

DEVELOPMENT OF THE LABOUR COST INDEX AT STATISTICS CANADA

Lenka Mach and Abdelnasser Saïdi¹

ABSTRACT

Statistics Canada is currently working on the development of a new index, the Labour Cost Index (LCI), to respond to the need for a measure of change in the total labour cost in Canada. The LCI is supposed to measure the rate of change in the cost of one unit of labour, equivalent to one hour of labour, where the cost of labour should include both wages and salaries as well as non-wage benefits. In the development of the LCI methodology, we can borrow a lot from the methodology of price indices and learn from the experiences with Consumer Price Index and other price indices. However, there are some fundamental differences between the LCI and a price index that will lead to differences in the methodology. In this paper, we will describe the similarities and differences between the LCI and the price indices as well as the proposed LCI methodology.

KEY WORDS: Economic weight; Fixed basket; Laspeyres index; Non-wage benefits.

RÉSUMÉ

Statistique Canada développe actuellement un nouvel indice, l'indice des coûts de main-d'œuvre (ICM), pour répondre au besoin de mesure de la variation du coût total du travail au Canada. L'ICM est supposé mesurer le taux de variation du coût total d'une unité de main-d'œuvre, égale à une heure de travail. Le coût d'une heure de travail devrait inclure aussi bien les gains et les salaires que les avantages non salariaux. Dans le développement de la méthodologie de L'ICM, nous pouvons nous inspirer largement de la méthodologie des indices des prix et bénéficier des expériences du calcul de l'indice des prix à la consommation et d'autres indices de prix. Cependant, il existe des différences fondamentales entre l'indice ICM et les indices de prix qui entraînent des différences dans la méthodologie. Dans cet article, nous décrirons les similarités et différences entre l'ICM et les indices de prix ainsi que la méthodologie proposée pour le calcul de l'ICM.

MOTS CLÉS : Bénéfices non salariaux, indice de Laspeyres, panier fixe; poids économique.

1. INTRODUCTION

The Labour Cost Index (LCI) project is a new initiative of Statistics Canada (STC). Labour Statistics Division of STC started to research the subject in 1999 in response to the requests of Canadian policy makers and researchers for a Canadian index of total labour costs. This need is discussed in the LCI background paper by Sharan (2001): "In recent years policy makers, analysts, academics and decision-makers in Canada have expressed the need for a reliable and comprehensive measure of the rate of change, in labour costs in this country. A measure of change in the total labour cost would provide both a better understanding of how specific labour markets adjust to changes in the demand and supply of labour and a timely measure of wage pressures. A Labour Cost Index would be invaluable in understanding the role of variable pay and benefits in

overall compensation and whether such forms of compensation are increasing wage flexibility."

The Canadian LCI is supposed to measure the rate of change in the total cost of one hour of labour. The cost of one hour of labour should include wages and salaries as well as non-wage benefits for time worked and time not worked.

In order to measure the "pure" rate of change in the labour costs, the impact of the changes in the composition of the workforce must be eliminated. Furthermore, the LCI should measure the change in the costs for the same quality and quantity of work. Therefore, the LCI will measure the rate of change in the employers' costs of labour for a fixed workforce that we will refer to as a *fixed basket of occupations* or *fixed basket of jobs*. To construct

¹ Lenka Mach and Abdelnasser Saïdi, Business Survey Methods Division, Statistics Canada, 11th floor, R.H.Coats Building, Tunney's Pasture, Ottawa, Ontario, K1A 0T6, Lenka.Mach@statcan.ca, Abdelnasser.Saïdi@statcan.ca.

this basket, we will use the composition of the workforce in some previous time period, for example in the base time period. Thus the LCI will be a *Laspeyres type of index*.

The total labour cost represents all costs paid by the employer for labour and includes:

- Regular wages and salaries
- Variable pay (commissions, bonuses, paid overtime, etc.)
- Employer's cost of statutory non-wage benefits (Employment Insurance, Canada Pension Plan/Quebec Pension Plan, Health Tax)
- Employer's cost of other non-wage benefits:
 - Health-related benefits (dental care plan, life insurance, supplementary medical insurance, etc.)
 - Pay-related benefits (severance allowance, supplementary maternity benefits, etc.)
 - Pension-related benefits (defined contribution plan, group RRSP plan, etc.)
 - Paid leave benefits (vacation leave, sick leave, etc.)

Indexes similar to the LCI are produced by a few other countries. For example, in the USA, the Bureau of Labor Statistics produces the Employment Cost Index (ECI) as described by Russer (2001). New Zealand and Australia also produce a Labour Cost Index (see Australian Bureau of Statistics, 2000). Currently, Eurostat is developing a European Labour Price Index.

In Section 2, we develop the Laspeyres index formulae for the LCI. Then in Section 3, we discuss the estimation of the LCI, including the economic weights, construction of labour categories and the fixed basket of jobs. The collection, derivation and modelling of the labour cost data is described in Section 4. Finally, we discuss future work in Section 5.

2. LASPEYRES FORMULAE FOR LCI

The LCI measures the rate of change in the labour costs for a fixed workforce that we refer to as a fixed basket of jobs. To construct this basket, we will use the number of hours worked by different groups of workers in some previous time period. Thus the LCI will be a Laspeyres type of index. There exist two formulas to calculate a Laspeyres type of index:

i) aggregative formula, and ii) weighted-arithmetic-mean formula. See, for example, Szulc (1986) or Fixler (1993) who discuss the use of Laspeyres index in the estimation of the price indexes.

For the LCI, the **aggregative formula** can be written as:

$$LCI^{t/b} = \frac{\sum_{i=1}^N x_i^r c_i^t}{\sum_{i=1}^N x_i^r c_i^b}, \quad (1)$$

where

c_i^t is the cost of one hour of labour for the job i in the observation time period t ,

c_i^b is the cost of one hour of labour for the job i in the base time b ,

x_i^r is the total number of hours of labour of the job i used during the basket reference time r , and

N is the number of jobs covered by the index.

The quantities x_i^r , $i = 1, 2, \dots, N$, represent the **fixed basket of jobs** for which the rate of change in the employers' cost is measured.

We can write (1) as

$$\begin{aligned} LCI^{t/b} &= \frac{\sum_{i=1}^N x_i^r c_i^b \left(\frac{c_i^t}{c_i^b} \right)}{\sum_{i=1}^N x_i^r c_i^b} = \sum_{i=1}^N \left(\frac{x_i^r c_i^b}{\sum_{i=1}^N x_i^r c_i^b} \right) \left(\frac{c_i^t}{c_i^b} \right) \\ &= \sum_{i=1}^N \left(\frac{Z_i^{rb}}{\sum_{i=1}^N Z_i^{rb}} \right) c_i^{t/b}. \end{aligned} \quad (2)$$

The formula (2) is the **weighted-arithmetic-mean formula**, where

$c_i^{t/b}$ denotes the rate of change in the cost of one hour of labour for the job i between time periods b and t , and

Z_i^{rb} denotes the total compensation for labour for the job i , using quantity (total hours worked) in the basket reference time period r and labour cost per hour in the base time period b .

The expression in (2),

$$\frac{Z_i^{rb}}{\sum_{i=1}^N Z_i^{rb}} = \omega_i^{rb}, \quad i = 1, 2, \dots, N, \quad (3)$$

represents the share of the job i in the total compensation for the fixed basket of jobs. The share ω_i^{rb} is referred to as the "fixed weight" or the "**economic weight**". The term

“economic weight” is used because these weights are assigned on the basis of the economic importance of each job. Note that the values ω_i^{rb} are fixed during the use of a particular fixed basket of jobs, but change as soon as the basket is changed. Thus the term “fixed weight” could be misleading. The frequency of the changes of the LCI basket still needs to be determined.

The formulas (1) and (2) are general, in the sense that the basket reference time and the base time could be different.

That means that the compensation values, Z_i^{rb} , are “hybrid” values, as discussed by Szulc (1986), and cannot be directly obtained. When $r=b$, then $Z_i^{rb} = Z_i^b$, the actual value of total compensation for the job i in the base time b .

3. ESTIMATION OF LCI

Formulas (1) or (2) cannot be directly used in practice since it is impossible to collect costs and hours for all individual jobs. Instead, the N jobs need to be grouped into H labour categories or strata. Following this, the average costs and total quantities need to be estimated for each labour category in order to estimate the LCI.

3.1 Weighted-Arithmetic-Mean Formula

The weighted-arithmetic-mean formula is generally considered more suitable for estimation of price indexes. Firstly, because an “average price” of a basic aggregate, that could be composed of very heterogeneous commodities, seems meaningless while “average price change” makes sense even for a heterogeneous group of commodities. Secondly, the “average price change” can usually be estimated more precisely than the “average price”, as it is more feasible to form strata homogeneous with respect to the price change than with respect to the price. Finally, it is usually easier to obtain expenditures than quantities for basic aggregates. More discussion can be, for example, found in Szulc (1986).

The first two arguments, used in favour of the weighted-arithmetic-mean formula, apply for the estimation of the LCI as well. On the other hand, the quantities of labour used in the base period (measured by number of hours or employees) may be more readily available than the total compensation for different categories of labour.

The $LCI^{t/b}$ given in (1) or (2) above can be estimated as

$$\widehat{LCI}^{t/b} = \sum_{h=1}^H \omega_h^{rb} \widehat{c}_h^{t/b}, \quad (4)$$

where

ω_h^{rb} is the economic weight for the labour category h and represents the share of the labour category h in the total compensation for the fixed basket of jobs,
 $\widehat{c}_h^{t/b}$ is the estimated average rate of change in the cost of one hour of category h labour between time periods b and t , and
 H is the number of labour categories (or strata) covered by the index.

Note that $\widehat{c}_h^{t/b}$ in (4) is an index that measures the average rate of change in the employer’s cost of one hour of labour between b and t for the labour category h . We will refer to it as **the sub-index for stratum h** . The process of computation of the sub-indexes is often called “lower-level aggregation.” On the other hand, “upper-level aggregation” refers to the process of combining sub-indexes into an overall index. (Refer to Lent and Dorfman (2002) for a more detailed discussion.)

3.2 Calculation of the Economic Weights

To obtain the economic weights ω_h^{rb} used in the estimator (4) we need the values of the total compensation Z_h^{rb} for each stratum h :

$$Z_h^{rb} = x_h^r \bar{c}_h^b, \quad h = 1, 2, \dots, H, \quad (5)$$

where

x_h^r is the total number of hours of category h labour used during the basket reference time r , and
 \bar{c}_h^b is the average cost of one hour of category h labour in the base time period b .

The quantities x_h^r , $h = 1, \dots, H$, represent the fixed basket of jobs.

The total compensation Z_h^{rb} can also be equivalently expressed as

$$Z_h^{rb} = E_h^r \bar{x}_h^r \bar{c}_h^b, \quad h = 1, 2, \dots, H, \quad (6)$$

where

E_h^r is the total number of employees in the stratum h during the basket reference time r , and
 \bar{x}_h^r is the average number of hours worked by an employee in the stratum h during the basket reference time r .

If we make the assumption that the average hours worked by an employee during the basket reference time r do not vary across different strata, *i.e.*

$$\bar{x}_h^r \cong \bar{x}^r, \quad h = 1, 2, \dots, H, \quad (7)$$

then we can use formula (6) and replace \bar{x}_h^r by \bar{x}^r . Then the economic weight can be approximated as

$$\omega_h^{rb} \cong \frac{E_h^r \bar{c}_h^b}{\sum_{h=1}^H E_h^r \bar{c}_h^b}, \quad h = 1, 2, \dots, H. \quad (8)$$

If we use (8), the quantities E_h^r , $h = 1, 2, \dots, H$, represent the fixed basket of occupations.

For the Labour Cost Index, data on total compensation for the labour categories are not readily available. On the other hand, there exist estimates of the number of employees and the total number of hours worked for the different labour categories. We plan to use these existing measures of quantity along with estimates of the average hourly costs, \bar{c}_h^b , to estimate the economic weights. Thus the estimate of the LCI given in (4) can be expressed as

$$L\hat{C}I^{t/b} = \sum_{h=1}^H \left(\frac{x_h^r \hat{c}_h^b}{\sum_{h=1}^H x_h^r \hat{c}_h^b} \right) \hat{c}_h^{t/b}. \quad (9)$$

We have compared several STC surveys as sources of statistics on the number of hours or employees. The construction of the LCI basket is discussed in Section 3.4. The average hourly costs, \bar{c}_h^b , will be estimated using data collected by the Workplace and Employee Survey (WES) and the Labour Cost Survey (LCS). These two surveys will be described in Section 4.

3.3 LCI Stratification

As we have discussed above, to estimate the LCI we need to group jobs into H labour categories. A labour category is also referred to as an ‘‘LCI stratum’’ or simply a ‘‘stratum’’. So, in this context, a stratum represents a sub-population for which a sub-index will be estimated in order to produce an overall LCI estimate. (Thus, in this context, a stratum is not a stratum created for sampling purposes.)

If we use formula (9) to estimate the LCI, we need to form the strata so that the **cost relatives** between time periods b and t , $c_i^{t/b}$, are **homogeneous** for the different jobs within each stratum. In addition, we also need strata **homogeneous with respect to the hourly costs**, c_i^b . On the other hand, we have the following practical constraints:

- sample size and budget of the WES and LCS surveys
- response burden - especially when collecting data on the costs of the different non-wage benefits

- the level of detail at which the compensation cost data can be provided by the respondents
- the level of detail at which reliable measures of the number of hours (or employees) are available

The level and changes in labour costs depend on many factors, for example occupation, experience and tenure of the employee, industry, region and size of the workplace etc. Below we discuss the stratification variables that we plan to use for LCI.

i) Six occupational groups used by the WES survey (OCCUP6):

- Managers
- Professionals
- Technical/Trades
- Marketing/Sales
- Clerical/Administrative
- Production Workers with no Trade/Certification

ii) Three different employee categories used by the WES and LCS surveys when collecting data on non-wage-benefit costs (EMP3):

- Management
- Non-Management, Full Time
- Non-Management, Part Time

iii) 14 industry groups used by the WES and LCS surveys (IND14):

1. Forestry, Logging and Mining and Oil and Gas Extraction
2. Labour Intensive Tertiary
3. Primary Product Manufacturing
4. Secondary Product Manufacturing
5. Capital Intensive Tertiary Manufacturing
6. Construction
7. Transportation, Warehousing and Wholesale Trade
8. Communication and Other Utilities
9. Retail Trade and Consumer Services
10. Finance and Insurance
11. Real Estate, Rental and Leasing Operators
12. Business Services
13. Educational and Health Care and Social Assistance Services
14. Information and Cultural Industries

iv) Four size groups (SIZE4):

- 1 - 19 employees
- 20 - 99 employees
- 100 - 500 employees
- > 500 employees

For the estimation of the wage component we plan to use all four stratification variables (maximum of 616 strata). For the estimation of the non-wage benefit component we plan to use EMP3, IND14 and SIZE4 (maximum of 168 strata). For comparison, the US ECI uses about 650

categories of labour defined by industry and major occupation group.

3.4 Fixed Basket of Jobs

As discussed in Section 3.2, to construct the LCI basket, we need a good estimate of the total number of hours worked in the basket reference time t , x_h^t , for each stratum h . Or, if we assume that the average hours worked by an employee do not vary across the different strata (Assumption 7), then we need a good estimate of the total number of employees, E_h^t , for each stratum h .

We have compared the following three STC surveys as possible sources of statistics on the number of hours or employees:

i) Labour Force Survey (LFS)

LFS is a monthly survey of about 50,000 households with the main objective to estimate the number of employed and unemployed people and the unemployment rate.

ii) Census of Population

Census is conducted every 5 years and 20% of households receive a long questionnaire that includes questions on employment status and hours worked.

iii) Workplace and Employee Survey (WES)

WES is a new annual longitudinal survey of about 8,000 workplaces and 30,000 employees. The main goal of WES is to examine how employers and their employees respond to the changing business environment. Data on the number of employees and hours worked are also collected.

We compared the definitions and concepts of these three surveys, as well as their sampling and non-sampling errors. LFS is a strong candidate because one of its main objectives is to produce estimates of employment. In addition, LFS data could be used to estimate a sub-annual rate of change in hourly wages for sub-annual LCI. The obvious advantage of the Census employment data is the small sampling error of the estimates. However, both the LFS and Census definitions are different from the LCI definitions so various adjustments would have to be applied to the LFS or Census estimates. On the other hand, the WES and LCI definitions are identical. However, the coefficients of variation of the WES estimates could be quite large. At this point, the decision about the data source for the LCI basket has not yet been finalised.

We plan to update the LCI basket periodically. This is the usual practice used in the estimation of price indexes. For example, the consumer basket used by the Canadian Consumer Price Index (CPI) is usually changed every four to six years.

4. LABOUR COST DATA

Measuring the total labour cost of one hour of labour is a major challenge for the LCI. Contrary to the CPI that measures movement in prices, the LCI variable of interest has many components. Some of these components are very difficult and expensive to measure. We will discuss some aspects of the proposed strategy for measuring total labour costs in Section 4.

4.1 Collection of Labour Cost Data

Data needed for the estimation of the average hourly labour costs and average rate of change in the hourly labour costs is collected by the following STC surveys:

A) Workplace and Employee Survey, Workplace Component (WES-W):

This is an annual longitudinal survey of about 8,000 workplaces selected using stratified random sampling from a population of about a million workplaces. As already mentioned, the main objective of WES is to examine how employers and their employees respond to the changing business environment.

For LCI, we plan to use the following information collected by WES-W:

- Number of employees by occupational group and employee category
- Availability of the different non-wage benefits by employee category
- Gross payroll and Total expenditure on non-wage benefits by employee category

B) Workplace and Employee Survey, Employee Component (WES-E):

This is an annual survey of about 30,000 employees that are selected from the workplaces in the WES-W sample. The number of employees selected in each workplace varies between one and 24 and depends on the size of the workplace. A new sample of employees is selected every two years. For more information about the WES methodology see Patak, Hidiroglou, Lavallée (2000). For the LCI base year of 2001, additional 5,000 employees were surveyed. This was a sample of employees rotating out from the WES-E sample and we refer to it as the LCS-E sample. Data to be used by the LCI include:

- Number of regular hours and overtime hours
- Number of days of different types of leave taken
- Hourly wage and annual variable pay
- Participation in different non-wage benefits

C) Labour Cost Survey (LCS-W):

This is also an annual survey of workplaces that collects the same variables as listed in (A) above. In addition, the LCS-W survey collects the employer's costs for 13

different non-wage benefits. The first LCS-W sample of about 5,000 workplaces was selected in May 2001 using stratified random sampling with the same stratification as the WES-W sample. It was selected so that there is no overlap between the WES-W and LCS-W samples. After screening for the availability of benefits, slightly over 3,000 workplaces were surveyed in the fall of 2001. Figure 1 below shows the different WES and LCS samples and how they related to each other.

4.2 Derivation of Total Labour Cost

As discussed in Introduction, the LCI should measure the rate of change in the *total* cost paid by the employer for labour. The cost of one hour of labour thus includes wages and salaries as well as non-wage benefits for time worked and time not worked.

The estimated stratum average hourly cost of labour, used in the LCI estimator (9), can be decomposed as follows:

$$\hat{c}_h^b = \hat{w}_h^b + \hat{s}_h^b + \hat{B}_h^b, \quad h = 1, 2, \dots, H, \quad (10)$$

where

\hat{w}_h^b is the estimated average wage per hour worked in stratum h and base time b ,

\hat{s}_h^b is the estimated average hourly cost of statutory benefits in stratum h and base time b , and

\hat{B}_h^b is the estimated average hourly cost of other non-wage benefits in stratum h and time b .

It is planned that \bar{w}_h^b will be estimated using the WES-E and LCS-E samples. To estimate \bar{s}_h^b , the parameters of the statutory-benefits programs and wage data will be used. Finally, to estimate \bar{B}_h^b , we will combine data collected by the WES-W and LCS-W surveys.

In the following example, we want to illustrate how hourly wage is derived for the LCI.

Example:

Suppose the following data was collected by the WES-E survey for employee j :

- usual hours = 37.5 per week
- annual earnings = \$50,000 (including basic wage, overtime payments and other types of variable pay)
- time worked/ leave taken during the past year: no overtime, 10 days of statutory holidays, 10 days of vacation

From this data we derive for employee j :

- hourly wage = $50,000 / (37.5 \times 52) = 50,000 / 1,950 = \25.64
- hours worked during past year = $1,950 - 150 = 1,800$
- wage per hour worked:

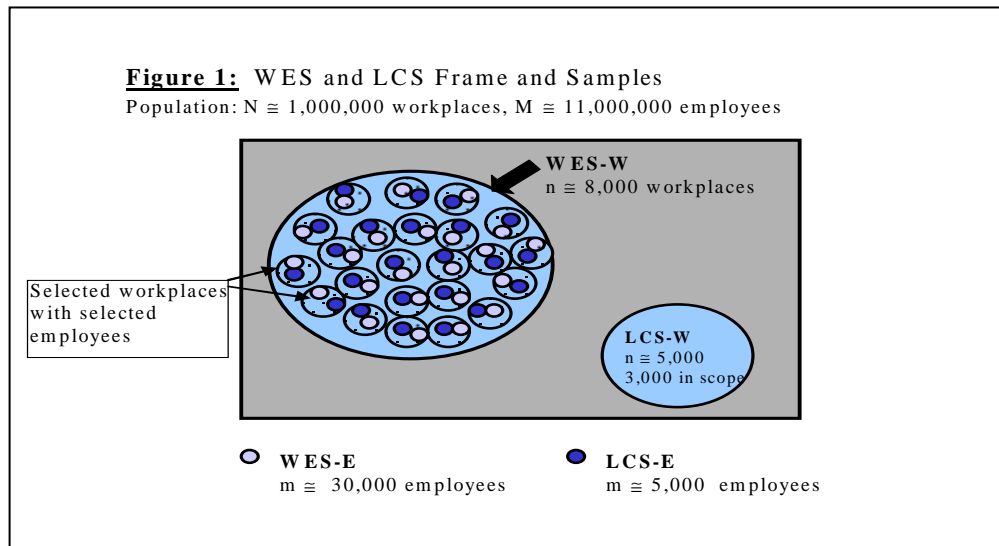
$$\frac{50,000}{1,800} = \frac{50,000}{1,950} + \frac{50,000}{1,950} \left[\frac{75}{1,800} \right] + \frac{50,000}{1,950} \left[\frac{75}{1,800} \right]$$

$$\$27.77 = \$25.64 + \$1.068 + \$1.068$$

The wage per hour worked of employee j is \$27.77. It is equivalent to the sum of his hourly wage, his hourly cost of statutory holidays (\$1.068) and his hourly cost of vacation (\$1.068).

4.3 Non-Wage Benefit Data

One of the three components of the total labour cost is the cost of the other non-wage benefits. This component includes, in fact, the costs of many different kinds of benefits. When the LCI estimates become available, it will be very important for the economists to be able to determine which benefits cause the changes in the total labour costs. However, questions about the costs of the different non-wage benefits are not included in the WES-W questionnaire because they would increase the burden



on respondents beyond an acceptable level. Instead, this data is collected by the LCS-W survey as discussed in Section 4.1. In this section, we discuss our plans for combining the non-wage benefits data from the two surveys.

The WES-W survey collects total expenditure for non-wage benefits by employee category $i=1,2,3$ (where 1=Management; 2=Non-Management, Full Time; and 3=Non-Management, Part Time). So let

B_{ji} denote the total expenditure on non-wage benefits for workplace j and employee category i per employee per day.

The LCS-W survey collects data on B_{ji} too, but also the employer's costs for 13 different non-wage benefits. We will group these 13 different benefits into three groups and use the following notation:

Y_{1ji} is the cost of **health-related benefits** for workplace j and employee category i per employee per day,

Y_{2ji} is the cost of **pay-related benefits** for workplace j and employee category i per employee per day, and

Y_{3ji} is the cost of **pension-related benefits** for workplace j and employee category i per employee per day.

The total expenditure is supposed to be equal to the sum of the costs of the individual benefits:

$$B_{ji} = Y_{1ji} + Y_{2ji} + Y_{3ji}, \quad (11)$$

$j = 1, 2, \dots, N$, and $i = 1, 2, 3$.

Note that ideally we would work with expenditures and costs per employee per hour but LCS-W does not collect data on hours worked and WES-W only collects data on regular hours for full-time employees.

We assume the following model:

$$\begin{aligned} Y_{1ji} &= \beta_{1g} B_{ji} + e_{1jg}, \\ Y_{2ji} &= \beta_{2g} B_{ji} + e_{2jg}, \\ Y_{3ji} &= \beta_{3g} B_{ji} + e_{3jg}, \end{aligned} \quad (12)$$

$j = 1, 2, \dots, N$, $i = 1, 2, 3$, $g = 1, 2, \dots, G$, where g represents a regression group. Each of the three error terms are independent observations from normal distribution with mean of zero and variance σ_{1g}^2 , σ_{2g}^2 , and σ_{3g}^2 respectively.

To form regression groups, we use the type of employee i , availability of benefits (health & pay, health & pension, health & pay & pension), industry and size of workplace. Note that we could assume more complex models that use several variables collected by the two surveys but our

analysis so far suggests that the simple model given in (12) is sufficient.

We plan to use the data from the LCS-W survey to fit the model given in (12) and then use the estimated regression parameters to predict Y_{1ji} , Y_{2ji} , Y_{3ji} for the workplaces in the WES-W sample. We will apply pro-rating or micro-level benchmarking to achieve the equality (11) between the sum of the predicted costs and the reported total expenditure for the workplaces in the WES-W sample. We also plan to combine the WES-W and LCS-W data to estimate \bar{B}_h^b .

5. FUTURE WORK

We plan to produce the first LCI estimate in the fall of 2003. It will estimate the annual rate of change in the labour costs between 2001 and 2002. To produce this first LCI estimate we need to develop strategy to estimate:

- the average cost, \bar{c}_h^b , for each stratum h and $b=2001$,
- the sub-index, $\bar{c}_h^{t/b}$, for each stratum h , $b=2001$ and $t=2002$, and
- the variance of $L\hat{C}I^{t/b}$.

As the users require a sub-annual measure, we will also need to develop a strategy for producing quarterly LCI estimates.

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