer analytiquement la productivité des employés avant et après l'adoption de ce programme. Nos résultats révèlent que l'expérimentation de la semaine réduite de travail provoque une baisse significative de la productivité des travailleurs.

This paper is the first to examine empirically how work sharing influences workers' productivity, using a unique data set from a large Canadian firm. This firm has adopted a work sharing scheme for one year, which allows us to introduce a "natural experiment approach" of comparing workers' productivity before and after the implementation of work sharing. We find that work sharing has led to a significant decrease in labor productivity.

Mots Clés : Productivité, partage du travail, modes d'organisation du travail

Keywords : Productivity, Work Sharing, Work Organisation Methods

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1. INTRODUCTION

Since the Great Depression, the idea of work sharing or reducing the standard work week, has gained popularity, as a policy to reduce unemployment (OECD, 1994). Much of this popularity has stemmed from the political arena (see, for example Conyers forward to McGaughey, 1980) and the policy's attractive feature of (potentially) sharing the burden of unemployment amongst the workforce. Alternatively, if unemployment gives rise to social problems such as the increased incidence of health problems (Merrigan et al. 1995, Shearer and Marceau 1995) society may benefit from the reduced costs associated with a reduction in the unemployment rate.

As many authors have noted the effectiveness of work sharing in reducing unemployment will depend on how firms react to the policy (see, for example, Ehrenberg and Schumann 1982). There are undoubtedly some benefits to firms of work sharing. For example, during economic downswings work sharing may allow firms to maintain a skilled labour force thus avoiding future hiring and training costs (Lacroix 1995). Furthermore, the ability to avoid layoffs may improve industrial relations and worker moral[1]. Yet, the same hiring and training costs that render layoffs unprofitable also reduce the desirability of substituting new hires for hours worked by existing employees (Fortin 1989). Thus, the trade off between hours worked by existing employees and new hires may be less than one to one.

Another factor affecting a firm's response to worksharing is the effects of the program on worker productivity. For example, if working fewer hours per week reduces worker fatigue, workers may become more productive thus further reducing the incentive to hire more workers (Reid 1982). Alternatively, work sharing may introduce coordination costs that reduces worker productivity. That is, if the reduction in hours worked implies some workers must finish tasks that were started by others. This sharing of tasks can lead to lost time that is needed to coordinate actions.

While these ideas are not new, little empirical work has been done to measure the consequences of work sharing. While some macroeconomic studies have examined the impact of reduced work time on employment (Drèze 1986), data that would permit the measurement of the productivity effects of work sharing has generally not been available. This paper presents a simple model of worker productivity under work sharing that allows for the effects of fatigue and coordination costs. We apply these ideas to productivity data collected from the archives of a large

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[1] A well documented American success story, Lincoln Electric Company, has a no layoff policy; see, for example Milgrom and Roberts (1992, p. 338).

Canadian telecommunications company. This company recently implemented a work sharing program, largely in response to increased competition resulting from a recent deregulation of the telecommunications industry in Canada. We consider this change in government policy as an exogenous event and treat the data as the result of a natural experiment. Comparing average productivity before and after the introduction of the program allows us to measure the effect of work sharing on worker productivity. We argue that coordination costs are task specific and identify those tasks in which they are likely to be more important.

Our results suggest that average worker productivity was reduced during the worksharing program by between 3% and 8%. We argue that coordination costs cannot, however, provide a complete explanation for this reduction since productivity decreases in tasks for which coordination costs would seem to play an insignificant role. We thus provide some alternative explanations and make suggestions for further research.

The rest of the paper is organized as follows. Section 2 describes the work sharing experiment as it was implemented in the firm. Section 3 presents the model and predictions on the impact of work sharing on productivity. In Section 4 we describe the data and our econometric methodology. Section 5 presents and discusses the results and Section 6 provides concluding remarks.

2. THE WORK SHARING "EXPERIMENT"

The Canadian firm that provided us with our data is large (around 40 000 workers in 1994) and works in the telecommunication industry (mainly telephones). In this study, we consider the Quebec component of the firm (18,613 employees in 1994). At the end of 1993, facing increasing competition due to a recent deregulation, the firm offered its workers a vast work sharing program including reduction in the regular number of hours worked during the week (with reduced salary), a program of special holidays (for studies, parental leave, etc.), an incentive scheme to quit the company, and a program for early retirement. It was mentioned at the start that the program would last one year (January to December 1994).

For the purpose of our study, we concentrate on the part of the program associated with a reduced working week. This program induced a change from a "8 hours per day/5 days a week" work pattern to a "9 hours per day/4 days a week" one. For certain categories of workers (mainly telephonists and office workers), the scheme was made voluntary, while for others more in an "excess supply" position (the technicians), it was made compulsory.

Our objective was to examine the impact of this work sharing scheme on workers'productivity (being broadly defined as a measure of outputs divided by a measure of inputs). In order to do so, we wanted to focus on an area of the firm's activities where outputs and inputs were measurable and relatively uniform, where these measures were available before the implementation of the scheme and after, and where the scheme was extensively adopted.

After discussion with officials of the company, we rapidly decided that the study would focus on the technicians installing and repairing phones[2] in the residential sector (as opposed with the commercial sector). As mentioned earlier, these workers were forced to adopt the reduced working week, the number of hours they work is available since 1992 for certain workers and since 1993 for others, their output (as will be described below) is measured on a regular basis, again since 1992 for certain items and 1993 for others, and is more uniform than that of the commercial sector[3].

For a better understanding of our analysis, it is useful to describe more precisely the typical routine of these workers. The technicians spend the day "on the road", with a truck from the company. Every morning, they pick up the truck at a central garage in the area where they are working, and a list of addresses where there are requests for repair or phone installation. Their productivity (number of repairs or installations per hour worked) is not only related to their own ability, but also to the time they take to go from one address to the next. In the case of the installations, which are longer operations (as will be shown below), it is possible that the worker cannot complete the task during the day it was started and has to go back the day after.

3. THEORETICAL FRAMEWORK

We construct a model of the relationship between productivity per worker and hours worked in the presence of setup costs, which is suitable with the working context described above. We concentrate on two factors that affect this relationship. First, workers may fatigue as they work more hours rendering the production function concave in hours worked. Second, we allow for setup costs in the form of hours spent at work for which no output is produced. These setup costs result from the sharing of tasks that occurs under work sharing due to the reduced hours worked by each

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[2] Most of the time, technicians responsible for repairs do not install phones and vice-versa.

[3] Indeed, in the commercial sector, an installation of a very large and sophisticated telephone system in a big firm is counted the same way as the installation of a phone in a corner store.

individual worker. Namely, some workers may be forced to finish tasks that were started by other workers.

It is important to note that our goal is to present a fairly general model of productivity that would be plausible within this environment. We do not attempt to model the optimal behaviour of the firm taking these setup costs into account as we believe the existence of the work sharing experiment suggests that the firm did not know the exact nature of the production function.

Let the production function in the absence of work sharing be given by

$$y = \{f(h)\} \tag{1a}$$

where h is the number of hours worked per week[4]. We assume that $f'>0,\ f''<0$ *and* $f(0) = 0$. The concavity of f captures the effects of fatigue. Under the work sharing program, productivity becomes

$$y = \max\{f(h-c),0\}, \tag{1b}$$

where c represents the coordination costs that arise under the work sharing scheme. Figure 1 shows a graphical representation of the production function.

Under the work sharing program weekly hours worked were reduced. We define average productivity to be the total productivity per worker divided by the number of hours worked. That is,

$$AP(h) = \frac{y}{h}.$$

We first consider the effects on average productivity of introducing a work sharing program in the absence of setup costs.

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4 We implicitely assume that productivity is not function of the capital stock (building, equipment, material, etc) since discussions with the company's officials convinced us that, in the context of this study, it was constant throughout the period.

Result 1:

In the absence of any setup costs, a reduction in weekly hours worked increases average productivity.

Proof: *See Appendix.*

The proof follows directly from the concavity of the production function.

We now consider the effects of introducing the work sharing program in the presence of setup costs. Let h_0 and h_1 denote respectively the number of hours worked before and after the work sharing program was introduced. Furthermore, define the function $G(c|h_1,h_0)$ to be the difference in average productivity under the two schemes. That is,

$$G(c|h_1,h_0) = \frac{f(h_0)}{h_0} - \frac{f(h_1\text{-}c)}{h_1}.$$

Result 2:

There exists a value of $c = c^* < h_1$ *such that* $AP(h_1, c^*) = AP(h_0, c^*)$.[5]

Proof: *See Appendix.*

Corollary 2.1:

Tasks with higher coordination costs are more likely to exhibit decreased average productivity during work sharing.

Proof: *See Appendix.*

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5 This is actually the situation depicted in Figure 1.

Result 2 and the corollary show that average productivity can increase or decrease depending on the size of the coordination costs and that, the larger are the coordination costs, the more likely is productivity to decrease. In effect, the setup cost that results from the work sharing program reduces the average productivity of any given number of hours worked. This is due to the lost time in which workers must coordinate with other workers. The size of the reduction in average productivity is proportional to the amount of time lost. The overall effect is ambiguous since the reduction in hours increases average productivity as workers are less fatigued.

This result is important since the size of coordination costs may be task specific. In particular, tasks which are more complex and which take a long period of time to complete, are more likely to be interrupted and require finishing by someone else. Such tasks are more likely to demonstrate decreased average productivity as a result of the work sharing program.

Empirical Implications

We seek to measure the effect of work sharing on average worker productivity. Our results suggest that this effect will depend on the hours worked, the extent of coordination costs. We have argued that coordination costs are likely to be task specific. We will therefore allow for the productivity relation to depend on the task performed *j*.

$$AP_j = f_j(h,\ T,\ d,\ X) \qquad (2)$$

where AP_j is the productivity per hour per worker in task j, h is the hours worked, d indicates the work sharing program, T captures transportation costs, and X represents a vector of control variables representing human capital and demand side characteristics. Transportation costs are important since workers travel from site to site in order to install and repair phones. Furthermore, workers in large cities, i.e. Montréal, are expected to have smaller distances between calls than workers in rural areas. Also, transportation time is likely to be longer in the winter months, when roads are in poor condition.

4. DATA AND ECONOMETRIC FRAMEWORK

Our data set includes information on aggregate productivity and hours worked for four geographical regions of the province of Quebec: 1) Montreal; 2) Quebec City; 3) The South Shore of the St-Lawrence River; and 4) The North Shore of the St-Lawrence River. The technicians in our data set are responsible for repairing and installing telephones. Installations can be of two types: new installations, when phones are installed in new houses, and reinstallations, when phones are installed in houses that previously had phones installed in them. New installations tend to be more complicated and time consuming activities since original wiring must be completed[6].

We have collected monthly productivity measures on each of these tasks. These are: the number of new installations per hour worked (NEW INSTALLATIONS); the number of reinstallations per hour worked (REINSTALLATIONS); and the number of repairs per hour worked (REPAIRS). An additional measure, the number of hours between the time a repair is requested and its completion (DELAY), was also collected. These productivity measures were available from January 1992 to August 1995 for REPAIRS and DELAY, and form January 1993 to August 1995 for NEW INSTALLATIONS and REINSTALLATIONS. Furthermore, data on NEW INSTALLATIONS were not available for the Quebec City region. We therefore have 176 observations on the variables REPAIRS and DELAY, 128 observations on the variable REINSTALLATIONS and 96 observations on the variable NEW INSTALLATIONS.

Descriptive statistics on these measures are presented in Table 1. For each measure, we present the productivity per hour worked during and prior to the work sharing experiment (per region and for the whole province). We also present the descriptive statistics of the independent variables used (to be described below). The average delay in completing repairs during and prior to work sharing is also presented.

Notice that new installations is the most time consuming activity; average productivity per hour is lower (0.311 new installations completed prior to work sharing) than for both reinstallations (0.89 per hour) and repairs (0.636 per hour). This is consistent with the idea that new installations are more likely to be affected by coordination costs. Namely, it is more likely that tasks started by one technician will have to be completed by another when hours are reduced. We therefore expect the work sharing program to result in a larger reduction in productivity in new installations than for the other tasks. The last columns of Table 1 demonstrate that average productivity decreased in each task under work sharing. Yet, the largest percentage decrease in average productivity was experienced in new installations (8.03%). This tendency is observable in all regions except Montreal.

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[6] Following discussions with the company's officials, it became clear that it was important to distinguish between reinstallations and new installations since both involve very different tasks. A reinstallation can be, for example, the installation of an extra phone in an existing house.

We thus consider four separate specifications of equation (2); one for each of the available measures of productivity: REPAIRS, DELAY, NEW INSTALLATIONS, and REINSTALLATIONS. In each case (except delay), we use productivity per hour worked as our dependent variable. As for independent variables we include the total hours worked (HOURS) to identify returns to scale. To capture the effects of the work sharing program on productivity we define a dummy variable WORK SHARING equal to one for all observations when the program was in place, and zero otherwise. Note that the use of such a dummy variable implicitly assumes that the work sharing program causes an immediate shift upward or downward in productivity and that this change is constant throughout the program. Other patterns are, of course, possible (Box, 1983). For example, one can imagine that work sharing creates a shock effect that changes productivity immediately, but that gradually workers adjust themselves to the new working environment so as to eventually return to the initial level of productivity. We experiment with a number of different patterns, but find that a model including a standard dummy variable and a model in which the impact is decreasing through time at an increasing rate[7] best fit the data.

To capture the effects of transportation costs on production, we include regional dummies (North-Shore is the default) and seasonal dummies (winter is the default). We expect transportation costs to be lower in Montreal than in the other regions since the population density is higher. Furthermore, transportation is more difficult in the winter than the summer due to road conditions. Seasonal dummies will also pick up seasonal variations in demand particularly important for new installations which, in Quebec, tend to be concentrated in the summer months[8].

To control for the quality of the labour force, we include the variable NEW EMPLOYEES. This accounts for the fact that during the period May 1994 to September 1994 the firm had to used some inexperienced workers to work as technicians in order to meet increased demand.

Finally, discussions with company officials led us to include the variable SMALL ORDERS in the REINSTALLATION equation to control for the difficulty of the required task. One example of a small order is when the order only requires changing the colour of the phone.

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[7] Specifically, the WORK SHARING dummy is then defined as $1 - 1/12\ Z^2$ where Z is the number of months since the implementation of the work sharing program.

[8] For historical reasons, most people in Quebec who move from one place to another do it at the beginning of July.

5. EMPIRICAL RESULTS

Empirical estimation was performed using ordinary least-squares[9] and the log of average productivity as the dependent variable. Table 2 presents the results for our four productivity measures. We present three specifications for each equation allowing for MONTHLY instead of SEASONAL dummies, and for interaction terms between the WORK SHARING variable and the REGIONAL dummies to see if the impact of work sharing was constant across regions. Log-likelihood ratio tests led us to conclude that, for the REPAIRS, DELAY, and REINSTALLATIONS, the specification with seasonal dummies and no interaction term provided the best fit, while for the NEW INSTALLATION, the one with monthly dummies and no interaction term was best.

First, it is noteworthy that, in each case, WORK SHARING has led to a significant decline in productivity (8.6 % for REINSTALLATIONS; 8.3 % for NEW INSTALLATIONS; 3 % for REPAIRS and 13 % for DELAY)[10]. In the first three cases, it is the WORK SHARING variable defined as a conventional dummy variable that better fits the data, while in the last case (the delays), the impact is declining through time. Conversations with the company's officials provided us with further insights on this feature of the results. They mentioned that the tendency of the average delay to be increasing rapidly during the first months of 1994 was the first signal that productivity was declining. Specific actions were taken to reduce these delays (e.g., moving employees across sectors and hirings), which were effective as suggested by our result.

Furthermore, these results suggest that the impact of work sharing on productivity is "task specific" and that longer operations (installations), for which the coordination cost is likely to be higher, are more affected.

The coefficients of the variable capturing the number of HOURS worked indicate that average productivity is not affected by the number of hours worked for the REPAIRS and the REINSTALLATIONS, while the provision of NEW INSTALLATIONS is affected negatively by the number of hours worked.

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9 Preliminary tests were performed to detect the presence of heteroskedasticity and/or serial correlation. These tests showed that first-order serial correlations was a problem, and estimations were corrected using the well-known technique of Corchrane and Orcutt.

10 The interaction terms between WORK SHARING and the REGIONAL DUMMIES are generally non-significant, implying that the impact of work sharing on productivity is uniform across regions.

The REGIONAL dummies show that workers in the Montreal region are significantly more productive (21 % for REPAIRS; 16 % for REINSTALLATIONS and 46 % for NEW INSTALLATIONS) than in the others. This suggests that the higher density of the population in the Montreal reduce transportation time between "calls", enhancing workers'productivity. Furthermore, workers in the South-Shore region are less productive (5 %) in the REPAIR sector.

Moreover, SEASONAL and MONTHLY dummies indicate that productivity is higher in the NEW INSTALLATIONS and REINSTALLATIONS areas during summer months (respectively 42.1 % and 10. 7 %), and during the fall (respectively 12.4 % and 10.5 %); winter is default. This suggests that there are strong economies of scale since most installations take place during these months, which make trips between calls shorter enhancing workers' productivity, and that tranportation costs are higher during winter.

Furthermore, the variable capturing the "quality" of labour used, NEW EMPLOYEES, has everywhere a positive coefficient (significant in the NEW INSTALLATION equation). This suggests unexpectedly that the arrival of new inexperienced employees has enhanced productivity. Finally, as expected, small orders are associated with higher productivity in the REINSTALLATION area.

6. DISCUSSION AND CONCLUSION

This paper has examined empirically how work sharing influences workers'productivity, using a unique data set from a large Canadian firm. This firm has adopted a work sharing scheme for one year, which allowed us to introduce a "natural experiment approach" of comparing workers'productivity before and after the implementation of work sharing.

Our results showed that work sharing has induced a significant reduction in productivity (from 3 % to 8.6 %). While the results are broadly consistent with the presence of coordination costs in the production function, it is clear that other factors must be playing a role as well in determining productivity. For example, even though new installations are a more complex and time consuming task than are reinstallations, a larger percentage decrease in productivity was displayed in reinstallations.

Another possible contributing factor to the decrease in productivity is the change in the work schedule that was introduced along with the work sharing program. Namely that workers changed from working 8 hours a day for 5 days a week to working 9 hours a day for 4 days a week. It is possible that the extra hour tacked onto the end of the day was much less productive than the hours worked on the fifth day of the week. Unfortunately without information on daily production, our data set does not permit us to identify such effects. One further possibility is that worker morale may have been negatively affected by the work sharing program. Given that technicians were not given a choice of whether or not to participate in the program whereas other types of workers were, technicians may have felt they were being unfairly treated (Akerlof 1982). The fact that absenteism increased following the introduction of the program lends support to this interpretation.

Interestingly, this analysis was presented to the top officials of the company, and we used our results to raise a certain number of questions about managerial practices. First, it is not clear why the relative advantage of the Montreal area is more than two times as high for new installations than for repairs. Is it due to heterogeneity across workers (indicating that Montreal workers in the installations sector are more productive than their colleagues in the repairs sector)? Or, is it a sign that those in the installation sectors are better managed? Similarly, why are the technicians in the South-Shore area less productive than others in the repair sector, but not in the installation sector? Why is there decreasing marginal productivity in the new installation sector and not in the others? Why is productivity higher during summer and fall, especially for NEW INSTALLATION; is it uniquely due to economies of scale? Or, is it a sign that workers could be more productive the rest of the time? And finally, why are new inexperienced workers contributing to raise productivity? Such an exercise shows that regression analysis with a company's database can be useful in better understanding workers' performance.

Finally, we note the fact that the work sharing program was not pursued after a year, which suggests that the productive consequences may have been neglected when introducing the work sharing scheme. While further research on the impact of similar programs in other companies is needed to corroborate this result, we believe the demonstrated decrease in productivity signals an important consideration for other firms and governments considering implementing such a program.

Figure 1 : Worksharing and Productivity

(Figure 1 is not available in electronic version)

INSERT TABLE 1 HERE

Table 2
Impact of Work Sharing on Productivity[11]
Estimated Coefficient (standard errors)

	Repairs			Delay		
Intercept	-0.596 (0.244)	-0.273 (0.379)	-0.598 (0.248)	-0.366 (0.482)	-1.460 (0.747)	-0.316 (0.487)
Hours worked	0.011 (0.027)	-0.026 (0.042)	0.012 (0.028)	0.393 (0.054)	0.518 (0.083)	0.387 (0.055)
Work sharing	-0.031 (0.015)	-0.054 (0.027)	-0.055 (0.030)	0.122 (0.034)	0.156 (0.039)	0.103 (0.036)
Montreal	0.191 (0.022)	0.181 (0.026)	0.175 (0.026)	-0.268 (0.050)	-0.279 (0.049)	-0.269 (0.048)
Quebec	-0.029 (0.021)	-0.032 (0.023)	-0.028 (0.025)	0.126 (0.123)	0.141 (0.107)	0.132 (0.095)
South-shore	-0.042 (0.021)	-0.05 (0.024)	-0.052 (0.024)	-0.063 (0.044)	-0.065 (0.044)	-0.064 (0.043)
Montreal*work sharing		0.057 (0.041)	0.058 (0.044)		0.0197 (0.112)	0.074 (0.115)
Quebec*work sharing		-0.003 (0.041)	-0.001 (0.041)		0.128 (0.079)	0.179 (0.077)
South-Shore*work sharing		0.044 (0.041)	0.043 (0.041)		-0.013 (0.081)	0.042 (0.081)
Summer	0.027 (0.018)		0.028 (0.019)	-0.096 (0.037)		-0.094 (0.037)
Spring	-0.003 (0.013)		-0.003 (0.014)	-0.058 (0.027)		-0.056 (0.027)
Autumn	0.014 (0.015)		0.014 (0.016)	-0.060 (0.030)		-0.057 (0.031)
% New employees	0.604 (0.368)	0.546 (0.405)	0.552 (0.384)	1.257 (0.704)	0.227 (0.754)	1.37 (0.713)
% Small orders						
Monthly dummies	No	Yes	No	No	Yes	No
Log of the likelihood function	276.71	281.78	278.47	149.67	164.57	151.07

[11] For repairs, reinstallation and new installation : Impact of work sharing on productivity is represented by immediate shift upward or downward that is constant throughout work sharing period.
For delay : Impact of work sharing on productivity is represented by an immediate drop in productivity, but gradually, workers adjust themselves to this working environment so as to return to the initial level of productivity.

Table 2 (suite)
Impact of Work Sharing on Productivity
Estimated Coefficient (standard errors)

	Reinstallations			New Installations		
Intercept	0.301 (0.352)	0.018 (0.457)	0.266 (0.345)	-0.283 (0.394)	1.743 (0.674)	-0.376 (0.383)
Hours worked	-0.055 (0.045)	-0.025 (0.054)	-0.051 (0.044)	-0.128 (0.046)	-0.362 (0.079)	-0.116 (0.044)
Work sharing	-0.09 (0.031)	-0.141 (0.047)	-0.141 (0.049)	-0.081 (0.027)	-0.087 (0.044)	-0.122 (0.039)
Montreal	0.151 (0.045)	0.143 (0.056)	0.129 (0.049)	0.371 (0.026)	0.386 (0.039)	0.331 (0.032)
Quebec	0.116 (0.034)	0.091 (0.039)	0.087 (0.041)			
South-shore	0.012 (0.033)	-0.001 (0.038)	0.004 (0.040)	-0.020 (0.026)	-0.077 (0.039)	-0.027 (0.031)
Montreal* work sharing		0.095 (0.062)	0.092 (0.065)		0.061 (0.057)	0.098 (0.049)
Quebec* work sharing		0.108 (0.064)	0.092 (0.067)			
South-Shore*work sharing		0.015 (0.062)	0.019 (0.064)		0.007 (0.056)	0.027 (0.049)
Summer	0.102 (0.042)		0.098 (0.042)	0.352 (0.041)		0.348 (0.039)
Spring	-0.027 (0.035)		-0.029 (0.034)	-0.067 (0.035)		-0.072 (0.034)
Autumn	0.100 (0.037)		0.100 (0.036)	0.117 (0.035)		0.114 (0.033)
% New employees	0.071 (0.098)	0.004 (0.097)	0.056 (0.096)	0.263 (0.108)	0.314 (0.112)	0.252 (0.102)
% Small orders	0.167 (0.071)	0.085 (0.103)	0.135 (0.071)			
Monthly dummies	No	Yes	No	No	Yes	No
Log of the likelihood function	86.13	97.59	87.74	68.12	103.43	70.29

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Appendix

Proof of Result 1:

By the Mean Value Theorem there exists $0 < h_1 < h_0$ such that $f(h_0)/h_0 = f'(h_1)$.

Since $f''(h)<0$, $f'(h_0)<f'(h_1)$ and so $f'(h_0)<f(h_0)/h_0$ or $\frac{d[f(h)/h]}{dh<0}$.

Proof of Result 2:

Define $G(c|h_0,h_1)$ to be the difference in average products before and after work sharing; that is,

$$G(c|h_0,h_1) = \frac{f(h_0)}{h_0} - \frac{f(h_1-c)}{h_1}.$$

Note that G is a continuous function in c with

$$\frac{dG(c|h_0,h_1)}{dc} = \frac{f'(h_1-c)}{h_1} > 0.$$

Furthermore,

$$G(0|h_0,h_1) = \frac{f(h_0)}{h_0} - \frac{f(h_1)}{h_1} < 0.$$

by Result 1, and

$$G(h_1|h_0,h_1) = \frac{f(h_0)}{h_0} > 0$$

since *f0) = 0*. Therefore, there must be a value of *c* denoted c^* that solves $G(c^*|h_0,h_1)=0$.

Proof of Corollary 2.1

The proof follows directly from the derivative of *G* with repect to *c*.

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Table 1

Descriptive statistics - Mean and standard deviation

	Montreal				North Shore				South Shore			
	Repairs	Delay	Reinstal.	New installat.	Repairs	Delay	Reinstal.	New installat.	Repairs	Delay	Reinstal.	New installat.
Worker's productivity with work sharing	0.744 (0.027)	23.06 (4.73)	0.955 (0.185)	0.382 (0.074)	0.597 (0.039)	27.03 (5.17)	0.720 (0.095)	0.253 (0.052)	0.593 (0.044)	25.60 (5.93)	0.725 (0.095)	0.261 (0.077)
Worker's productivity without work sharing	0.745 (0.034)	18.95 (3.64)	0.99 (0.122)	0.376 (0.079)	0.609 (0.037)	23.50 (3.80)	0.830 (0.116)	0.277 (0.053)	0.590 (0.038)	22.67 (3.21)	0.823 (0.096)	0.280 (0.068)
Hours worked / month	10410 (2888)	------	3321 (1171)	8358 (2023)	9249 (2855)	-------	2715 (843)	7311 (2892)	9626 (2744)	-------	3253 (1101)	5842 (2697)
% of new employees	0.005 (0.018)	------	0.054 (0.146)	0.054 (0.146)	0.003 (0.01)	------	0.056 (0.151)	0.056 (0.151)	0.007 (0.02)	------	0.048 (0.129)	0.048 (0.129)
% of small orders	-------	-------	0.733 (0.060)	------	-------	-------	0.491 (0.099)	------	------	------	0.479 (0.094)	------

Table 1 (suite)

Descriptive statistics - Mean and standard deviation

	Quebec				Total			
	Repairs	Delay	Reinstal.	New installat.	Repairs	Delay	Reinstal.	New installat.
Worker's productivity with work sharing	0.576 (0.032)	30.94 (6.99)	0.904 (0.127)	------	0.627 (0.077)	26.66 (6.28)	0.826 (0.166)	0.286 (0.087)
Worker's productivity without work sharing	0.602 (0.043)	26.77 (5.76)	0.916 (0.133)	------	0.636 (0.074)	22.97 (5.02)	0.890 (0.135)	0.311 (0.081)
Hours worked / month	8079 (2299)	------	2459 (894)	-------	9341.71 (2813.18)	------	2937.52 (1064.08)	7170.84 (2741.54)
% of new employees	0.005 (0.015)	------	0.077 (0.209)	0.077 (0.209)	0.005 (0.016)	------	0.053 (0.141)	0.059 (0.161)
% of small orders	-------	-------	0.559 (0.115)	------	------	------	0.565 (0.138)	------