Essays on Productivity Analysis in the Canadian Tourism
and Hospitality Industries

by

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This thesis is to investigate the relationship between the productivity in the Canadian tourism and hospitality industries and workforce characteristics, human resources management practice, technology change. The productivity analysis is conducted with different measures of productivity, such as labour productivity and total factor productivity.

The first chapter is to calculate labour productivity using the Canadian National Tourism Indicator (NTI) and the Canadian Human Resource Module of Tourism Satellite Account (HRM) for six tourism industries during the period 1997-2008 and to estimate an econometric model of labour productivity. Labour productivity is found to increase with the capital labour ratio, the proportion of part-time hours, the share of immigrant workers and by the proportion of the most experienced workers.

The second chapter decomposes the total factor productivity growth for the Canadian tourism/hospitality industries with dynamic factor demand models which is estimated with non-linear Full Information Maximum Likelihood (non-linear FIML) estimator. The results show that only a few Canadian tourism/hospitality industries experienced positive total factor productivity growth and had a major gain from technological change during the period 1983-2003.

The final chapter is to examine the impact of technology use (ICT), training and labour turnover on labour productivity in the Canadian tourism/hospitality industries, using cross-
section time-series firm-level representative data (Canada Workplace and Employee Survey (WES), 1999-2005). The study found that the labour productivity is positively related to the share of workforce using computer and having computer training both on-the-job and in-classroom.
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Chapter One  Introduction

The Canadian tourism/hospitality sector has suffered low productivity or negative productivity growth in the past decade. In order to improve the productivity in the Canadian tourism/hospitality sector, it is crucial to identify the sources of productivity growth in this sector. The dissertation contributes to this literature by investigating the sources of labour productivity growth from the perspective of human resource management practices and information and communication technology (ICT) use and the decomposition of total factor productivity (TFP) growth. In the first chapter I examine the relationship between workforce characteristics and the labour productivity by using the Canadian Human Resource Module of Tourism Satellite Account and other datasets specially developed for Canada’s tourism/hospitality sector. The second chapter of my thesis is to identify the sources of total factor productivity growth by decomposing the Divisia Index based TFP growth with dynamic factor demand model. The final chapter explores the impact of ICT usage and its training and other human resource management practices on the labour productivity with the Canadian Workplace and Employee Survey (WES) dataset.

The measures of productivity can be distinguished as average productivity, such as output per labour unit, marginal productivity, such as wage rate, and total factor productivity. According to Kohli (2010), if the income share of labour holds constant over time, the marginal labour productivity measure and average labour productivity measure should yield similar results. In the first chapter, the study used average labour productivity measure to examine the relationship between the workforce characteristics and labour productivity. The first part of this
study is to calculate labour productivity using the Canadian National Tourism Indicator (NTI) and the Canadian Human Resource Module of Tourism Satellite Account (HRM) for six tourism industries during the period 1997-2008 and to estimate an econometric model of labour productivity. Using the HRM data we are able to determine to what extent characteristics of the labour force have an impact on labour productivity. The empirical results produced by the feasible generalized least squares estimator (FGLS) suggest that labour productivity increases with the capital labour ratio, the proportion of part-time hours, the share of immigrant workers and by the proportion of the most experienced workers. The study also finds a positive relationship between labour productivity and investment in information and communications technology, and human capital.

The measures of productivity with single factor, such as labour productivity and capital productivity, have advantage of simplicity, but these measures ignore the substitution between factors of production and can generate interpretation problems. Total factor productivity is a measure of overall productivity change, which is a weighted average of each single factor productivity growth. The second chapter uses total factor productivity as the measure of productivity instead of labour productivity and decomposes the total factor productivity growth for the Canadian tourism/hospitality industries with dynamic factor demand models which is estimated with non-linear Full Information Maximum Likelihood (non-linear FIML) estimator. The empirical results indicate that the information and communication technology capital and labour input are substitutes. Also, energy inputs and the information and communication technology capital are substitutes. The total factor productivity growth is decomposed into technical change effect, scale effect, temporary equilibrium effect and direct adjustment effect.
The study found that a few of Canadian tourism/hospitality industries experienced positive total factor productivity growth and had a major gain from technological change during the period 1983-2003. One half fraction industries had increasing returns to scale which positively affect the growth of total factor productivity.

In the last three decades, information and communication technology arises as a rapidly changing technology. The adaption of ICT and the appropriate and up to date skills ensure the Canadian tourism/hospitality sector remaining globally competitive. The general education system can provide most of basic skills, but it takes up much time to chang the education system to provide the up to date skills. Instead, workplace training can be an alternative and flexible way for workers and firms to make up skill shortage. The final chapter is to examine the impact of ICT adoption and training on labour productivity in the Canadian tourism/hospitality industries, using firm-level representative panel data (Canada Workplace and Employee Survey (WES), 1999-2005) with FGLS estimator. WES data is a micro-level data which provides rich information on human capital and technology use for firms and their employees. The information allows the human capital and technology use to be linked to productivity at the firm level. The empirical results found that computer training in classroom and on-the-job have positive impact on labour productivity. The share of computer user in workforce has positive impact on the labour productivity while the share of computer related or controlled technology user in workforce has no impact on the labour productivity.

In sum, this thesis explores various data sources which are available to the public and feasible for the productivity analysis in the Canadian tourism/hospitality sector with different
measures of productivity and methodologies. One of the findings is that the adaptation of ICT and human capital (for example education and computer training) promotes the productivity growth in the Canadian tourism/hospitality sector. However, the picture of the gains from technology change for the Canadian tourism/hospitality sector is mixed.
Chapter Two  
Labour Productivity in the Canadian Hospitality and Tourism Sector

2.1 Introduction

Recently Statistics Canada (2009) published a report that describes the data set known as the Human Resource Module (HRM) of the Tourism Satellite Account (TSA). From an industry perspective, the data are drawn from six tourism industries, that is, industries whose output is consumed in large part by ‘tourists.’ The annual data are aggregated to the national level and cover the period 1997 to 2007. The Statistics Canada study presents a descriptive analysis of the key variables: hours of work by women, men, and immigrants; the mix of part-time and full-time hours and jobs as well as information on wages. The report (Statistics Canada, 2009, p. 19) concludes:

The HRM provides a rich source of information for the planning and analysis of tourism employment in Canada. The linking of the HRM with other tourism databases such as the CTSA and the NTI, allows for even greater analysis. Variables such as labour productivity (GDP divided by hours worked) can now be calculated.

The primary objective of the present study is to take up this suggestion by integrating the information available in the National Tourism Indicators (NTI) and the HRM. Specifically, we calculate labour productivity from the industry GDP data available in the NTI and the hours of labour data reported in the HRM. By estimating an econometric model of labour productivity, we are able to determine to what extent characteristics of the labour force have an impact on
labour productivity.

The combination of 6 industries and 11 years provides 66 observations, which is a rather small sample for an exercise of this type. Nevertheless, we do find quantitative relationships that have been established in the productivity literature. Many are statistically significant and fairly robust over alternative model specifications. At the very least, these results appear to validate the data contained in the HRM.

Section 2 of this report presents our theoretical model and surveys some recent literature that is relevant to this study. Section 3 presents our analysis of tourism productivity using the NTI and the HRM. Section 4 reports the results of a separate investigation of productivity in the combined accommodation and food and beverage services industry in ten provinces. Labour force information for his study is drawn from the Labour Force Survey. We are able to include some variables that the literature suggests are important to labour productivity, in particular investment in public capital, the stock of information and communications technology and measures of human capital. Again, the sample size of 100 observations is relatively small and so while the results are sensible and encouraging the statistical reliability of the parameter estimates is correspondingly modest.

2.2 Context and Theoretical Framework

2.2.1 Theoretical Model

The production of marketable goods and services naturally entails the use of inputs such as labour, land, capital equipment and material inputs. Through the combined use of human labour and capital equipment the production process ‘adds value’ to raw materials as they are
transformed into a saleable product or service. It is this value-added that constitutes the output of the production process. The concept of productivity measures the effectiveness of capital and labour in production. Labour productivity is the ratio of the value of output to the quantity of labour used in production. It is increases in labour productivity that allow for improvements in economic well-being as well as enhanced competitiveness of a firm, industry or country.

Changes in labour productivity can come from a variety of sources and there is a large empirical literature devoted to quantifying the origin of labour productivity and its improvements. Clearly the quantity of physical capital that is available to each worker - the capital labour ratio - is a contributing factor. Improvements in the quality and quantity of capital over time enhance labour productivity. Not all labour is identical. Better educated, better trained and more experienced workers are more productive. This notion is captured in the concept of human capital. Labour also differs in other ways: some workers are hired full-time, others work part-time hours; some workers are native born, others are immigrants; some are male and some are female. The labour market experiences of these different types of workers are not necessarily identical and this may be reflected in different hourly wage rates. Whether the wages paid to a particular type of worker truly reflects their productivity has been the subject of considerable research.

The production of goods and services takes place within a geographical area as well as a legal, social and political environment. These factors can have a measureable effect on labour productivity. The political, legal and social environment has been referred to as ‘social capital’ and this has been shown to explain a large share of the differences in labour productivity between countries. Governments invest in public infrastructure such as roads, water systems, ports and the like. The physical capital embodied in public infrastructure has been shown to
have a positive effect on labour productivity in private industry.

The primary objective of this study is to relate the information available in the Human Resource Module of the Tourism Satellite Account to a measure of labour productivity in six tourism industries. Labour productivity, measured by the ratio of industry GDP to hours of labour input, is the variable we endeavour to explain. In econometric terms, it is our dependent variable. It is helpful to use some notation to explain the theoretical context of the study. The production function describes the relationship between inputs and output, $Y$:

$$Y_{it} = A_{it} L_{it}^{1-\beta} K_{it}^\beta$$  \hspace{1cm} (1)

where $i = 1,\ldots,6$ is an industry index and $t = 1997,\ldots,2007$ is a time index.

$L$ is labour input measured in hours of work and $K$ is the physical capital stock (buildings, machinery, equipment and vehicles.) The term denoted by $A$ is known as the Solow residual which is determined by demographic variables including the age structure of the labour force, the gender ratio, the proportion of immigrant workers, and the proportion of part-time hours.

$$A_{i,t} = E_{i,t} S_{i,t}^\gamma M_{i,t}^\delta F_{i,t}^\rho P_{i,t}^\mu$$  \hspace{1cm} (2)

where $E$ allows for disembodied technical progress, $S$ is the age structure of the workforce, $M$ is the proportion of hours provided by immigrants, $F$ is the proportion of hours provided by females and $P$ is the proportion of part-time hours. The combination of equations (1) and (2) gives the following equation to be estimated, where all variables are in natural logarithms:

$$y_{it} - l_{it} = \theta_i + \theta_t + \gamma s_{it} + \delta m_{it} + \rho f_{it} + \mu p_{it} + \beta (k_{it} - l_{it})$$  \hspace{1cm} (3)

In equation (3), $\log E_{i,t} = \theta_i + \theta_t$, $\theta_i$ is the industrial fixed effect and $\theta_t$ is the time fixed effect.

Typically, labour productivity is related to human capital in the form of educational attainment. However, the HRM does not include information on education and training. This could bias results and we will comment on this later in the report.
In a second empirical study we use provincial data for the combined accommodation and food and beverage services industries. This not only allows us to look at the provincial dimension but also permits us to include some information on education that is available in the labour force survey. In addition, we are able to include information on public investment and private investment in information and communications technology.

In the following subsection, we present brief overviews of the recent literature on productivity analysis that are of particular interest to the present study.

2.2.2 Labour productivity and ICT

In the productivity literature, there has been great interest in the effect of the technological revolution in information and communications technology (ICT). ICT is defined as computer and telecommunications technologies considered collectively. ICT convergence has given rise to technologies such as the internet, videoconferencing, groupware, intranets, and third-generation cell phones. ICT enables organizations to be more flexible in the way they are structured and in the way they work. Certainly, the workplace whether it be the office or the shop floor has changed dramatically since the introduction of desktop computers, networks and robots. Sharpe (2006) studied the relationship between ICT and productivity in the Canadian economy. He analyzed ICT investment and capital stock per worker for the Canadian economy as well as 20 industries as defined in the North American Industry Classification System (NAICS) between 1980 and 2005. In general, ICT has a positive impact on productivity growth in Canada and the United States since the mid-1990s. However, in this study (Sharpe, 2006, p. 33) pointed out the relationship between ICT investment and productivity growth is complicated and depends on the way productivity is measured:
Labour productivity is defined as the ratio of real output, measured as either value added or gross output, to labour input, measured as either hours worked or persons employed.

Total factor productivity (TFP) is defined as the ratio of output to all inputs used in the production process.

In addition to the positive impact of ICT investment on labour productivity growth through the higher ICT capital intensity channel, ICT investment and capital stock can directly contribute to TFP growth and thereby to labour productivity growth. Thus, part of the contribution of ICT investment and capital to labour productivity growth is picked up by higher ICT capital intensity and part by technological progress to TFP growth. Unfortunately, there is no simple methodology to capture the total effect of ICT investment on labour productivity. Estimates of the contribution of ICT investment to TFP growth, and hence labour productivity growth, should be considered as very approximate in nature and as likely underestimating the true contribution of ICT to labour productivity growth as ICT investments are the carriers or manifestation of technological progress, the ultimate driver of labour productivity growth.

At the same time Sharpe (2006, p. 34) points to limitations on the basic growth accounting framework for the estimation of the impact of ICT investment on labour productivity growth:
First, the impact of ICT investment on labour productivity growth may not occur the same period in which the investment takes place due to lags…. Second, the benefits of ICT investment on firm performance may go well beyond productivity increases and include quality improvements in products and services produced….Third, ICT investments may be so small in magnitude that they have minimal effect on the capital stock, but represent such technological breakthroughs that they raise productivity significantly….Fourth, ICT may indeed have important productivity-enhancing effects; they also may have non-trivial productivity-reducing effects, either directly or indirectly.

Nevertheless his key conclusion is that ICT has been the driving force behind the acceleration of productivity growth in Canada and the United States since 1996 and he suggests that the potential of ICT has not been fully exploited and that this type of investment will continue to contribute to productivity growth in the future.

2.2.3 Labour productivity, human capital and demography

There is a vast literature on the effect of human capital in earnings and productivity. An important strand of this research focuses on the individual: what is the rate of return to a person who invests in education? How do hourly wages and earnings vary with educational attainment and years of experience? This notion is typically captured by the age profile of wages or earnings of individuals – that is, the path of wages/earnings over the working life of an individual. In competitive markets for labour, economic theory predicts that wages equal the
marginal productivity of labour. More precisely, the hourly wage paid by a profit-maximising firm operating in competitive markets equals the contribution to output of one extra hour of labour input. Following this line of thought, the productivity of individuals can be measured by their wages or earnings. However, there are a number of reasons why wages may differ from marginal productivity. For example, discrimination against women or visible minorities could result in wages falling below marginal productivity. Industries dominated by monopolies can afford to pay their workers more than those workers would earn in a competitive industry.

Kotlikoff (1988, p. 1) offers some compelling reasons why variations in productivity over the life-cycle are so important:

Understanding how productivity varies with age is important for a variety of reasons. A decline in productivity with age implies that aging societies must increasingly depend on the labor supply of the young and middle age. It also means that policies designed to keep the elderly in the work force, while potentially good for the elderly, may decrease overall productivity. A third implication is that, absent government intervention, employers may not be willing to hire the elderly for the same compensation as younger workers. Labor economists are particularly interested in the relationship of productivity and age because it can help test alternative theories of the labor market.

To that we can add: as the average age of the labour force increases, some industries in the tourism sector that tend to rely on relatively scarce younger workers could find it increasingly difficult to attract and retain employees from that age group.
Kotlikoff examined over 300,000 records of employee data for a particular company over the period 1969 to 1983. He found (Kotlikoff, 1988, p. 1) that “... productivity falls with age. For young workers, compensation (earnings plus pension accrual) is below productivity and for older workers compensation exceeds productivity. For several worker groups the discrepancy between compensation and productivity is very substantial. In addition to confirming some features of contract theory, the results lend support to the bonding models of Becker and Stigler and Lazear which suggest that firms use the age-earnings profile as an incentive device.”

Hellerstein et al (1999) also uses establishment data to estimate marginal productivity differentials among different types of workers. They then compare these productivity differentials to estimated relative wages. Among the findings are (1) the higher pay of prime-aged workers (aged 35-54) and older workers (aged 55 + ) is reflected in higher point estimates of their relative marginal products, and (2) for the most part, the lower relative earnings of women are not reflected in lower relative marginal products.

Both of these studies find that the productivity of the most senior workers falls below that of prime age workers. But they also find that wages do not necessarily match marginal productivity. In particular, Hellerstein finds that women are paid less than their marginal product while Kotlikoff claims older workers are paid more than their marginal product.

A significant portion of the literature on earnings profiles uses large surveys that are administered over long periods of time. Beaudry et al (2000) estimate earnings profiles for Canadian males and females using annual Surveys of Consumer Finance (1971-1993) to follow age cohorts through time. For males whose highest level of education is a high school diploma, weekly earnings rise relatively slowly over time to about age 40 or slightly younger, gaining
about 20-25% over initial earnings. Weekly earnings then flatten out before declining somewhat. For those with a university degree, earnings rise much more quickly with age as on the job experience complements the human capital embodied in the years of formal education. By age 40, earnings have almost doubled for these more highly educated workers. Earnings for most cohorts peak in the workers’ early 40s and then decline somewhat. These findings suggest that for males, productivity peaks in the middle years. The picture for females is complicated by the effect of years spent rearing children. Earnings for women with a high school diploma are noticeably flat while for women with a degree, there is some growth which is sustained throughout the working lifespan – there is only weak evidence that earnings decline in later years.

Heckman et al (2008) use US census data from 1940 to 2000 to estimate annual earnings functions for white and for black males. Before 1960, earnings profiles rise with age (experience) before flattening out and remaining fairly flat. More recent surveys show earnings peaking well before retirement and since the 1980 census the decline in annual earnings is considerable for older workers.

Given these systematic findings on earnings profiles that are derived from the lifetime earnings of individuals or the experience of age cohorts over time, it is not surprising that economists have attempted to explain inter-regional and cross-country differences in economic growth by differences in the demographic characteristics of populations.

Gomez and Hernandez de Cos (2006) used a sample of 144 countries observed over a fifty year period, 1950 to 2000, to examine the role of the age structure of the population as a determinant of economic growth. They note that a decline in the birth rate is likely to stimulate economic growth by reducing the dependency ratio, increasing labour market participation and
possibly household saving. A second channel comes through the effect of a maturing labour
force on productivity. They argue that “Labour force participation and productivity peak
sometime during the prime working ages of 35 and 54 when the balance between formal
education and experiential human capital reaches its optimum." As a result economies that have
a relatively large share of prime age workers should be more productive. Their key empirical
findings are that demographically mature countries are significantly better off in terms of GDP
per head than non-mature counterparts and that demographic maturation has contributed to over
half of the increase in global per capita GDP averaged across countries since 1960. They also
suggest that inter-country differences in rates of maturation have contributed to rising economic
inequality.

Feyrer (2007) analyzes data from 87 countries over ten years and finds that changes in
workforce demographics have a strong and significant correlation with the growth rate of
productivity. Changes in the proportion of workers between the ages of 40 and 49 seem to be
associated with productivity growth. To illustrate the implications of his results Feyrer (2007, p.
100) calculates that a 5% increase in the size of this cohort over a ten-year period is associated
with a 1%–2% higher productivity growth in each year of the decade.

Bhatta and Lobo (2000) find that differences in human capital and the age structure of the
labour force explain a high proportion of inter-state differences in Gross State Product (GSP)
within the United States. Interestingly they find that differences in the proportion of workers
with academic qualifications below a university degree account for more of the differences in
GSP than variations in the proportion of people with university degrees. In the same vein, Hirte
and Brunow (2008) find that inter-regional productivity differences in the Germany are in part
explainable by differences in human capital.

1 Gomez and Hernandez de Cos (2006, p. 5)
Taken together, these studies suggest that within the Canadian tourism sector, variations in labour productivity across industries and over time may in part be explained by differences in educational attainment and the age structure of the labour force.

2.2.4 Labour productivity and immigrant workers

In 2007, the Accommodation and the Food and Beverage industries together accounted for 68% of the jobs in the tourism sector (that is, in the six industries that comprise this sector – see Table 3.2). The labour force working in these two industries includes a significant number of immigrants who contributed about 28% of the total hours worked in 2007. Immigrants to Canada admitted through the economic class tend to be well educated and well trained. The very fact that they have taken the enormous step of leaving their home country to settle in a new land implies immigrants are generally ambitious and hard working. Yet studies of how well immigrants adjust to the Canadian labour market show that earnings are lower than for the comparably educated Canadian born and estimates of how quickly, if at all, immigrants catch up to their native counterparts vary. Part of the explanation for lower earnings on immigration could be that foreign credentials, work experience and formal education do not yield the same economic return in Canada that they would have done if such experience and education had been undertaken in Canada. It is also possible that some immigrants need time to develop the language skills that are effective in the Canadian labour market.

Baker and Benjamin (1994) compared the experience of Canadian immigrants that arrived in the 1970s with earlier cohorts. They conclude (Baker and Benjamin, 1994, p. 400):

We have painted a fairly pessimistic picture of the immigrant experience in the Canadian labor market. Entry earnings are falling across successive immigrant
cohorts, while their rates of assimilation are uniformly small. Recent immigrants start with earnings up to 20% lower than their predecessors and have assimilated at a very modest pace in their first years in Canada. If their future assimilation matches that of earlier cohorts, convergence with natives may be unattainable.

A more recent study by Aydemir and Skuterud (2005) that employs Canadian census data shows that the entry earnings of recent cohorts of immigrants relative to the Canadian born have continued to deteriorate. They claim that about a third of the decline can be attributed to compositional shifts in language ability and region of birth. They find no deterioration in the economic returns to foreign education but a marked decline in the return to foreign labour market experience.

Hum and Simpson (2004) used longitudinal data in the form of the Survey of Labour Income and Dynamics (SLID) to look at the labour market experience of Canadian immigrants and reported rather similar pessimistic conclusions as reached ten years earlier by Baker and Benjamin. They find (Hum and Simpson, 2007 p. 129) “our instrumental variable estimates which allow for unobservable fixed effects suggest that immigrants never catch up to otherwise comparable native born workers.”

As noted above the HRM of the TSA records the proportion of hours supplied by immigrant workers. In a later section we report on estimates of how this proportion affects overall labour productivity.

2.2.5 Labour productivity and infrastructure

The productivity and growth literature distinguishes between social infrastructure and public infrastructure. The first concept was introduced by Hall and Jones (1999) in their influential paper entitled “Why do some countries produce so much more output per worker than
others?” To Hall and Jones, social infrastructure includes legal and social institutions and government policies that work to equate private and social returns to investment. If private returns are low due to high taxation, crime, bribery, the inability to enforce contracts etc. then investment will be lower than otherwise, with growth and productivity correspondingly lower while unproductive rent-seeking will be all the greater. Hall and Jones argue that differences in social infrastructure go a long way towards explaining differences in labour productivity across countries.

The concept of public infrastructure refers to public investment in physical capital such as roads, bridges, tunnels, ports and airport runways. That such investment in public capital contributes to the aggregate economy’s productive capacity has been demonstrated in a number of empirical studies. Fernald (1999) answered a question that had troubled this literature – what is the direction of causation? Do highly productive economies enjoy a large stock of public capital because they are rich? Or does the existence of public capital causally affect the economy’s aggregate level of productivity? Fernald examined the history of the largest component of US public investment, namely roads. He concluded that vehicle-intensive industries benefitted from investments in roads. This was especially true immediately after the interstate system was established in the 1950s and 1960s. Subsequent investment in roads was found to be beneficial but not unusually productive. Destefanis and Sena (2005) examine Italian regional data to study the relationship between public infrastructure and total factor productivity. They are also concerned with the direction of causality and conclude that it flows from public infrastructure to total factor productivity. More recently, Bronzini and Piselli (2009) returned to Italian regional data to re-examine this link but using a model that includes investment in R&D and human capital as well as public infrastructure. They argue it is necessary to examine
simultaneously how all three types of investment impact total factor productivity in order to distinguish their separate effects and avoid attributing to one the contributions of others. They find that public infrastructure does Granger-cause total factor productivity while the converse is not true. Moreover, by using a spatial model they find that public infrastructure in a given region has positive spill-over effects on productivity in neighbouring regions.

The Statistics Canada report by Harchaoui et al (2003a) provides an informative description of Canada’s public infrastructure over time and by level of government. It is useful to note what is not included in this concept: the physical investments that support education and health are excluded, as is the capital owned by government enterprises. Public infrastructure does include roads, ports, runways, bridges, sewer systems, waterways, irrigation systems and parks. In 2002 the total stock of public infrastructure was valued at $227.5 billion, which amounted to 20% of Canada’s total business physical capital. By level of government, the largest share was held by local governments (48.1%), followed by provincial governments (34.3%), leaving 17.6% in the hands of the federal government. In a separate paper Harchaouri and Tarkhani (2003b, p. -ii-) measure the contribution of Canadian public capital to productivity and conclude:

Public capital contributed for about 18% of the overall business sector multifactor productivity growth over the 1961-2000 period. This is somewhat lower than the figures reported in the literature. However, the magnitudes of the contribution of public capital to productivity growth vary significantly across industries, with the largest impact occurring in transportation, trade and utilities.

In our second statistical study we analyze labour productivity in the accommodation and food and beverages services industries over time and by province. Since public infrastructure data are available by province we are able to include this variable in our model.
2.2.6 Labour productivity and part-time workers

In situations in which demand fluctuates greatly by time of day or day of the week it is likely that firms will find it profitable to hire more part-time employees since it is costly to satisfy a highly variable demand for labour by relying exclusively on full-time workers (for example by using overtime or scheduling short shifts). Owen (1978) investigates this hypothesis. By comparing employment practices across industries, he finds a positive correlation between fluctuations in demand and the proportion of employees that work part-time.

Nelen et al (2009) used a matched employer-employee dataset of Dutch pharmacies to investigate the productivity of pharmacy assistants. Output of each establishment (pharmacy) is measured by the number of filled prescriptions. The authors conclude that firms with a high share of part-time employment are more productive than firms with a high share of full-time employment and that the measured differences in productivity levels are significant both statistically and quantitatively. Other implications of their results are that given a certain level of on the job experience (with the current employer), older workers are less productive than younger ones. It is suggested that younger workers may have more up-to-date knowledge and may be more motivated. Conversely, amongst workers of a given age, those with more years of experience at their current employer are more productive than workers of the same age but with shorter job tenure.

2.3 Productivity Analysis: The Human Resource Module of the TSA

The Human Resource Module of the Canadian Tourism Satellite Account provides detailed demographic data on the labour force working in six tourism and hospitality industries
Table 2.1 – Dimensions of the Human Resource Module of the TSA

<table>
<thead>
<tr>
<th>Industry Groups</th>
<th>Labour Force Characteristics</th>
<th>Job Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Transport</td>
<td>Employed/Self-Employed</td>
<td>Number of Jobs</td>
</tr>
<tr>
<td>Other Transport</td>
<td>Full- Part-Time</td>
<td>Total hours worked</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Male/Female</td>
<td>Total wages/salaries</td>
</tr>
<tr>
<td>Food and Beverage</td>
<td>Immigrant</td>
<td>Average annual hours</td>
</tr>
<tr>
<td>Recreation and Entertainment</td>
<td>Age Ranges (4)</td>
<td>Average annual wage/salary</td>
</tr>
<tr>
<td>Travel Services</td>
<td></td>
<td>Average hourly wage</td>
</tr>
</tbody>
</table>

As shown in the Table 2.1 above, the HRM provides labour market data on the number of jobs, hours worked, job status, and employment earnings according to the gender, age group and immigrant status of workers in six tourism industries. The available data cover the eleven-year period 1997-2007. Our ultimate objective is to examine the relationship between these labour market variables and labour productivity (GDP per hour of work.) For this purpose, we have 66 observations – a relatively small sample for an econometric exercise of this type. The results are presented and discussed towards the end of this section.

A detailed analysis of the 2007 HRM data has been published by Statistics Canada (2009). Here, we begin with a brief overview of the data available in the HRM by looking at the selected statistics presented in Table 2.2.

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2 The components of aggregate industry groups are listed in Appendix C.
Table 2.2—Summary Statistics from the HRM, 2007

<table>
<thead>
<tr>
<th>Industry</th>
<th>Share of Hours by Type of Worker by industry*</th>
<th>Wage/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jobs*</td>
<td>Females</td>
</tr>
<tr>
<td>Air Transport</td>
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<td>Other Transport</td>
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<tr>
<td>Accommodation</td>
<td>0.142</td>
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<td>Food and Beverage</td>
<td>0.534</td>
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</tr>
<tr>
<td>Recreation, Entertainment</td>
<td>0.171</td>
<td>0.467</td>
</tr>
<tr>
<td>Travel Services</td>
<td>0.028</td>
<td>0.677</td>
</tr>
</tbody>
</table>

*Share of Jobs by Industry: industry share of all jobs in 6 tourism industries (column sum = 1.0)

In 2007, the total number of jobs in the six tourism industries amounted to 1.65 million of which 114,417 (7%) were self-employed. More than half of these jobs were found in the food and beverage services industry which employed a larger than average share of women. This industry relies heavily on younger workers (36.2% of all hours are worked by employees aged under 25) and is relatively more reliant on part-time workers (who account for 27.1% of all hours worked) and immigrants (28.2% of hours worked.) The food and beverage services industry paid the lowest average hourly wage of the six industries.

Figure 2.1a presents the time series of total industry GDP for three of the six industries and shows that the food and beverage services industry has the largest GDP of all six. These data are taken from the National Tourism Indicators and consequently the GDP estimates plotted
in Figures 2.1.1 and 2.1.2 reflect specifically tourism demand\textsuperscript{3}. The Tourism Satellite Account reports that in 2002 tourism demand accounted for about 17% of the total GDP generated by the food and beverage services industry. The share of tourism demand in total industry output or supply varies considerably by industry. It is highest for Travel Services at 92% and is also high for accommodation services at 66%. The tourism share is relatively low in those service industries that rely principally on ‘local’ demand that is, not demand by visitors and travellers. These are the food and beverage services and the recreation and entertainment industries for which tourism demand is 17% and 22% of the total, respectively. Averaged over all six industries tourism demand accounts for 34% of total industry demand.

\textbf{Figure 2.1.1– GDP by Industry, 1997-2007}

\textsuperscript{3} According to Human Resource Module of Tourism Satellite Account, tourism demand is defined as the spending by Canadian and non-resident visitors on domestically produced commodities. This spending has a direct impact on a wide range of industries, some more so than others.
The data recorded in the Human Resource Module of the Tourism Satellite Account refers to measures relevant to the total industry. Hence, the total number of jobs in all six industries that were referred to earlier is a measure of total industry employment. In other words, the 1.65 million jobs in the six tourism industries cannot all be attributed to tourism demand. Statistics Canada (2009) refers to these 1.65 million jobs as a feature of ‘tourism supply’ and estimates that 525,000 of these jobs (about 32%) can be attributed to tourism demand. It is the 525,000 jobs that are defined as ‘tourism employment’.4

In order to integrate the industry GDP data of the National Tourism Indicators with the data available in the Human Resource Module, these two datasets need to be made compatible. Essentially, we need to estimate the hours of work in the HRM that is attributable to tourism demand. To do so, we make use of the weights available in the Tourism Satellite Account. The

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*4* ‘tourism employment’ understates the number of jobs that could potentially be attributable to tourism demand since non-tourism industries are excluded from the calculations.
TSA was produced every two years between 1996 and 2002 inclusive.\footnote{The tourism shares of total industry GDP attributable to tourism demand used to calculate the inputs, such as capital stock and labour inputs, and outputs, such as GDP should not bias the estimation of the production function towards constant returns to scale. For example, the dependent variable is tourism GDP per labour hour for tourism. The numerator is calculated as industrial GDP * tourism share, and the denominator is calculated as industrial labour hours * tourism share. The tourism share’s variation in different years should not bias the estimation because the tourism shares in numerator and denominator will cancel out each other.} As an example, consider accommodation. The published tourism shares of total industry GDP attributable to tourism demand for accommodation (in 1996, 1998, 2000 and 2002) are 65.0\%, 64.4\%, 65.9\% and 66.4\%. These are fairly stable with a hint of a slight increase over time. For some industries, the tourism share in 1996 was well below the share in later years. Air transportation, for example, has these shares: 61.6\%, 77.3\%, 77.9\% and 78.7\%. From these shares we need to estimate annual tourism shares for each of six industries for the years 1997-2007 (these are the years for which HRM data are available.) Our interpretation of the air transportation shares is that 1996 is an outlier while the three subsequent shares are stable. Based on this description, we decided to estimate the 1997 share by averaging the observed shares in 1996 (61.6\%) and 1998 (77.3\%).

For the years 1998, 2000 and 2002 we used the published shares and for the remaining years for which we do not have official estimates (1999, 2001, 2003-2007) we used the average of the (very similar) shares in 1998, 2000 and 2002. We applied the same method to all six industries.

Having calculated tourism share for all six industries for the years 1997 to 2007 we then calculated the industry GDP. The ratio of industry GDP to the hours of work is our measure of labour productivity. The results of these calculations are plotted in Figures 2.2.1 and 2.2.2. Note that the vertical axis measures real GDP per hour worked in constant 2002 dollars.
Labour productivity is highest in the transportation industries which not only employ older, well educated workers, but also use a great deal of physical capital. Output per hour is much the same in accommodation, travel services and recreation and entertainment with annual data varying between $20 and $30 per hour. Output per hour is lowest in the food and beverage services industry. The series displayed in Figures 2.2a and 2.2b are the dependent variables in the regression analysis that will be reported later in this section. But first, we take a look at the time series paths followed by the explanatory variables. All but one of these variables is drawn from the HRM of the TSA. To construct each industry’s capital labour ratio we used data from the Statistics Canada’s Economic Accounts (see Appendix B for details.)
Figures 2.3.1 and 2.3.2 show the share of hours contributed by employees aged between 15 and 24 years. Clearly, the food and beverage services industry relies most heavily on this age group and the level of dependence rose over the period covered by the data. Little use of this youngest group of workers and indeed the shares have declined somewhat over time.
Figure 2.3. 2– Shares of Hours Contributed by Employees Aged 15-24, by Industry

The remaining age figures are available in Appendix A. A feature common to all industries is that the share of mature workers has increased over time. Alone amongst the six industries, the food and beverage services industry has seen an increase in the shares of both the oldest and youngest workers, with a concomitant decline in the share accounted for by workers aged 25 to 44. As noted earlier, the empirical literature suggests strongly that an increase in the share of prime age workers is associated with increases in productivity. Note however, that the oldest age category in the HRM is 45 years and older which means that prime age workers are combined with the oldest workers whose productivity is generally shown to be somewhat lower than that of prime age workers.

Figures 2.7.1 and 2.7.2 plot the share of hours supplied by female workers (see Appendix A). The biggest differences are between industries rather than within industries over time. The industries with the largest share of female hours are, in declining order, travel services,
accommodation, food and beverage services, other transportation and recreation and entertainment with air transportation completing the list. There are some variations over time; in 5 of 6 industries the share of hours supplied by women was higher in 2007 than in 1997.

In the same vein, five out of six industries have seen the share of hours supplied by immigrants increase between 1997 and 2007. Growth has been greatest in other transportation and in food and beverage services. Again, differences between industries are quite pronounced with over 30% of hours supplied by immigrants in travel services and around 15% in recreation and entertainment.

For five of six industries, the share of hours provided by part-time workers has remained relatively stable over time. Only recreation and entertainment has shown any appreciable positive trend. Again, there are noticeable differences between industries.

Figure 2.9. 1– Shares of Hours Contributed by Part-time Workers, by Industry

The highest shares of part-time hours are in the food and beverages and recreation and
entertainment industries with part-time hours accounting for in excess of 20% of total hours. About 15% of hours in accommodation are supplied by part-time workers while the share drops to 10% in the transportation industries and well below 10% in travel services. Finally, Figures

Figure 2.9. 2- Shares of Hours Contributed by Part-time Workers, by Industry

2.10.1 and 2.10.2 show the time series of capital per labour unit which is measured by the real value of the capital stock per hour of labour input
The transportation industries are clearly much more capital intensive than the other four, having a capital labour ratio an order of magnitude larger. Capital per labour unit has also
increased over time in the transportation sector but shows no net increase in two of the other four industries. Recreation and entertainment recorded a small jump in capital per unit of labour in 2005. Accommodation is the exception, and like transportation, it shows a positive trend in capital per unit of labour.

2.4 Human Resource Module Model Regression Results

In this section we present the results of estimating a model of labour productivity. The dependent variable is labour productivity (lnGDPH) measured annually over the period 1997 to 2007 for each of six tourism industries. Consequently, there are 11x6 = 66 observations available at the present time. This is a small sample by any standard and one cannot expect to estimate a vast number of coefficients with any precision with such a sample. Despite the small sample size, the results appear to be plausible, robust across model specifications and broadly consistent with the published literature.

Since the productivity levels differ considerably across industries, one might anticipate that it would be appropriate to take account of heteroskedasticity. That is to say, it is likely that the error variances vary across industries and possibly over time. We therefore employ Feasible Generalized Least Squares (FGLS) in STATA as our method of estimation. Accounting for heteroskedasticity should make the estimation procedure more efficient. Further efficiency gains are offered by FGLS through the estimation of the inter-industry error covariances. Some mild autocorrelation is detected in the residuals and this also is accounted for in the estimation procedure. The diagnostic test results for heteroskedasticity and autocorrelation reported in the tables are the test results on the OLS results. Variables other than the industry and time dummy variables are measured in natural logarithms.
Table 2.3 presents estimation results for a model that includes the following explanatory variables: Capital per unit of labour (lnCAPH); the proportion of part-time hours (lnPPT); the proportion of hours supplied by women (lnPFEM); the proportion of hours supplied by immigrants (lnPIMMIG); variables that measure the age composition of the labour force (lnp_15-24, lnp_25-34 and lnp_35-44); and industry dummy variables (air transport(Dat), other transports(Dot), accommodation(Das), recreation and entertainment(Der) and food and beverage services(Dfb)). Since we have six industries, we have included a constant and five industry dummy variables. No dummy variable is included for the travel services industry, so this industry effectively becomes the benchmark against which the other industries are compared. Similarly, we have omitted the share of hours supplied by the most mature workers (aged 45 and older) so again these workers become the base case relative to whom the other age groups are compared.

The positive coefficient on capital is consistent with economic theory and indicates that a 10% increase in capital per labour input increases average labour productivity by about 7.5%. The coefficient on the share of part-time hours is also positive and statistically significantly different from zero. This is consistent with the results reported by Owen (1978) and Nelen et al (2009) who find empirical support for the claim that part-time workers raise labour productivity by allowing for variations in labour input that match variations in demand. The coefficient of 0.2 implies that at the sample mean, a 10% increase in part-time hours has the effect of raising labour productivity by 2%. 
### Table 2.3—FGLS Estimates for HRM model

<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDPH</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>lnCAPH</td>
<td>.7495</td>
<td>.0834412</td>
<td>8.98</td>
</tr>
<tr>
<td>lnPPT</td>
<td>.2099</td>
<td>.0699325</td>
<td>3.00</td>
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<tr>
<td>lnPFEM</td>
<td>2.4240</td>
<td>.321744</td>
<td>7.53</td>
</tr>
<tr>
<td>lnPIMMIG</td>
<td>1.0377</td>
<td>.3530836</td>
<td>2.94</td>
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<td>lnp_15-24</td>
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<td>.0996757</td>
<td>-1.08</td>
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<td>lnp_25-34</td>
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<td>.1537509</td>
<td>3.51</td>
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<td>lnp_35-44</td>
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</tr>
<tr>
<td>Dat</td>
<td>-.6489</td>
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<td>-1.79</td>
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<tr>
<td>Dot</td>
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<td>.300216</td>
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<td>Das</td>
<td>-.6517</td>
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</tr>
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<td>Der</td>
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<td>.3005343</td>
<td>-0.34</td>
</tr>
<tr>
<td>_cons</td>
<td>5.8804</td>
<td>.7549053</td>
<td>7.79</td>
</tr>
</tbody>
</table>

Breusch-Pagan LM for Heteroskedasticity: p-value 0.00
Wooldridge test for AR(1): p-value 0.01

An increase in the proportion of women is also associated with an increase in labour productivity and while the standard error is small, the coefficient itself is large. The coefficient of 2.4 implies that a 1% increase in the proportion of women is associated with an almost 2.4% increase in labour productivity. Certainly the proportion of women employed in tourism industries has increased over time as it has in other industries. How might we interpret the finding that an increase in the proportion of women working in an industry raises labour productivity? It would probably come as no surprise to academics such as Judy Rosener of the
Merage School of Business at the University of California, Irvine. Rosener (2007, 1997 and 1990) argues that inherently female characteristics (consensus-seeking leadership, an emphasis on collaboration, less power-obsessed) are increasingly valuable in the workplace. This view is not necessarily limited to feminist researchers in business. The Economist recently quoted Niall FitzGerald, chairman of Reuters and former head of Unilever “Women have different ways of achieving results and leadership qualities that are becoming more important as organisations become less hierarchical.”

An alternative explanation focuses on our statistical model’s inability to take account of investment in human capital. The HRM of the TSA does not contain any information on the educational achievements of workers. The productivity literature shows very clearly that human capital is a key factor in determining wages and productivity. The exclusion of an important variable from a statistical model can result in other proxy variables assuming the role of the omitted variable. In the present case, it could be that the proportion of women in a workforce is a proxy for average educational achievement. Parsons and McMullen (2009) report on trends in university education between 1992 and 2007 using Canada’s Post-secondary Student Information System – an annual survey of university graduation data. In 1992 universities in Canada graduated 28% more females than males. Over the next 15 years, women dramatically and consistently increased their participation in university education. In every province and in all subject areas except mathematics and computer science, the growth in the number of women graduates far exceeded that of male graduates. In BC and Alberta combined, women graduates more than doubled while numbers of male graduates increased by less than 60%. In Manitoba, male graduates barely increased in these 15 years, but the number of women graduates grew by over 30%. The result was that in 2007, Canadian universities graduated 148,000 women and

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95,000 men - a margin in favour of women of some 56%. It is exceedingly likely that an industry that hires more women is also hiring employees with a high level of educational achievement with a correspondingly higher level of productivity. We believe this is the most plausible explanation for the statistically significant and positive coefficient on the proportion of women in the labour force.

The positive coefficient on the proportion of immigrants in the labour force implies that immigrant workers enhance productivity. It is impossible to say precisely how this effect may come about but it is not necessarily inconsistent with the literature on immigrant workers’ wages. As we have seen, that literature finds immigrant wages are low relative to the wages of native born Canadians with similar characteristics. It is conceivable that in general the wages of immigrants understate their productivity (measured by output per hour worked) just as Hellerstein et al (1999) found that women are paid less than their marginal product while Kotlikoff (1988) claims older workers are paid more than their marginal product.

There is a vast literature on how the age composition of the labour force affects productivity. In particular, it is well established that productivity increases when the share of prime age workers increases. Prime age is typically cited to be somewhere in the age interval of 40 to 50 years. The coefficients reported in Table 2.3 are consistent with this literature. The youngest workers are associated with the lowest levels of productivity (although the small negative coefficient is not statistically significantly different from zero.) The coefficients on the proportions of workers aged 25-34 and 35-44 are positive and statistically different from zero, implying that these workers are more productive than the most mature workers (45 years and older) with the 35-44 year old group having the highest levels of labour productivity. We might have expected the younger workers, 25-34, to be somewhat less productive than the prime age
workers, but as we noted previously, the most mature group also includes the oldest workers whose productivity is also generally found to be below that of prime age workers.

The coefficients on the industry dummy variables are negative, which implies that output per hour of work is highest in the benchmark industry (Travel Services) once other variables are taken into account, namely the level of capital per unit of labour and the labour force variables from the HRM.

Table 2.4 reports the estimation results for a model that includes time dummy variables (excluding 2001, which is the reference year) along with all the variables included in the previous specification. Given the small sample size, it is extremely encouraging that many coefficients are robust when the time dummy variables are included. This increases our confidence that the estimated coefficients are supported by the data and not sensitive to changes in model specification. It may be useful to clarify the role of the industry and time dummy variables in Table 2.4. The inclusion of industry dummy variables allows for differences in labour productivity across industries. But these industry differences are averages over time, that is, the estimated inter-industry differences do not vary over time. Similarly, the time dummy variables allow for labour productivity variations over time – but these year-to-year variations are necessarily the same for every industry. It is the other variables (capital and labour force characteristics) that allow for or explain variations in labour productivity that are more complex than time-invariant inter-industry differences and industry-invariant differences over time.

First, consider the variables whose coefficients are essentially unchanged when the time dummy variables are included. These are: the proportion of part-time hours, the proportion of hours supplied by women and by immigrants and the share of hours supplied by workers in the 25-34 and 35-44 age groups. It’s reasonable to say that coefficients on these variables are fairly
robust. The coefficient on capital per worker remains positive and statistically significantly different from zero while shrinking to a more plausible numerical value. In an augmented Cobb-Douglas technology such as the model used here, the capital coefficient should reflect the share of total output that goes to capital (as opposed to labour). The estimate in Table 3.4 implies a capital share of 45%.

Interestingly, the inclusion of the time dummy variables changes the estimates of the coefficients on the industry dummy variables, some of which are positive and statistically significantly different from zero in the model reported in Table 3.4. Taking into account all the other variables in the model, the latest results imply that even accounting for differences in capital per worker, the transportation industries and recreation and entertainment have the highest levels of labour productivity.

Table 2.4– FGLS Estimates of HRM Model (Preferred Model)

<table>
<thead>
<tr>
<th></th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>z</th>
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<tbody>
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<td>.0087231</td>
<td>-1.30</td>
</tr>
<tr>
<td>D02</td>
<td>.0511</td>
<td>.0087201</td>
<td>5.86</td>
</tr>
<tr>
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<td>.0245</td>
<td>.012713</td>
<td>1.93</td>
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<td>.0669</td>
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<td>4.61</td>
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</table>

Breusch-Pagan LM for Heteroskedasticity: p-value 0.00
Wooldrige test for AR(1): p-value 0.01

The time coefficients themselves measure the changes in labour productivity over time, having allowed for the effects of the other variables. So, for example, to the extent that the labour force is maturing and capital per worker is increasing there is a concomitant increase in labour productivity over time. The time coefficients do not ‘double count’ these contributions, rather they measure changes over time that the other variables cannot explain. The time coefficients essentially provide estimates of the growth of annual labour productivity that comes about from unidentified sources (that is, sources not identified by this particular model). Moreover, the time coefficients can be identified directly as growth rates relative to the base year, 2001. Consider, for example, the coefficient on D07, which is 0.188. This implies, after the effects of the other variables are accounted for, labour productivity increased 18.8% between 2001 and 2007. On the other hand, labour productivity was about 2.4% higher in 2003 than it was in 2001. The negative coefficients on years prior to 2001 indicate to what extent productivity was below the level in 2001. Thus, the coefficient of -0.063 for 1997 suggests labour productivity that year was some 6% below the level in 2001. Over the entire period covered by the sample, labour productivity, as measured by the time dummy variable coefficients, is estimated to have grown a total of approximately 25.5% or about (25.5/10)% =
2.5 Productivity Analysis of Accommodation, Food and Beverages Industrial Group in Ten Provinces

Variations in labour productivity between provinces can only be studied at a level of aggregation for which such data are available. As far as the hospitality and tourism sector is concerned the only meaningful industry for which provincial data are available is the combined accommodation, food and beverage services industry. According to the Tourism Satellite Account, the proportion of industry output (supply) that is consumed by tourism demand is about 34.0% in 2002. This is a weighted average of tourism demand in accommodation (66.4%) and Food and Beverages (17.3%). The ratio of industry GDP to the total hours of labour supplied is the measure of labour productivity that is used in the following analysis. The data are available annually for all ten Canadian provinces between 1998 and 2007 inclusive, which gives a cross-section time-series sample of 100 observations.

In this study, characteristics of the labour force are taken from the Labour Force Survey (LFS) which provides data for this specific industry. Unlike the HRM of the TSA, the LFS records the highest level of educational achievement as well as other demographic details such as age. However, in the LFS there are just three age categories. Consequently, we use the proportion of workers who are between 15-24 years of age and between 25-54 years of age. These age categories are represented in the model as dummy variables. The omitted group of mature workers therefore serves as the benchmark against which the others are measured. Three

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7 A more precise calculation shows that the results imply an average compound rate of growth of labour productivity equal to 2.66%
variables representing capital intensity are included in the model. CapH is the value of physical capital per hour of labour input. ICTH refers specifically to information and communications technology per unit of labour input. Finally, the real value of public investment within the province is included. This variable is expressed in per capita terms by dividing the real value of public investment by the provincial population. Public investment includes public expenditures for the construction and renovation of government buildings, expenditures for infrastructure, and expenditures for machinery and equipment. Public investment in infrastructure is the largest component of total public investment. Public investment in infrastructure ranges from communication towers, electric power construction, waterways and canals, bridges, parking lots, sewage systems, waste disposal facilities, historical sites to roads and highways.

Labour force characteristics are represented by: the proportion of female (lnPFEM); the proportion of part-time (lnPPT); the proportion of workers in the 15-24 (lnp_15-24) and 25-54 (lnp_25-54) age categories; the proportion of workers with postsecondary certificate or degree (lnPOSTSEC); the proportion of immigrant workers (lnPIMMIG). All variables are in the natural logarithmic form. The diagnostic test results for heteroskedasticity and autocorrelation reported in the tables are the test results on the OLS results. The method of estimation is Feasible Generalised Least Squares (FGLS) which is used to correct for heteroskedasticity and AR(1)

<table>
<thead>
<tr>
<th>Table 2. 5– FGLS Estimates for AFB Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDPH</td>
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<tr>
<td>-------</td>
</tr>
<tr>
<td>lnCAPH</td>
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<tr>
<td>lnICTH</td>
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<td>lnPUBK</td>
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<td>lnPFEM</td>
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<td>-------</td>
</tr>
<tr>
<td>lnPPT</td>
</tr>
<tr>
<td>lnIMMIG</td>
</tr>
<tr>
<td>lnP_15-24</td>
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<tr>
<td>lnP_25-54</td>
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<td>lnPOSTSEC</td>
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<td>_cons</td>
</tr>
</tbody>
</table>

Breusch-Pagan LM for Heterskedasticity:p-value 0.04
Wooldridge test for AR(1):p-value 0.00

The first set of results are reported in Table 2.5 All three capital intensity variables have positive and statistically significant coefficients, which is what we would expect from economic theory and the empirical literature. According to these results, information and communications technology and public investment are very effective in boosting labour productivity in the accommodation and food and beverage industry. The proportion of part-time hours has a positive coefficient, which consistent with the results obtained with the HRM data. However, here we find the proportion of females is associated with lower average productivity. As in the HRM study, the proportion of immigrants in the labour force is positively related to average labour productivity.

Investment in human capital through the acquisition of a university degree or a post-secondary certificate is seen to raise labour productivity significantly. A ten percentage point increase in the proportion of the province’s labour force that holds a post-secondary certificate or a university degree is associated with a 0.4% increase in labour productivity.
Table 2.6- FGLS Estimates for AFB Model

<table>
<thead>
<tr>
<th>lnGDPH</th>
<th>Coef.</th>
<th>Std. Err.</th>
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<td>lnp_25-54</td>
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</table>

Breusch-Pagan LM for Heterskedasticity:p-value 0.03
Wooldridge test for AR(1):p-value 0.00

The results reported in Table 2.6 include provincial dummy variables. We have excluded provincial dummy variables that were shown to have coefficients not statistically different from zero. The omitted provinces are therefore judged to have similar levels of labour productivity, after taking into account inter-provincial differences in the variables included in the model (such as capital intensity and characteristics of the labour force). Of the included provinces, only B.C. is shown to have higher labour productivity than the omitted group – Newfoundland and Labrador - while productivity is lower in Nova Scotia, Ontario and Quebec. Not surprisingly the inclusion of the provincial dummy variables has an impact on some of the other coefficients. However, many remain statistically significantly different from zero.
Table 2.7 - FGLS Estimates for AFB Model (Preferred Model)

<table>
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<tr>
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<th>Coef.</th>
<th>Std. Err.</th>
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<td>SASK</td>
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<td>QUEBEC</td>
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<td>ONTARIO</td>
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<td>_cons</td>
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<td>.1161814</td>
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</tr>
</tbody>
</table>

Breusch-Pagan LM for Heterskedasticity: p-value 0.03
Wooldrige test for AR(1): p-value 0.00
A third specification is reported in Table 2.7 where time dummy variables are included for all years except 2003 which becomes the reference year against which the others can be evaluated. The year 1998 is represented by D98 and so on. Again, most of the previously statistically significant coefficients are robust to the inclusion of time dummy variables, the age group variables excepted. The coefficients on the time dummy variables represent percentage differences in labour productivity relative to the base year, which is arbitrarily set to 2003. According to these results, productivity was at a low point in 2003. It had risen 9% by 2007 and was apparently 5% higher in 1998 than in 2003. These results imply that over the entire sample period there was no net change in labour productivity beyond what is accounted for by investment in physical and human capital. In the six-industry HRM study the time dummy variables did detect a positive trend in productivity (averaged over all six industries) over and above what can be explained by the other variables. The two sets of results imply that the Accommodation and Food and Beverage Services industries probably did not contribute much to that trend productivity increase – it presumably has its source in the other four industries.

2.6 Extensions and Future Work

We believe that in this paper we have undertaken a thorough investigation of the extent to which the data available in the HRM of the TSA can be used to explain levels of labour productivity in six tourism industries. It is always possible to measure variables slightly differently and to look for others that might be included in the analysis. However, we believe there is little scope for any useful advances in this direction. Even if promising variables could be identified, the small sample size itself makes it unlikely that they could be accommodated in a statistical model. Further analysis of these data will likely have to wait until more data become available, as they will with the passage of time.
The second of our studies, which focused on the combined Accommodation, Food and Beverage Services industry benefitted from a slightly larger sample size, but nevertheless 100 observations constitutes a relatively small data set. Also, the regression is using public infrastructure investment instead of public infrastructure capital stock due to the availability of data. However, the investments of public infrastructure and its proper depreciation rate can be used to construct the capital stock for improving the model in the future. Again, it is unlikely that with the currently available data we will be able to find fruitful avenues of further research.

Instead, we suggest that further work on productivity in tourism industries should look at other sources of data and in particular the Workplace and Employee Survey (WES). Statistics Canada’s own description of this unique data set is as follows:\(^8\):

The survey aims to shed light on the relationships among competitiveness, innovation, technology use and human resource management on the employer side and technology use, training, job stability and earnings on the employee side.

The survey is unique in that employers and employees are linked at the micro data level; employees are selected from within sampled workplaces. Thus, information from both the supply and demand sides of the labour market is available to enrich studies on either side of the market.

To create the best conditions for growth in the knowledge-based economy, governments need to fine-tune their policies on education, training, innovation, labour adjustment, workplace practices, industrial relations and industry development. The results from the survey will help clarify many of these issues and will assist in policy development.

The Workplace and Employee Survey offers potential users several unique

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\(^8\) Information on WES is available at this site http://www.statcan.gc.ca/imdb-bmdi/indexW-eng.htm
innovations: chief among these is the link between events occurring in workplaces and the outcomes for workers. In addition, being longitudinal, it allows for a clearer understanding of changes over time.

As noted in the survey section, in the broader productivity literature there has been considerable interest in assessing the contribution of ICT to productivity growth. The purpose of the proposed research would be to examine the relationship between the use of information and communications technology as well as investment in education and training that is relevant to this technology and levels of productivity at the firm level specifically within the Canadian tourism sector. We are not aware of any studies, let alone Canadian studies, that specifically address the tourism sector. Statistics Canada staff have reviewed this proposal and determined that a sufficiently large sample exists for the study to be undertaken. The most significant challenge will be finding a cost effective way to select the appropriate sample and to conduct the research.

2.7 Conclusions and Recommendations

This paper has presented two related statistical studies. The first addresses the challenge of determining to what extent the labour force characteristics of workers in the six tourism industries identified in the HRM of the TSA contribute to labour productivity in those industries. We refer to this as the HRM study. There is a vast literature on the connections between demographic factors and productivity and this paper attempts to summarize the key findings that are relevant to the present study. In the main, the lessons from the broader literature are borne out here. Labour productivity is found to increase with the capital labour ratio, the proportion of part-time hours employed, the share of hours supplied both women and immigrants and with the share of prime-age workers. The fact that a relatively small sample of 66 observations yielded statistically significant results that broadly accord with the established literature is in itself an encouraging result provides a validation of the data contained in the HRM.
At first glance it may seem odd that productivity increases with the proportion of women that are employed. Our preferred explanation is that in this particular study being a woman is a proxy for being somewhat better educated so the economic returns to being female are really the economic returns to education. The HRM does not contain any information on educational attainment and yet it is well established that wages and productivity are higher for better educated workers. It has also been established that the proportion of Canadian university graduates who are female has increased noticeably over the past few decades so hiring females implies hiring people who on average have a higher educational attainment.

The positive effect of the proportion of immigrants on productivity is not so easily explained by the evidence available in this study although it is possible to speculate. The research literature shows that immigrants earn less than the Canadian born with similar characteristics and that the returns to education and labour market experience that have been accumulated outside Canada command a smaller premium than if those components of human capital had been developed in Canada. But this study did not focus on wages and earnings; rather the variable of interest is on productivity, that is, labour’s contribution to the value of production. Immigrants are selected and tend to have relatively high levels of education. One may speculate that as a group, immigrants tend to be highly motivated. While we present no direct evidence here, it could be that these characteristics are reflected in high levels of productivity (even if not in wage levels).

Finally the HRM study finds that there has been some ‘disembodied’ productivity growth. That is, growth that is not explained by the demographic factors or the quantity of capital per worker. The estimates are necessarily averaged over all six industries. To anticipate the results of the second empirical study, we find that this trend was not apparent in accommodation and food and
beverage services, so its source is presumably to be found in the other four industries.

The second study addresses productivity in the combined Accommodation, Food and Beverage Services industry – we refer to this as the AFB study. The combined industry is sufficiently large for data to be available on a provincial basis so we are able to analyse productivity changes over a ten year period within ten provinces, giving a sample of 100 observations. In the AFB study, data are drawn from a wide range of sources. In particular, we use information on the educational achievement of workers and find that higher levels of education are associated with higher productivity – but being female in this industry does not raise productivity when education is controlled for. It is interesting that the two studies are otherwise in broad agreement. Productivity is found to increase with capital per worker, the proportion of immigrants, the proportion of part-time workers and the proportion of workers who are close in age to the so-called prime age group for whom productivity is greatest.

The AFB study also incorporated provincial public investment per capita and industry investment in information and communications technology per hour of labour input. Both of these forms of capital were found to have a positive effect on labour productivity, which is consistent with the broader literature.

In principle, it should be possible to compare levels of productivity across provinces and to do this we included so-called provincial dummy variables. The statistical results are mixed in that there is some shifting depending on whether or not time dummy variables are also included. It must be recognized that with 100 observations, not all questions will be answered by the data with robust and highly precise numerical estimates. Looking at the results as a whole, it would seem that after accounting for the effects of the included variables, Ontario, Quebec and Nova Scotia appear to have lower levels of labour productivity. However it is important to note that
these dummy variables are measuring residual productivity differences after account has been taken of other effects (say from capital per worker and average levels of education).

2.7.1 **Recommendations:**

1. The HRM contains a great deal of interesting information on the characteristics of workers in tourism industries with one obvious omission, namely any measure of educational achievement. Given the demonstrated importance of human capital for labour productivity, we recommend that this dimension be added to the data base.

2. While recognizing that data is costly to acquire, we nevertheless would support the development of the HRM in the provincial dimension.

3. Further work on productivity in tourism industries in Canada would be most fruitful if it is based on alternative data sources and we have suggested that the WES is the ideal candidate. It is firm level data that surveys both employees and employers. It has a focus on investment in training and in ICT. Such a study would shed considerable light on the potential of ICT and related training to raise productivity in this service industry.
Appendix A

Figure 2.4. 1– Shares of Hours Contributed by Employees Aged 25-34, by Industry

Figure 2.4. 2- Shares of Hours Contributed by Employees Aged 25-34, by Industry
Figure 2.5. 1– Shares of Hours Contributed by Employees Aged 35-44, by Industry

Figure 2.5. 2– Shares of Hours Contributed by Employees Aged 35-44, by Industry
Figure 2.6. 1– Shares of Hours Contributed by Employees Aged 45 and Older, by Industry

Figure 2.6. 2– Shares of Hours Contributed by Employees Aged 45 and Older, by Industry
Figure 2.7. 1– Shares of Hours Contributed by Female, by Industry

Figure 2.7. 2– Shares of Hours Contributed by Female, by Industry
Figure 2.8. 1– Shares of Hours Contributed by Immigrants, by Industry

Figure 2.8. 2– Shares of Hours Contributed by Immigrants, by Industry
Appendix B – Data Sources and Analytical Methods

Data Sources – the Human Resource Module (HRM) Model

The HRM model uses annual data for all of Canada, which is the only frequency and geographical definition that is available. The six tourism/hospitality industries are defined within the Canadian Tourism Satellite Account: air transportation, other transportation, accommodation, food and beverage services, recreation and entertainment, and travel services. This dataset contains 66 observations from six national level tourism/hospitality industry groups for the period 1997 to 2007. Four data sources are used to create this model’s cross-sectional time-series data set. The dependent variable, labour productivity is real industry GDP per hour worked. Annual real industry GDP for six tourism industries is provided by Statistics Canada’s Productivity Accounts. The hours of work supplied to each of the six industries is provided by the Human Resource Module (HRM) of the TSA. The method of reconciling the tourism demand-oriented GDP data and the tourism supply-oriented HRM data is explained in detail in the main body of this report – it uses information in the TSA. Labour force characteristics, such as age, gender, immigrant status, and the role of part-time workers are also provided by Human Resource Module of Tourism Satellite Account. Age groups in the HRM model are aggregated by Statistics Canada as follows: 15-24 years old, 25-34 years old, 35-44 years old and 45 years old and up. The model uses the end-of-year gross capital stock in chained (2002) dollars which is provided by Statistics Canada’s Economic Accounts for each of the six industries. The capital intensity variable is computed as the real capital stock divided by hours worked. Table A1 provides a summary of the data sources for the HRM study.
**Data Sources – the Accommodation, Food and Beverage Services (AFB) Model**

The AFB model uses annual data for a single combined industry. The advantage of using a combined industry, namely Accommodation, Food and Beverage Services, is that the data have a provincial dimension. The dataset contains 100 observations from Canada’s 10 provinces for the period: 1998 to 2007. Six data sources are used to create this study’s cross-sectional time-series data set. A summary of the data sources is provided in Table A2. The dependent variable is labour productivity measured by real GDP per hour worked. Real GDP is drawn from the provincial Input-Output Accounts and the number of hours is taken from Statistics Canada’s Productivity Accounts. The Labour Force Survey (LFS) provides information on work force characteristics such as age, gender and the level of education. The age groups available in the LFS are: 15- 25 years old, between the ages of 25 and 54, and over age 55. The role of immigrants in provincial production is not available as a direct measure. We have constructed a proxy using information from the HRM (which provides hours supplied by immigrants at the national level) and data on immigrant populations available from provincial Mobility and Migration surveys.

The AFB model makes uses information on three types of physical capital. Two of these are measures that are available for the specific industry under consideration and are divided by hours of labour supplied to this industry. Thus, the total capital stock is provided by provincial Economic Accounts and the input of information and communication technologies (ICT) is obtained from the provincial Input-Output Accounts – both measures are specific to the Accommodation, Food and Beverage Services industry. Public investment is a proxy for infrastructure investment and is drawn from provincial Income-Expenditure Accounts. It supports all industries, not just the AFB industry. Public investment per capita is computed as
the ratio of real provincial infrastructure investment to the provincial population, which of course is not industry specific. The GDP deflator is obtained from the provincial Economic Accounts and is used to deflate ICT input and public investment.

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<td></td>
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<td>Tourism Satellite Account</td>
<td>share of tourism GDP in tourism/hospitality industries</td>
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<tr>
<td>Human Resource Module of Tourism Satellite Account</td>
<td>number of hours-worked and jobs and workforce characteristics in tourism/hospitality industries: type of jobs, gender, immigrant status, and age</td>
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<td>Flows and Stocks of Fixed Non-Resident Capital</td>
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**Table 2.9- AFB Model Variables and Their Data Sources**

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<td>Input-Output Account</td>
<td>information and communication technology input, provincial level GDP, GDP deflator</td>
<td>3800056, 3810013, 3790025</td>
</tr>
<tr>
<td>Productivity Account</td>
<td>Number of hours-worked</td>
<td>3830010</td>
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<tr>
<td>Mobility and Migration</td>
<td>International immigrants</td>
<td>510011</td>
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<tr>
<td>Labour Force Survey</td>
<td>Provincial level workforce characteristics: gender, type of jobs, education, age</td>
<td>2820008</td>
</tr>
<tr>
<td>Estimates of Total Population, Canada, Provinces and Territories</td>
<td>Provincial population</td>
<td>510005</td>
</tr>
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</table>
Statistical Methods for both the HRM and AFB Models

In order to estimate the two models’ parameters we used the statistical program STATA and in particular the Feasible Generalized Least Squares procedure which is applicable to panel data sets such as the ones used here. We test and make adjustments for heteroscedasticity and autocorrelation. The estimation procedure should provide consistent parameter estimates. Detailed statistical output is available on request.
Appendix C: Tourism industries in the HRM of TSA

North American Industry Classification System (NAICS) 2002

1. Transportation

Air transportation
4811 – Scheduled air transport
4812 – Non-scheduled air transport

All other transportation industries
4821 – Rail transportation
4831 – Deep sea, Coastal and Great Lakes water transportation
4832 – Inland water transportation
4851 – Urban transit systems
4852 – Interurban and rural bus transportation
4853 – Taxi and limousine service
4854 – School and employee bus transportation
4855 – Figureeer bus industry
4859 – Other transit and group passenger transportation
4871 – Scenic and sightseeing transportation, land
4872 – Scenic and sightseeing transportation, water
4879 – Scenic and sightseeing transportation, other
5321 – Automotive equipment rental and leasing

2. Accommodation
7211 – Traveller accommodation
7212 – RV (recreational vehicle) parks and campgrounds

3. Food and beverage services
7221 – Full-service restaurants
7222 – Limited-service eating places
7224 – Drinking places (alcoholic beverages)

4. Recreation and entertainment
51213 – Motion picture and video exhibition
7111 – Performing arts companies
7112 – Spectator sports
7115 – Independent artists, writers and performers
7121 – Heritage institutions
7131 – Amusement parks and arcades
7132 – Gambling industries
7139 – Other amusement and recreation industries

5. Travel services
5615 – Travel arrangement and reservation services
Chapter Three  Productivity Analysis Using Statistics Canada's KLEMS Data to Estimate Dynamic Factor Demand Model

3.1  Introduction

This paper presents the results of an empirical analysis of productivity changes in the Canadian hospitality and tourism industries over the period 1983 to 2003. The study takes advantage of the comprehensive Canadian industry database known as KLEMS. The KLEMS acronym identifies five inputs (factors of production) used in the production process: capital, labour, energy, materials and services. The KLEMS database also includes information on factor prices as well as industry output. Consequently this dataset is ideally suited to an analysis of total factor productivity at the industry level. It has been used for this purpose by Sharpe and Arsenault (2009) but the present study is the first to use this unique dataset to investigate Canada’s hospitality and tourism industries.

The concept of productivity measures the effectiveness of capital, labour and other inputs in the process of producing goods and services (output). Investment in both physical and human capital allows more output to be produced with a given level of inputs. Changes in productivity can therefore be calculated by comparing the growth of output with the growth of inputs. To the extent that over a particular time interval, output grows faster than inputs, there is evidence that productivity has increased.

This is the basis of the widely used Divisia Index approach to calculating total factor productivity. On the input side it is clear that firms and industries use a number of distinct inputs such as labour, physical capital, energy and so on. The overall growth of inputs is therefore a weighted average of the growth rates of the individual inputs. The Divisia Index method uses
the expense shares as the weights, so if twice as much is spent by a firm on labour as on capital, the input index weights the growth of labour input twice as heavily as the growth of capital input. As the expense shares change over time, so too do the weights used in the Divisia Index. Similarly, firms and industries typically produce a range of distinct outputs. The growth of overall output can be computed as a weighted average of the growth of individual outputs. The Divisia Index method uses the relative dollar values of output (revenue shares) as the weights. The growth of Total Factor Productivity (TFP) over a specific time interval, such as a year, is calculated by subtracting the growth of the input index from the growth of the output index. The KLEMS dataset contains the information required to calculate the growth of TFP using the Divisia Index method and the results of these calculations are presented in this report.

The accuracy of the Divisia Index method rests on a number of assumptions that may not hold precisely in practice. For example, if a production process benefits from economies of scale, a 10% increase in all inputs will result in an increase in output by something in excess of 10%. In this case, the Divisia Index approach to calculating productivity growth will attribute the scale effect to an improvement in Total Factor Productivity since all of the difference between output growth and input growth is attributed to a change in TFP. In fact, the Divisia Index approach implicitly assumes the production process exhibits constant returns to scale, that is a 10% increase in all inputs will generate a 10% increase in output. An improved method would be not make such a restrictive assumption and would be able to distinguish a scale effect from enhanced TFP. Similarly, over the business cycle there are likely to be variations in the utilization rates of inputs such as capital and labour. During an economic downturn a firm could find that it has excess capacity particularly with respect to physical capital. The firm may also prefer to retain labour that is expensive to train rather than risk losing employees that will likely
be needed when demand picks up. The Divisia Index method does not take account of such variations in input utilization rates and is consequently subject to another potential source of bias in the estimates of TFP growth. For example, during the recovery phase following a recession, increases in output may be supported by higher utilization rates of capital and labour and there might not be any measurable increase in inputs – no new investment in physical capital and no new hiring of personnel. In this situation, the increase in output would be attributed to an increase in TFP by the Divisia Index approach and not to higher rates of factor utilization.

In a series of papers Nadiri and Prucha (Nadiri and Prucha, 1986, 1990, 1996, 1999 and 2001) have developed a remarkably flexible framework for computing TFP that relaxes many of the restrictive assumptions inherent in the Divisia Index methodology. This study makes use of the Nadiri and Prucha (2001) model to provide a rich set of observations on the Canadian hospitality and tourism industries. In the Nadiri and Prucha framework, firms maximize the present value of their future profit stream and in so doing choose their level output and determine the optimal input levels of labour, capital and so on. These calculations are recomputed every period in the light of new information. In the short run, firms use both variable and quasi-fixed inputs. Variable inputs can be adjusted fully from one period to another. Quasi-fixed inputs are costly to adjust and so firms do not immediately jump to the long run equilibrium level of quasi-fixed inputs.

The statistical estimation results in a rich set of information on the production process. In particular, the sensitivities of input demands to factor prices are measured through both short run and long run price elasticities (for example, how much does the demand for labour change when industry wages rise). When energy prices rise, firms will economize on energy use. The reaction to a potentially permanent increase in energy prices is likely to be less in the immediate
future than it will be after a period of time – hence the distinction between short and long run price elasticities. Features of the industry’s technology are captured by such measures a scale economies and the degree of substitutability between the various inputs. Economies of scale indicate whether an expansion of output can be achieved through constant, rising or falling average unit costs. The substitutability of inputs reveals to what extent capital investment can, for example, reduce energy use or hours of labour per unit of output. Finally, the estimated model is capable of decomposing the Divisia Index measure of Total Factor Productivity into a rigorously defined measure of TFP and the biases that result from the presence of scale economies and variations in factor utilization rates.

3.2 Literature Review

The models of industrial demand for factor inputs can be often grouped into two categories, static models and dynamic models. According to Pindyck and Rotemberg (1983) and Morana (2007), a static model implicitly assumes that all factor inputs adjust instantaneously to their long-run equilibrium values and cannot depict real economic activity, where the adjustment process can only be gradual. Dynamic factor demand models were introduced to deal with the problems of neglected dynamics, such as parameter instability and serially correlated residuals. The dynamic factor demand models used in this study is the third generation dynamic factor demand models. According to Morrana (2007), the key feature of third generation factor demand models is the introduction of adjustments costs for quasi-fixed inputs. This study expands the dynamic factor demand models purposed in Nadari and Prucha (1990), by using material, energy and labour as variable inputs and distinguishing non-information-&-communication technology capital and information & communication technology capital. According to Mun (2002), the traditional neoclassical model of investment assumes that there exist internal adjustment costs
from expansion of physical capital stock. Goth (2005) suggests the period of 1990s displays high growth in investment in ICT in United Kingdom and the U. S. and there exist adjustment costs for ICT capital.

Decomposition of TFP growth allows people to identify the sources of productivity growth. The impact of technological change on productivity growth is a major concern in tourism/hospitality sector. Barros and Alves (2004) analyzed the efficiency of a Portuguese public-owned hotel chain, Enatur, with data envelopment analysis (DEA). The study estimate total factor productivity change which is broken into technological change and technical efficiency. The study revealed that many hotels achieved efficient technical change but no technological change and concluded that Enatur needs organizational governance, with incentives, transparency, and accountability. The competition stimulates growth and innovation. More often, it assumes that productivity is mostly driven by physical and human capital, innovation and competitive environment. Botti et. al.(2010) analyzed productivity growth and sources of technological change in Portuguese travel agencies sector in the period 2000-2004 by using the Luenberger productivity indicator for estimating and decomposing productivity change into efficiency change and technological change. The authors also decomposed the process of technological change to study the sources of bias within it. The findings indicated that improvement of technological change is the most important source for productivity growth in the travel agencies sector and most of the travel agencies experienced a capital-saving and wage-using bias.

According to Callan (1991) and Karagiannis and Mergos (2000), to obtain precise measures of TFP and reliable decomposition of its sources within the parametric approach, the appropriate behavioural and structural assumptions have to be correctly specified. Using
parametric approach, the focus of improvement of theoretical framework of TFP measurement and attribution has been based on duality and on cost function. Denny et al. (1981), Morrison (1986, 1992), Berndt and Fuss (1986), Nadiri and Prucha (1990) incorporated the impact of technical change, returns to scale and capacity utilization in TFP changes for competitive, monopolistic and regulated firms in manufacturing sector. Chen and Soo (2007) used a multi-product translog cost function to investigate economies of scale and scope, the price elasticity and elasticity of substitution of factor inputs, and technological progress in the Taiwanese international tourist hotels. This study used the dataset which consisted of annual data on 47 Taiwanese international tourist hotels (four- and five star equivalent) from 1997 to 2001. It found there exists both scale and scope economies in the Taiwanese international tourist hotels and the productivity and technological improvements.

3.3 The Theoretical Model

Assume the production process of a representative firm that uses m variables and n quasi-fixed inputs to produce a single output good Y for any period t can be described by the following generalized production function$^9$:

$$Y_t = Y(V_t, F_{t-1}, \Delta F_t, T_t)$$

Where $Y_t$ is output, $V_t = V_{it}$ ($i=1,\ldots,m$) is a vector of variable inputs, $F_t = F_{it}$ ($i=1,\ldots,n$) is a vector of the end of period stocks of the quasi-fixed inputs, $\Delta F_t = F_t - F_{t-1}$ is a vector to internalize the adjustment costs$^{10}$ into the production function in terms of forgone output due to changes in the stocks of quasi-fixed inputs, and $T_t$ is a technology index.

---

$^9$ $Y(\cdot)$ is twice continuously differentiable and $Y(\cdot)>0$, $Y_{x\cdot}>0$ and $Y_{xx}<0$. $Y(\cdot)$ is strictly concave in all arguments (except possibly in technology index).

$^{10}$ A change in the levels of the quasi-fixed factors will result in costs of adjustment due to the necessity of devoting resources to change the input stock rather than producing output.
The real investments of the quasi-fixed inputs (motion for quasi-fixed input) are defined as

\[ I_{it} = F_{it} - (1-\delta_i)F_{it-1} \]

where \( \delta_i \) denotes to the depreciation rate of the stock of quasi-fixed input.

According to the principle of duality in production theory, given the production function, under appropriate regularity conditions, it is possible to derive an unique corresponding firm’s total minimum cost function \( C(w, Y) \) as the solution to the problem of minimizing the cost of producing a specified level of output.

\[
C(w, Y) = \min_x \{ xw : f(x) \geq Y \}
\]

where \( x \) is a vector of input quantities and \( w \) is a vector of input prices.

The regularity conditions required on the cost function are:

I) if \( w \geq w' \), then \( C(w, Y) \geq C(w', Y) \), \( w > 0 \), which requires that \( C(\cdot) \) is nondecreasing in \( w \);

II) \( C(\lambda w, Y) = \lambda C(w', Y) \), \( \forall \lambda > 0 \), \( w > 0 \), which ensures that \( C(\cdot) \) is positive homogeneous of degree one;

III) \( C(\lambda w + (1- \lambda)w^*, Y) \geq \lambda C(w', Y) + (1- \lambda)C(w^*, Y) \), \( 0 \leq \lambda \leq 1 \), \( w', w^* > 0 \), which requires that \( C(\cdot) \) is concave.

IV) \( C(w, Y) \) is a continuous function of \( w \), for \( w > 0 \), which requires \( C(\cdot) \) to be a continuous function of \( w \).

As a result, we can describe the production structure equivalently in terms of restricted cost function. We assume the firm faces perfectly competitive markets with respect to its factor inputs. The acquisition price for the variable and quasi-fixed inputs are denoted as \( \hat{p}_i^V \) \((i = 1,...,m)\) and \( \hat{p}_i^F \) \((i = 1,...,n)\), respectively. It proves convenient to normalize all prices in terms of the price of the first variable factor. We denote normalized prices as \( p_i^V = \hat{p}_i^V / \hat{p}_{1i}^V \) and \( p_i^F = \hat{p}_i^F / \hat{p}_{1i}^V \). The normalized restricted cost function\(^{11} \) is defined as

\[
G(p_i^V, F_{t-1}, \Delta F, Y, T_r) = \sum_{i=1}^{m} p_i^V \psi_i
\]

\(^{11}\) Restricted cost function is short-run cost function. According to Jehle and Reny (2001), “when the firm is “stuck” with fixed amounts of certain inputs in the short run, rather than being free to choose those inputs optimally as it can in the long run, we should expect its costs in the short run to differ from its costs in the long run.”
where $\hat{V}_t = \{\hat{V}_m\}$ is the cost minimizing variable inputs needed to produce output Y, conditional on $F_{t-1}$ and $\Delta F_t$

The firm’s cost in period t is described as

$$C = G(p_t^Y, F_{t-1}, \Delta F_t, Y_t, T_t) + \sum_{i=1}^{n} p_t^X I_{it}$$

The dynamic programming problem facing the firm is assumed to minimize the expected present value of current and future cost given the initial value of the quasi-fixed inputs. The firm’s optimization problem can be specified by two alternatives regarding to the length of the planning horizon. The first case is an infinite planning horizon in which the firm, in each period, derives an optimal plan for the quasi-fixed inputs for periods $t, t+1, ...$ and then the firm chooses its quasi-fixed inputs in period $t$ by this plan. The second case is a finite but shifting planning horizon in which, according to Nadiri and Prucha (1982, 1986, 1990), the stocks of the quasi-fixed inputs at the end of the planning horizon are assumed to be determined endogenously subject to the assumption of static expectations and a constant firm size beyond the planning horizon. As Nadiri and Prucha (1986, 1990) suggested, the optimal plans for the finite horizon model converge rapidly to those of the infinite horizon model as the planning horizon extends. Hence, we use optimal plans for infinite planning horizon. The firm’s intertemporal cost minimization problem with respect to the quasi-fixed factors is defined as

$$EPV(0) = \min_{F} E_t \sum_{\tau=0}^{\infty} C(F_{t+\tau}, F_{t+\tau-1}, \bar{\sigma}_{t+\tau}) (1 + r_t)^{-\tau}$$

subject to the equation of motion of quasi-fixed inputs. EPV is expected present value. $E_t$ is the expectations in time $t$ and $r_t$ is real discount factor. $\bar{\sigma}$ is a vector composed of normalized factor
prices, Y and T.

3.4 Empirical Model

The model is specified to the employment of optimal levels of material (M), energy (E), labour (L), non-information and communication technology (non-ICT) capital (K), and information and communication technology (ICT) capital (A). Material, energy and labour are defined as variable inputs, while non-ICT capital and ICT capital are defined as quasi-fixed capital. We assume material, energy and labour can be adjusted instantaneously in response to a change in relative input prices, and the adjustment of the stocks of capital responding to a change in relative input prices will be slow. \( p^E, p^L, p^K, \) and \( p^A \) denote to energy price, labour price, acquisition price of non-ICT capital and acquisition price of ICT capital normalized by material price, respectively. We solve the following dynamic cost minimisation problem with respect to the quasi-fixed factors with static expectation:

\[
\min_{\{K_{t,t+\tau},I_{t,t+\tau}\}} \sum_{\tau=0}^{\infty} \left[ G(p^E_i, p^L_i, K_{i,t+\tau-1}, A_{i,t+\tau-1}, \Delta K_{i,t+\tau}, \Delta A_{i,t+\tau}, Q_{i,t+\tau}, T_{i,t+\tau}) + p^E_i I_{i,t+\tau} + p^K A_{i,t+\tau} \right] (1+r_i) \tau)
\]

s.t.

\[
I_{i,t+\tau} = K_{i,t+\tau} - (1-\delta)K_{i,t+\tau-1}
\]

\[
H_{i,t+\tau} = A_{i,t+\tau} - (1-\mu)A_{i,t+\tau-1}
\]

where I is real investment in non-ICT capital and H is real investment in ICT capital. Depreciation rates of non-ICT capital and ICT capital are denoted by \( \delta \) and \( \mu \). \( r \) denotes to discount rate.

According to Theil (1957) and Robles (1995), the optimal input paths in period \( t \) that correspond to the stochastic control problem are equivalent to those obtained by invoking
certainty equivalence\(^{12}\) and solving the non-stochastic dynamic control problem as \(G(\cdot)\) is assumed to take a quadratic form. Introduced by Denny et al. (1981) and Morrison and Berndt (1981), normalized restricted cost function, \(G(\cdot)\), is expressed in quadratic form as following

\[
G(p_{i,t}^L, p_{i,t}^E, K_{i,t-1}, A_{i,t-1}, \Delta K_{i,t}, \Delta A_{i,t}, Q_{i,t}, T_{i,t}) = M_{i,t} + p_{i,t}^L L_{i,t} + p_{i,t}^E E_{i,t} = \\
\left[ \alpha_o + \alpha_l p_{i,t}^L + \alpha_e p_{i,t}^E + \alpha_T T_{i,t} + \alpha_{it} T_{i,t} p_{i,t}^L + \alpha_{te} T_{i,t} p_{i,t}^E + \frac{1}{2} \alpha_{il} (p_{i,t}^L)^2 + \frac{1}{2} \alpha_{ec} (p_{i,t}^E)^2 \right] Q_{i,t} \\
+ \alpha_k K_{i,t-1} + \alpha_A A_{i,t-1} + \left[ \frac{1}{2} \alpha_{kk} K_{i,t-1}^2 + \frac{1}{2} \alpha_{aa} A_{i,t-1}^2 + \frac{1}{2} \alpha_{kk} \Delta K_{i,t}^2 + \frac{1}{2} \alpha_{aa} \Delta A_{i,t}^2 \right] Q_{i,t} \\
+ \alpha_{lk} p_{i,t}^L K_{i,t-1} + \alpha_{ka} p_{i,t}^E A_{i,t-1} + \alpha_{te} T_{i,t} A_{i,t-1} + \alpha_{Ta} A_{i,t-1} T_{i,t} \\
(4)
\]

The above normalized restricted cost displays linearly homogeneous technology, which can be described in a general form

\[
G\left( p_{i,t}^L, p_{i,t}^E, K_{i,t-1}, A_{i,t-1}, \Delta K_{i,t}, \Delta A_{i,t}, Q_{i,t}, T_{i,t} \right) Q_{i,t} \\
(5)
\]

In the steady state for quasi-fixed inputs, marginal adjustment costs have to be zero when \(\Delta K\) and \(\Delta A\) are equal to zero. According to Denny et al. (1981a) and Morrison and Berndt (1981), \(\partial G(\cdot)/\partial \Delta K = 0\) and \(\partial G(\cdot)/\partial \Delta A = 0\) will be zero at \(\Delta K = \Delta A = 0\) only when we impose the following parameter restrictions:

\[
\alpha_k = \alpha_{\dot{k}} = \alpha_{kk} = \alpha_{\dot{a}} = \alpha_{ka} = \alpha_{\dot{k}a} = \alpha_{\dot{a}k} = \alpha_{\dot{a}a} = \alpha_{Tk} = \alpha_{Ta} = 0 \\
(6)
\]

Furthermore, Morana (2007) stated that the separability is an issue of fundamental importance in empirical analysis, which is normally associated with substitution. The assumption of separability is necessary to sustain efficient two-stage allocation procedures\(^{13}\). A weak

\[12\] Certainty Equivalence Principle: The decision rule that solves the stochastic optimal linear regulator problem is identical with the decision rule for the corresponding nonstochastic linear optimal regulator problem. The certainty equivalence principle is a special property of the optimal linear regulator problem and comes from the quadratic objective function, the linear transition equation, and the property \(E(x_{t+1} | x_t) = 0\). — Ljungqvist and Sargent (2004)

\[13\] Robles (1995) described the two-stage optimization procedure as: (1) the normalized restricted-cost function includes the solution for the optimal variable factor-demand schedules conditional on the quasi-fixed (restricted)
separability of production function with respect to the partition selected requires the marginal rate of substitution between any two production inputs is independent of the quantities of the inputs belonging to the other subset. Following Nadiri and Prucha (1990) and Robles (1995), the assumption of separability in the quasi-fixed inputs greatly simplifies the derivation of the model. In our case, the separability in quasi-fixed inputs implies \( \alpha_{ka} = \alpha_{k\bar{a}} = 0 \).

The convexity and concavity conditions of the normalized restricted-cost function under separability imply that: \( \alpha_{kk} > 0, \alpha_{aa} > 0, \alpha_{\bar{a}a} > 0, \alpha_{k\bar{k}} > 0, \alpha_{li} < 0, \alpha_{ee} < 0 \)

The optimal input paths of investment in non-ICT capital and ICT capital must satisfy the necessary conditions given by the Euler equations obtained by solving (1), (2) and (3) with respect to \( K \) and \( A \):

\[
-\alpha_{kk} K_{i,t+\tau} + [\alpha_{kk} + (2 + r_t)\alpha_{k\bar{k}}]K_{i,t+\tau} - (1 + r_t)\alpha_{k\bar{k}} K_{i,t+\tau-1} = -1\left( (1 + \delta) p_{i,t}^K + \alpha_k + \alpha_{kk} p_{i,t}^L + \alpha_{ek} p_{i,t}^E + \alpha_{ek} T_{i,t} \right) Q_{i,t}^K
\]

(7)

\[
-\alpha_{\bar{a}a} A_{i,t+\tau} + [\alpha_{aa} + (2 + r_t)\alpha_{a\bar{a}}]A_{i,t+\tau} - (1 + r_t)\alpha_{a\bar{a}} A_{i,t+\tau-1} = -1\left( (1 + \mu) p_{i,t}^A + \alpha_a + \alpha_{ka} p_{i,t}^L + \alpha_{ea} p_{i,t}^E + \alpha_{ea} T_{i,t} \right) Q_{i,t}^A
\]

(8)

The following transversality conditions rule out the unstable roots for the Euler equations:

\[
\lim_{\tau \to \infty} (1 + r_t) (\alpha_{kk} K_{i,t+\tau} - \alpha_{k\bar{k}} K_{i,t+\tau-1}) = 0, \lim_{\tau \to \infty} (1 + r_t) (\alpha_{aa} A_{i,t+\tau} - \alpha_{a\bar{a}} A_{i,t+\tau-1}) = 0,
\]

The solutions corresponding to the stable roots for the Euler equations can be expressed in the accelerator equations.

\[
\text{inputs and the change in the quasi-fixed (restricted) inputs; and (2) the dynamic solution for the quasi-fixed (restricted) inputs is found by obtaining their long-run equilibrium values while minimizing the present value of costs.}
\]

14 Goldman and Uzawa (1964) prove that weak and strong separability impose specific restrictions on the underlying cost and production functions.
\[ \Delta K_{i,t} = m_{kk} (K_{i,t}^* - K_{i,t-1}) \]  
\[ \Delta A_{i,t} = m_{aa} (A_{i,t}^* - A_{i,t-1}) \]  
\[ m_{kk} = \frac{1}{2} \left( r_{i} + \alpha_{kk} / \alpha_{kk} \right) - \left( r_{i} + \alpha_{kk} / \alpha_{kk} \right)^2 + 4 \alpha_{kk} / \alpha_{kk} \right]^{1/2} \]  
\[ m_{aa} = \frac{1}{2} \left( r_{i} + \alpha_{aa} / \alpha_{aa} \right) - \left( r_{i} + \alpha_{aa} / \alpha_{aa} \right)^2 + 4 \alpha_{aa} / \alpha_{aa} \right]^{1/2} \]  
\[ K_{i,j}^* = -\alpha_{kk}^{T} \left[ r_{i} + \delta \right] p_{i,j}^{E} + \alpha_{k} + \alpha_{ik} p_{i,j}^{L} + \alpha_{ik} p_{i,j}^{E} + \alpha_{ie} T_{i,j} \right] Q_{i,j} \]  
\[ A_{i,j}^* = -\alpha_{aa}^{T} \left[ r_{i} + \mu \right] p_{i,j}^{A} + \alpha_{a} + \alpha_{ia} p_{i,j}^{L} + \alpha_{ia} p_{i,j}^{E} + \alpha_{ie} T_{i,j} \right] Q_{i,j} \] 

Substituting the steady-state solutions for the Euler equations, (9.5) & (9.6), and the form of the adjustment coefficients, (9.3) & (9.4), into the accelerator equations, (9.1) & (9.2), respectively, and we yield the optimal quasi-fixed input path for non-ICT capital, K and ICT capital, A:

\[ \Delta K_{i,t} = -\left( \frac{1}{2} \right) \left[ r_{i} + \alpha_{kk} / \alpha_{kk} \right] - \left( r_{i} + \alpha_{kk} / \alpha_{kk} \right)^2 + 4 \alpha_{kk} / \alpha_{kk} \right]^{1/2} \]  
\[ \Delta A_{i,t} = -\left( \frac{1}{2} \right) \left[ r_{i} + \alpha_{aa} / \alpha_{aa} \right] - \left( r_{i} + \alpha_{aa} / \alpha_{aa} \right)^2 + 4 \alpha_{aa} / \alpha_{aa} \right]^{1/2} \] 

By Shephard’s Lemma we obtain the variable inputs demand equations for labour, L, energy, E and material, M:

\[ L_{t} = \frac{\partial G(\cdot)}{\partial p_{i,j}^{L}} = \left( \alpha_{l} + \alpha_{q} p_{i,j}^{L} + \alpha_{el} p_{i,j}^{E} + \alpha_{el} T_{i,j} \right) Q_{i,j} + \alpha_{ik} K_{i,j-1} + \alpha_{ia} A_{i,j-1} \]  
\[ E_{t} = \frac{\partial G(\cdot)}{\partial p_{i,j}^{E}} = \left( \alpha_{e} + \alpha_{ee} p_{i,j}^{E} + \alpha_{el} p_{i,j}^{L} + \alpha_{el} T_{i,j} \right) Q_{i,j} + \alpha_{ek} K_{i,j-1} + \alpha_{ea} A_{i,j-1} \] 

Due to G(\cdot) = M_{t} + p_{i,j}^{L} L_{t,j} + p_{i,j}^{E} E_{t,j}, we get

\[ M_{t} = G(\cdot) - p_{i,j}^{L} L_{t,j} - p_{i,j}^{E} E_{t,j} = \left[ \alpha_{o} + \alpha_{T} T_{i,j} - \frac{1}{2} \alpha_{ll} (p_{i,j}^{L})^2 - \frac{1}{2} \alpha_{ee} (p_{i,j}^{E})^2 - \alpha_{el} p_{i,j}^{L} p_{i,j}^{E} \right] Q_{i,j} + \alpha_{k} K_{i,j-1} + \alpha_{a} A_{i,j-1} \]  
\[ + \left[ \frac{1}{2} \alpha_{kk} (K_{i,j-1}^2) + \frac{1}{2} \alpha_{aa} \left( A_{i,j-1}^2 \right) + \frac{1}{2} \alpha_{kk} \left( \Delta K_{i,j}^2 \right) + \frac{1}{2} \alpha_{aa} \left( \Delta A_{i,j}^2 \right) \right] Q_{i,j} \]  
\[ + \alpha_{kl} K_{i,j-1} T_{i,j} + \alpha_{la} A_{i,j-1} T_{i,j} \] 

The entire estimation system consists of the three variable inputs demand equations and the two
optimal quasi-fixed input path equations (10) to (14), with stochastic error terms added to each of these equations. These error terms capture the random error in cost minimization. The system of equations is non-linear in both the parameters and the variables.

3.4 Data and Estimation

3.4.1 Data Source

The system equations are estimated with time-series cross-sectional industrial level data for 8 four-digit Canadian tourism industries in the period 1983 to 2003. During this period, the ICT developed quickly, and there exhibited high growth in investment in ICT. The eight Canadian tourism industries, which are identified by Canada Tourism Satellite Account, include air transportation, rail transportation, water transportation, transit and ground passenger transportation, scenic and sightseeing transportation and support activities for transportation, arts, entertainment & recreation, motion picture and sound recording, and accommodation and food services. The data was collected from multiple data sources. The major data source is the KLEMS database from Canadian productivity accounts, which includes the information on the value of gross output, multi-factor productivity and the cost of labour, capital, services, material and energy, as well as their corresponding price, quality and quantity indices, for 83 industries in the period 1961-2003. The data on ICT capital is from CANSIM table 3830025. It contains the investment, cost, stock and price index of non-ICT and ICT capital. All price indices have been normalized to be equal to one at 2002 value.

The quantity of output of each industry is measured as the value of gross output divided by the chained-Fisher price index of gross output. The labour input quantity is measured as the cost of labour input divided by the chained-Fisher price index of labour input. The material input quantity is measured as the cost of material input divided by the chained-Fisher price index of
material input. The energy input quantity is measured as the cost of energy input divided by the chained-Fisher price index of energy input. The non-ICT capital quantity is measured as the cost of non-ICT capital services divided by the rental rate of non-ICT capital services. The rental rate of capital services is defined as $p^K = p_k(\delta + r)(1 - \tau)$ where $p_k$ is the chained-Fisher price index of capital services, $\delta$ is the physical capital deflator, $r$ is the discount rate and $\tau$ is the corporation income tax rate. The ICT capital quantity is measured by the cost of capital service of ICT divided by the price index of ICT capital services. A detailed description of the data is contained in Table 3.6 in Appendix A. To account the non-linearities in both the parameters and the variables and endogeneity in the system of equations, non-linear full information maximum likelihood (NLFIML) as the estimation procedure of the 5 equation system will be applied to the system.

### 3.4.2 Descriptive Statistics

This section includes 15 industries from service sector, which allows us to compare the economic performance between tourism/hospitality industries and non-tourism/non-hospitality industries. The list of the 15 industries is reported in Table 3.7 in Appendix A. The growth rates of TFP and factor demands of 15 industries for the period 1983-2003 are presented in the 15 figures in Appendix B. The figures show that the growth rates of ICT capital demands for all industries are much more volatile than those for other factor demands. The growth rates of material and energy demands for finance, insurance, real estate and renting and leasing industries fluctuate more compared to the growth rates of material demands for the other industries. The growth rates of labour demands for the 15 industries are fairly stable.

The average growth rates of TFP, factor demands and prices are reported in Table 3.1. The average growth rates of TFP for air transportation, transit and ground passenger
transportation, scenic and sightseeing transportation and support activities for transportation, arts, entertainment and recreation, insurance carriers, health care services and social assistance, and motion picture and sound recording industries for the period 1983-2003 are negative. Sharpe (2009) found negative growth of multi factor productivity for arts, entertainment and recreation for the period 1997-2007. According to Gu and Lafrance (2008), the early 1990s recession, effects of 9/11 and a number of other negative shocks associated with fuel price increases contributed to the productivity growth slow-down in air transportation. Rail transport, monetary authorities and depository credit intermediation, and retail trade are the three industries with highest average annual TFP growth rates among these 15 industries during the period 1983-2003. The rapid the productivity growth in rail transportation during the period 1983-2003 was largely attributed to the change of ownership, such as privatization of Canadian National Railways, and deregulation in the industry. Baldwin and Gu (2008) indicated that the firm turnover, the competitive process, the use of ICT and organizational innovation are importance to the productivity growth in the Canadian retail trade sector. The average growth rates of ICT capital demand vary among the 15 industries. Except for motion picture and sound recording industry, ICT capital demands for the period 1983-2003 had the most rapid growth on average among the factor inputs for the other 14 industries. Also, over the period 1983-2003, the average growth rates of ICT capital price are all negative but vary considerably across industries. According to Greenwood et al. (1997), the decreasing price on ICT capital and the high investment on the ICT capital can be explained as the evidence of rapid technological progress in ICT capital goods. The average growth rates of material price, labour price and energy price are all positive and different across industries. The average growth rates of demands for factor inputs with few exceptions are all positive. Water transportation and rail transportation are the two exceptional
industries which experienced negative growth of labour demand on average over the period 1983-2003. Also, the average growth rates of material and energy demand for rail transportation are negative at -4.19% and -0.31%, respectively. Water transportation is the only industry whose average growth rate of non-ICT capital demand over the period 1983-2003 is negative and equals -0.51%.

Table 3.1- Average Growth Rates of Total Factor Productivity, Factor Demands and Prices (%)
3.5 Empirical Results

3.5.1 Parameter Estimates

The system equations include industry dummy variables which take values either 1 or 0 to capture the industry specific effects because there are probably differences across industries which cannot be explained by the production structure alone. The Durbin-Watson test and White test revealed serial correlation and heteroskedasticity in the residuals. The variance-covariance estimator used for NFIML is generalized least-squares estimator. The generalized least-squares approximation to the Hessian is used in the minimization procedure. The estimation results using non-linear full information maximum likelihood procedure are reported in Table 3.2. The estimated parameters satisfy the convexity of normalized restricted cost function in K and A and the concavity in the variable input prices. The parameter estimates, $\alpha_{kk}, \alpha_{uu}, \alpha_{kk},$ and $\alpha_{aa}$ are positive. The parameter estimates, $\alpha_{ll}$ and $\alpha_{ee}$ are negative. The hypotheses of the absence of
adjustment costs for the quasi-fixed inputs, $K$ and $A$, $\alpha_{kk} = 0$ and $\alpha_{aa} = 0$ are rejected. According to Schankerman and Nadiri (1986) and Nadiri and Prucha (1990), these results suggest that a static equilibrium model is inappropriate to describe the technology and the structure of factor demand of the industries. The demand of variable inputs depends significantly and negatively on their own normalized price. The positive sign of quasi-fixed input, non-ICT capital in the labour demand function indicates that non-ICT capital input is a complement to the labour input. The negative sign of quasi-fixed input, ICT capital in the labour demand function implies the ICT capital input is a substitute for the labour input. The negative sign of quasi-fixed input, the ICT capital, in the energy demand function suggests that ICT capital input and energy input are substitutes. The positive sign of quasi-fixed input, non-ICT capital, in the energy demand function indicates non-ICT capital input is a complement to energy. The negative sign of parameter on technology index in the labour demand function is the evidence of increasing productivity of the labour input. Most coefficients for industry dummy variables are statistically significant at 5% level, which implies that there are significant differences in the cost structure across industries.

Table 3.2- Non-linear FIML Estimates of the Demand Equations for Labour, Materials, Non-ICT Capital, and ICT capital for the Canadian Industries in Tourism/Hospitality Sector, 1983-2003

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_l$</td>
<td>0.1522</td>
<td>6.8</td>
</tr>
<tr>
<td>$\alpha_{ll}$</td>
<td>-0.0531</td>
<td>-4.03</td>
</tr>
<tr>
<td>$\alpha_{le}$</td>
<td>0.0132</td>
<td>2.33</td>
</tr>
<tr>
<td>$\alpha_{ll}$</td>
<td>-0.0014</td>
<td>-5.36</td>
</tr>
<tr>
<td>$\alpha_{lk}$</td>
<td>0.0662</td>
<td>9.03</td>
</tr>
<tr>
<td>$\alpha_{la}$</td>
<td>-0.6756</td>
<td>-2.65</td>
</tr>
<tr>
<td>$\alpha_e$</td>
<td>0.0432</td>
<td>6.36</td>
</tr>
<tr>
<td>$\alpha_{ee}$</td>
<td>-0.0301</td>
<td>-7.3</td>
</tr>
</tbody>
</table>
\begin{tabular}{lrr}
\hline
$\alpha_{Re}$ & 0.0001 & 1.87 \\
$\alpha_{ek}$ & 0.0025 & 1.13 \\
$\alpha_{ea}$ & -0.4639 & -5.74 \\
$\alpha_o$ & 0.1611 & 6.2 \\
$\alpha_T$ & -0.0004 & -0.76 \\
$\alpha_k$ & -0.0990 & -5.23 \\
$\alpha_a$ & -5.5401 & -9.9 \\
$\alpha_{kk}$ & 0.0451 & 6 \\
$\alpha_{aa}$ & 80.05 & 6.69 \\
$\alpha_{kk}$ & 1.0391 & 7.56 \\
$\alpha_{aa}$ & 208.3223 & 8.06 \\
$\alpha_{Tk}$ & 0.0010 & 2.66 \\
$\alpha_{Ta}$ & 0.0760 & 6.51 \\
\hline
\end{tabular}

Note: Because the estimated system equations are dynamic, one observation in the time series was lost. Industrial dummies are included.

### 3.5.2 Adjustment Process

The estimated adjustment coefficients for quasi-fixed inputs, non-ICT capital and ICT capital, are contained in Table 3.3. The optimal paths for the quasi-fixed inputs are described by the flexible accelerator equations (partial-adjustment equations). The adjustment coefficients describe that a fraction of the gap between the initial stocks of quasi-fixed inputs non-ICT capital and ICT capital and the respective long-run optimal values are closed. According to Morrison and Berndt (1981) and Nadiri and Prucha (1990), the long-run optimal values are changing over time in response to changes in the variable exogenous to the firm’s input decisions. When the value of the adjustment coefficient is closed to zero, it says the stock of quasi-fixed input move slowly toward the optimal level. When the value of the adjustment coefficient is closed to one, it indicates the stock of quasi-fixed input moves rapidly toward the optimal level.

The adjustment coefficients for non-ICT capital and ICT capital, $m_{kk}$ and $m_{aa}$, from Canadian tourism/hospitality industries approximate to 0.167 and 0.439, respectively. Given the
estimated adjustment coefficients, it implies that for Canadian tourism/hospitality industries approximately 16.7 percentage of the gap between optimal and actual stock of non-ICT capital is closed within a year. About 43.9 percentage of the gap between optimal and actual stock of ICT capital is closed within a year. Tourism/hospitality industries are relative information intensive industries so it tends to invest more on ICT capital. Also, the average annual growth rates of ICT capital for tourism/hospitality industries are very much higher than the average annual growth rate of non-ICT capital, which could be a reason for a greater adjustment speed for ICT capital compared to the adjustment speed for non-ICT capital in Canadian tourism/hospitality industries. The capital adjustment speed could also be affected by the economic, legal, and political institutions that influence corporate governance, tax considerations, financial constraints, size of the firm, and the cost of accessing external capital.

<table>
<thead>
<tr>
<th>Table 3.3- The Coefficient of Adjustment Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-ICT capital (m_kk)</td>
</tr>
<tr>
<td>adjustment coefficient</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note: Standard deviations are in parentheses.

3.5.3 Elasticity

The short-run and long-run price and output elasticities of factor demand for Canadian tourism/hospitality industries are displayed in Table 3.4. The calculation of elasticities can be found in Appendix C. The short-run elasticity of variable input is defined as above when quasi-fixed inputs are fixed. The long-run elasticity of variable input is defined as above when quasi-
fixed inputs have adjusted fully to their steady state levels. Output elasticity of factor demand measures the percentage change in output induced by a percent change in inputs. If output elasticity of factor demand is equal to one, a production function is said to exhibit constant returns to scale. If output elasticity of factor demand is greater than one, a production function exhibits increasing returns to scale. If output elasticity of factor demand is less than one, a production function exhibits decreasing returns to scale.

The elasticities are calculated from the estimated parameters. The elasticities at the means across industries for 1988 have been chosen to evaluate. All short and long run own-price elasticities have the expected sign, which are negative. The own-price elasticities of labour demand for the Canadian tourism/hospitality industries are inelastic both in short-run and long-run, which are less than unity. The own-price elasticities of energy demand for the Canadian tourism/hospitality industries are less than one in both long-run and short-run, which implies an inelastic energy demand. The short-run and long-run own-price elasticities of energy demand are about the same size, which suggests fast adjustment to long run steady state levels. The own-price elasticity of material demand in long-run is greater than one, which indicates that the industries are facing elastic material demand in long-run. The short-run elasticity of material demand, however, is inelastic.

Because non-ICT capital and ICT capital are treated as quasi-fixed factors, there is no adjustment in short-run and their short-run elasticities are reported to be equal to zero. In the long-run, the own-price elasticity of non-ICT capital demand is less than one, which means that their demands are inelastic but the own-price elasticity of ICT capital demand is greater than one and elastic in long-run.

The output elasticity of labour demand for the Canadian tourism/hospitality industries is
0.834 in short-run and 0.957 in long-run, implying increasing returns to labour both in short-run and long-run. This finding that long-run output elasticity is greater than short-run elasticity for labour demand requires that labour and capital to be long-run complements. The cross-price elasticity of labour demand with respect to the non-ICT price and the cross-price elasticity of non-ICT capital demand with respect to the labour prices for the Canadian tourism/hospitality industries indicate that the labour and non-ICT capital are complements. The output elasticity of energy demand increase is 1.088 in short-run and 0.942 in long-run, while the output elasticity of material demand is 0.418 in short-run and 0.155 in long-run. There are substantial increasing returns to material in both short-run and long-run due to the substantial ICT capital & material and non-ICT capital & material substitutability.

The results reported in Table 3.4 indicate that labour and Energy are substitutes; energy and material are short-run substitutes but long-run complements; labour and material are substitutes. Labour and ICT capital are substitutes but the substitutability is small. Material and ICT capital are substitutes, and material and non-ICT capital are substitutes as well. Energy and ICT capital are substitutes, and Energy and non-ICT capital are complements but the complementary is fairly small. Many studies in the fields of manufacturing and technical processes concluded that ICT substantially reduces energy input. In the service sector, automation in buildings obviously has great potential to reduce energy use, particularly in large and complex buildings. Applying and investing on ICT can help to reduce energy consumption, which makes Canada’s tourism more sustainable and competitive, especially in the context of concern about climate change, energy and environmental conservation.
Table 3. 4- Short-Run and Long-Run Price Elasticities and Output Elasticities of Factor Demand for Canadian Tourism/Hospitality Industries (1988)

<table>
<thead>
<tr>
<th>Short-Run</th>
<th>K</th>
<th>A</th>
<th>L</th>
<th>E</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p^K$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$p^A$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$p^L$</td>
<td>0</td>
<td>0</td>
<td>-0.159</td>
<td>0.260</td>
<td>0.505</td>
</tr>
<tr>
<td>$p^E$</td>
<td>0</td>
<td>0</td>
<td>0.036</td>
<td>-0.559</td>
<td>0.156</td>
</tr>
<tr>
<td>$p^M$</td>
<td>0</td>
<td>0</td>
<td>0.123</td>
<td>0.299</td>
<td>-0.662</td>
</tr>
<tr>
<td>Q</td>
<td>0</td>
<td>0</td>
<td>0.834</td>
<td>1.088</td>
<td>0.418</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Long-Run</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$p^K$</td>
<td>-0.189</td>
<td>0</td>
<td>-0.257</td>
<td>-0.034</td>
<td>2.905</td>
</tr>
<tr>
<td>$p^A$</td>
<td>0</td>
<td>-1.162</td>
<td>0.042</td>
<td>0.1482669</td>
<td>0.3214428</td>
</tr>
<tr>
<td>$p^L$</td>
<td>-0.872</td>
<td>0.737</td>
<td>-0.466</td>
<td>0.1116304</td>
<td>2.8093637</td>
</tr>
<tr>
<td>$p^E$</td>
<td>-0.031</td>
<td>0.449</td>
<td>0.015</td>
<td>-0.611</td>
<td>0.201</td>
</tr>
<tr>
<td>$p^M$</td>
<td>1.092</td>
<td>-0.024</td>
<td>0.665</td>
<td>0.386</td>
<td>-6.238</td>
</tr>
<tr>
<td>Q</td>
<td>1.000</td>
<td>1.000</td>
<td>0.957</td>
<td>0.942</td>
<td>0.155</td>
</tr>
</tbody>
</table>
3.6 Effects on Total Factor Productivity Growth

The Divisia index is defined as a weighted sum of the growth rate of the variables. The weights are the variables’ shares in the total value. Tornqvist index is a discrete approximation to a continuous Divisia index in economics. If we measure the TFP growth rate by the conventional Divisia index, the corresponding Tornqvist index is defined as

\[
\Delta TFP_{i,t} = \Delta \ln Q_{i,t} - \Delta \ln N_{i,t}
\]  \hspace{1cm} \text{(15.1)}

Where \( \Delta \ln Y_{i,t} \) is the growth rate of output and \( \Delta \ln N_{i,t} \) is the growth rate of a cost share weighted index of aggregate inputs. \( \Delta \ln N_{i,t} \) is defined by

\[
\Delta \ln N_{i,t} = \frac{1}{2} \left[ \left( \frac{M_{i,t}}{C_{i,t}} + \frac{M_{i,t-1}}{C_{i,t-1}} \right) \Delta \ln M_{i,t} + \left( \frac{p_{i,t}^L L_{i,t}}{C_{i,t}} + \frac{p_{i,t-1}^L L_{i,t-1}}{C_{i,t-1}} \right) \Delta \ln L_{i,t} + \left( \frac{p_{i,t}^E E_{i,t}}{C_{i,t}} + \frac{p_{i,t-1}^E E_{i,t-1}}{C_{i,t-1}} \right) \Delta \ln E_{i,t} \right]
\]

\[
+ \frac{1}{2} \left[ \left( \frac{C_{i,t}^K K_{i,t}}{C_{i,t}} + \frac{C_{i,t-1}^K K_{i,t-2}}{C_{i,t-1}} \right) \Delta \ln K_{i,t} + \left( \frac{c_{i,t}^A A_{i,t}}{C_{i,t}} + \frac{c_{i,t-1}^A A_{i,t-2}}{C_{i,t-1}} \right) \Delta \ln A_{i,t-1} \right]
\]  \hspace{1cm} \text{(15.2)}

Where \( C_{i,t} = M_{i,t} + p_{i,t}^L L_{i,t} + p_{i,t}^E E_{i,t} + c_{i,t}^K K_{i,t-1} + c_{i,t}^A A_{i,t-1} \) is the total cost and \( c_{i,t}^K = p_{i,t}^K (r_t + \delta) \) and \( c_{i,t}^A = p_{i,t}^A (r_t + \mu) \) are the long-run rental price for non-ICT capital and ICT capital respectively.

As we know, technical change is often measured as the difference between the growth rate of aggregate output minus the growth rate of aggregate input. This approach is called Solow residual in economics. Divisia aggregation is mostly used in computing aggregation output and input, which were developed by Jorgenson and Griliches (1967), Richter (1966), Hulten (1973) and Diewert (1976), among others. However, According to Nadiri and Prucha (2001), the TFP growth estimated by Divisia index approach will yield biased estimates of technical change which may include scale effect and temporary equilibrium effect if any one of the set of
assumptions the Divisia index approach is based on is violated.

The growth of total factor productivity, $\Delta TFP$ can be decomposed as following, which is introduced by Nadiri and Prucha (1986, 1990, 2001):

$$\Delta TFP_{t,i} = \Delta TFP^T_{t,i} + \Delta TFP^S_{t,i} + \Delta TFP^E_{t,i} + \Delta TFP^I_{t,i}$$

(15.3)

Technical Change Effect:

$$\Delta TFP^T_{t,i} = \frac{1}{2} \left[ \lambda_s(t) + \lambda_s(t-1) \right]$$

(16.1)

where $\lambda_s = \frac{\partial G_{i,t}}{\partial T_{i,t}} \left[ G_{i,t} \left( \frac{\partial G_{i,t}}{\partial K_{i,t-1}} K_{i,t-1} + \frac{\partial G_{i,t}}{\partial A_{i,t-1}} A_{i,t-1} \right) - \left( \frac{\partial G_{i,t}}{\partial \Delta K_{i,t}} \Delta K_{i,t} + \frac{\partial G_{i,t}}{\partial \Delta A_{i,t}} \Delta A_{i,t} \right) \right]$ is input based measure of technical change.

Scale Effect:

$$\Delta TFP^S_{t,i} = (1 - e_{i,t-1}) \Delta \ln Q_{i,t}$$

(16.2)

where $e_{i,t} = \lambda_Q / \lambda_s$ is the return to scale, $\lambda_Q = - \frac{\partial G_{i,t}}{\partial Q_{i,t}} / \left( \frac{\partial G_{i,t}}{\partial Q_{i,t}} Q_{i,t} \right)$ is output based measure of technical change.

Temporary Equilibrium Effect:

$$\Delta TFP^E_{t,i} = - \frac{1}{2} \sum_{t=1}^{T-1} \left\{ \frac{(\partial G_{i,t} / \partial K_{i,t-1} + c_{i,t}^K) K_{i,t-1}}{\epsilon_{i,t} (\partial G_{i,t} / \partial Q_{i,t}) Q_{i,t}} \left[ \Delta \ln K_{i,t-1} - \Delta \ln N^T_{i,t} \right] \right\}$$

$$- \frac{1}{2} \sum_{t=1}^{T-1} \left\{ \frac{(\partial G_{i,t} / \partial A_{i,t-1} + c_{i,t}^A) A_{i,t-1}}{\epsilon_{i,t} (\partial G_{i,t} / \partial Q_{i,t}) Q_{i,t}} \left[ \Delta \ln A_{i,t-1} - \Delta \ln N^T_{i,t} \right] \right\}$$

(16.3)

\[^15\text{According to Nadiri and Prucha (2001), the Divisia index based measure of total factor productivity growth assumes: (1) producers are in long-run equilibrium, (2) the technology exhibits constant returns to scale, (3) output and input markets are competitive, and (4) factors are utilized at a constant rate.}\]

\[^16\text{According to Caves et al. (1981, 1982), output-based measure of technical change is the rate of output expansion that is achieved with technical change without changing input use; input-based measure of technical change is the decrease in input use that is achieved with the technical change without decreasing the output.}\]
Direct Adjustment Cost Effect:

\[
\Delta TFP_{i,t}^A = -\frac{1}{2} \sum_{r=\tau,j=1} \left\{ \left( \frac{\partial G_{i,t,r}}{\partial \Delta K_{i,t,j}} \right) \Delta K_{i,t,j} \left[ \Delta \ln \Delta K_{i,t,j} - \Delta \ln N_{i,t,j} \right] \right\}
\]

\[
-\frac{1}{2} \sum_{r=\tau,j=1} \left\{ \left( \frac{\partial G_{i,t,r}}{\partial \Delta A_{i,t,j}} \right) \Delta A_{i,t,j} \left[ \Delta \ln \Delta A_{i,t,j} - \Delta \ln N_{i,t,j} \right] \right\}
\]

(16.4)

The details of decomposition of TFP growth is in Appendix D. The technical change includes the process of innovation, invention and diffusion of technology. Adopting ICT and encouraging more innovation both in service and product and idea are examples to promote technical change. For example, a restaurant uses an iPad as a menu and order taking device which makes placing orders quicker and more accurate. The scale effect is about what happens to the demand of inputs when the firm expands its production. The temporary equilibrium effect is also called the market disequilibrium effect. It implies that rental prices do not reflect the marginal contribution of quasi-fixed factors into production. The quasi-fixed factors’ marginal value products are different from their rental prices due to the presence of adjustment cost of quasi-fixed factors. Such differences between shadow prices and rental prices ensure the existence of market disequilibrium effects. If the adjustment of quasi-fixed factors to a long-run equilibrium is instantaneous, their rental prices would be equal to their shadow prices and the temporary equilibrium effect on the change of TPF is zero. However, if the shadow prices are greater than rental prices, the existing stocks of quasi-fixed inputs are over-utilized, which implies that capacity utilisation is greater than one. Any attempt to reach full capacity utilisation induces an improvement in TFP and higher investment rates are positively related with TFP and vice versa. The direct adjustment cost effect on TFP change is uncertain. When firms are investing in capital, they may need to divert resources to installing new capital rather than producing marketable output, which means that in periods of rapid investment growth, firms
could be producing two types of products: the final product sold in the market and the services used within the firm to install capital. Marketable output may therefore be lower in periods of high investment growth, and this would cause a downward bias in estimates of measured productivity growth.

Table 3.5 shows the results of decomposition of TFP growth for the Canadian tourism/hospitality industries. The annual TFP growth rates for rail transportation, water transportation, and accommodation and food services are positive on average during the period 1983 – 2003. During the period 1983-2003, rail transportation has the rapidest average annual growth at 3.36 percent, and accommodation and food has a small average annual growth at 0.18 percent. The rest of tourism/hospitality industries, air transportation, transit and ground passenger transportation, scenic and sightseeing transportation and support activities for transportation, motion picture and sound recording industries, and arts, entertainment and recreation, have negative average annual growth rate of TFP during the period 1983-2003. In fact, Sharpe (2009) also reported that the industries which belong to tourism/hospitality industrial group, such as art, entertainment & recreation and transportations, experienced a negative average annual growth in multifactor productivity (MFP) during the period 1997-2007, and accommodation & food services had a positive average annual growth of MFP.

The effects of technical change on the growth of TFP for the Canadian tourism/hospitality industries are mixed. Except for scenic and sightseeing transportation and support activities for transportation, motion picture and sound recording industries, and arts, entertainment and recreation, technical change has positive effect on the TFP growth for the Canadian tourism/hospitality industries. The results of decomposition of growth of total factor productivity indicate that the TFP growth for air transportation and transit and ground passenger
transportation was mostly driven by the technical change. The most recent studies on the productivity in tourism industries, such as Jacob et al (2010), Botti et al (2010), and Blake et al (2006), found that technical change is the key determinant of productivity growth.

The picture of scale effects reported in Table 5 was mixed. There are half of the Canadian tourism/hospitality industries having decreasing returns to scale and another half having increasing returns to scale. Decreasing returns to scale means doubling inputs results in less than double the output, which describe the relationship between inputs and outputs in a long-run production function. Increasing returns to scale means doubling inputs results in more than double the output. Air transportation, rail transportation, transit & ground passenger transportation, and motion picture and sound recording industries have negative scale effects which imply decreasing returns to scale in the production. Water transportation, scenic and sightseeing transportation and support activities for transportation, arts, entertainment & recreation, and accommodation & food services have positive scale effects which imply increasing returns to scale. The scale effects contribute most to the TFP growth for arts, entertainment & recreation, accommodation & food services, and scenic and sightseeing transportation and support activities for transportation. There are other studies which found the evidences of existence of decreasing returns to scale in tourism industries. Neves and Lourenco (2009) used data envelopment analysis to analyze the performance management in the hotel industry with a world-wide sample and found there are many hotel companies operating under decreasing returns to scale. Moriarty (2008) studied the economic performance in New Zealand’s hospitality industry, and the results showed that hotels, motels, pubs and café divisions were characterized as having strongly decreasing returns to scale. Decreasing returns to scale can be caused by limits of managerial control, limits on entrepreneurial skill, trade off between quality
and industrialization, or capacity constrain. The results of scale effects experiencing by the Canadian tourism/hospitality industries suggested that the growth strategy of the industries can focus on replication rather than expansion in size and improvement on management control. The Canadian tourism/hospitality industries can attain scale economies with business process replication. The ability to replicate best practices within a firm is critical to building competitive advantage, and ICT has made the certain replication which has been traditionally difficult possible at little or no marginal cost. According to Brynjolfsson et. al. (2008), firms can create a store management software which contains better business processes to guide all employees worldwide. Franchisors and chain stores have been early examplars of the power of such business process replication.

Except for rail transportation and motion picture and sound recording industries, the temporary equilibrium effects on the TFP growth for the Canadian tourism/hospitality industries are positive. A positive sign of temporary equilibrium effect means the rental prices of quasi-fixed inputs are less than their shadow prices; quasi-fixed inputs are over-utilized. The negative temporary equilibrium effects for rail transportation and motion picture and sound recording industries indicate that the rental prices of quasi-fixed inputs are greater than their shadow prices; quasi-fixed inputs are under-utilized. The direct adjustment cost effect on the growth of TFP is uncertain. A positive direct adjustment cost effect implies that the accumulation of capital can increase the productivity. Arts, entertainment & recreation and rail transportation are the only two industries which experience positive direct adjustment cost effect on the growth of TFP.
Table 3. 5- Decomposition of the Traditional Measure of Total Factor Productivity Growth for Canadian Tourism Industries (annual average, 1983-2003)

<table>
<thead>
<tr>
<th>Industry and support activities for transportation [48B0]</th>
<th>Total factor Productivity ∆TFP</th>
<th>Technical Change ∆TFP⁵</th>
<th>Scale Effect ∆TFP⁶</th>
<th>Temporary Equilibrium Effect ∆TFP⁷</th>
<th>Direct Adjustment Cost Effect ∆TFP⁸</th>
<th>Unexplained Estimation Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air transportation [4810]</td>
<td>-1.26%</td>
<td>0.33%</td>
<td>-0.36%</td>
<td>0.11%</td>
<td>-0.05%</td>
<td>-1.28%</td>
</tr>
<tr>
<td>Rail transportation [4820]</td>
<td>3.26%</td>
<td>9.77%</td>
<td>-0.64%</td>
<td>-169.08%</td>
<td>108.15%</td>
<td>55.07%</td>
</tr>
<tr>
<td>Water transportation [4830]</td>
<td>0.48%</td>
<td>0.06%</td>
<td>0.03%</td>
<td>0.10%</td>
<td>-0.19%</td>
<td>0.47%</td>
</tr>
<tr>
<td>Transit and ground passenger transportation [4850]</td>
<td>-1.34%</td>
<td>0.07%</td>
<td>-0.03%</td>
<td>0.04%</td>
<td>0.00%</td>
<td>-1.42%</td>
</tr>
<tr>
<td>Scenic and sightseeing transportation and support activities for transportation [4880]</td>
<td>-1.41%</td>
<td>-0.01%</td>
<td>0.45%</td>
<td>0.08%</td>
<td>-0.98%</td>
<td>-0.95%</td>
</tr>
<tr>
<td>Motion picture and sound recording industries[5120]</td>
<td>-1.21%</td>
<td>-2.13%</td>
<td>-2.39%</td>
<td>-3.92%</td>
<td>-3.26%</td>
<td>10.49%</td>
</tr>
<tr>
<td>Arts, entertainment and recreation [7100]</td>
<td>-1.57%</td>
<td>-0.09%</td>
<td>0.45%</td>
<td>0.22%</td>
<td>0.03%</td>
<td>-2.17%</td>
</tr>
<tr>
<td>Accommodation and food services [7200]</td>
<td>0.18%</td>
<td>0.02%</td>
<td>0.35%</td>
<td>0.11%</td>
<td>-1.96%</td>
<td>1.67%</td>
</tr>
</tbody>
</table>

3.7 Conclusion

By using the dynamic factor demand model, this paper is able to derive the sources of TFP growth. During the period 1983-2003, some Canadian tourism/hospitality industries experienced negative average annual growth of TFP, and others experienced positive average annual growth of TFP. The results of decomposition of growth of total factor productivity indicate that the TFP growth for air transportation and transit and ground passenger transportation was mostly driven by the technical change. The temporary equilibrium effect is
another source promoting the TFP growth for most of the Canadian tourism/hospitality industries during the period 1983-2003. Positive temporary equilibrium effect indicates that, on average, the rental prices of quasi-fixed inputs were less than the shadow prices, implying that quasi-fixed inputs were over-utilized. Increasing investments on non-ICT capital and ICT capital can enhance the competitiveness of Canada’s tourism/hospitality industries in the world, so as the tourism/hospitality industries’ productivity. The picture of scale effects on ∆TFP was mixed. There are half of the Canadian tourism/hospitality industries having decreasing returns to scale and another half having increasing returns to scale. Decreasing returns to scale can be caused by limits of managerial control, limits on entrepreneurial skill, trade off between quality and industrialization, or capacity constrain. The results of scale effects experiencing by the Canadian tourism/hospitality industries suggested that the growth strategy of the industries can focus on business process replication rather than expansion in size and improvement on management control. Brynjolfsson et. al. (2008) pointed out the ability to replicate best practices within a firm is critical to building competitive advantage, and ICT has made the certain replication which has been traditionally difficult possible at little or no marginal cost. Firms can create store management software which contains better business processes to guide all employees worldwide. Franchisors and chain stores have been early exemplars of the power of such business process replication.

The approach used in this study is rooted in individual firm optimization that are estimated on data from industry aggregates. The criterion of internal closure of the model indicates that firms in an industry are taken as entities without a history. Firms in the same industry are viewed as the same because they are assumed to have the identical demand curve
and to face the same cost curves. It is very common to study industries from the point of view of a representative firm. The cost function used in this study is assumed as the cost function of representative firm.

In summary, the application of a dynamic factor demand model with non-ICT and ICT as quasi-fixed factors produces interesting and suggestive results. Moreover, the model lends itself to modifications for future research. For example, a future study employing another flexible functional form under rational expectations may provide more insight into the nature of the effect of ICT capital on the growth of TFP. Incorporating some important intangible factor into the model and the relaxation of separability between the quasi-fixed factors allow us to find out the interaction between the quasi-fixed factors and how the intangible factor affect growth of TFP.

17 "..... According to the criterion of internal closure of the model, only exogenous changes in the knowledge of the firm are allowed. ..."-Tsoukas (2005)
### Appendix A

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>FORMULA</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Raw Data Drawn for Statistics Canada Sources</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INDUSTRY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>YEAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPA</td>
<td>Real Gross Domestic Product per Hour Worked (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>LPV</td>
<td>Real Gross Product per Hour Worked (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFQV</td>
<td>Quantity Index of Gross Output (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFPK</td>
<td>Price Index of Capital Services (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFPL</td>
<td>Price Index of Labour Input (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFPE</td>
<td>Price Index of Energy Input (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFPM</td>
<td>Price Index of Material Input (Index, 2002=100)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>IFPICT</td>
<td>Price Index of ICT capital input</td>
<td>CANSIM TABLE 3830025: Investment, capital stock and capital services of physical assets, by North American Industry Classification System (NAICS), annually (Dollars unless specified)</td>
</tr>
<tr>
<td>PVV</td>
<td>PVV = Gross Output in Current Prices (Million Dollars)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>PKK</td>
<td>Cost of Capital Services (Million Dollars)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>PLL</td>
<td>Cost of Labour Input (Million Dollars)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>PEE</td>
<td>Cost of Energy Input (Million Dollars)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>PMM</td>
<td>Cost of Material Input (Million Dollars)</td>
<td>KLEMS DATABASE</td>
</tr>
<tr>
<td>PICT</td>
<td>Cost of ICT Capital Input (Dollars): 1. Sum up the cost of capital of the aggregated industries. 2. Find of the proportions of capital cost of each industry which is aggregated 3. Applied the proportion to the ICT cost from CANSIM TABLE 3830025: Investment, capital stock and capital services of physical assets, by North American Industry Classification System (NAICS), annually (Dollars unless specified)</td>
<td></td>
</tr>
</tbody>
</table>
CANSIM to get the individual industry’s ICT cost

**CDR**  
Capital Depreciation Rate = the average depreciation rate of 26 capital assets  

**ICTDR**  
ICT Capital Depreciation Rate = the average depreciation rate of 4 ICT capital assets  

**CITR**  
Corporate Income Tax Rate  
Corporate income tax rate: corporate income tax rate data base, Canada and the Provinces, 1960-2005

**LTGOVBR**  
Long-term Government Bond Interest Rate (%)  

**INFLATR**  
CPI Inflation Rate  
CPI Inflation: Recent Social Trends in Canada, 1960-200, pp45  
(reference: www.economics.utoronto.ca/jfloyd/modules/iavgd.p, Module 2 Interest Rates and Asset Values)

**RIR**  
Real Interest Rate = LTGOVBR - INFLATR

**IFPV**  
IFPV = Price Index of Gross Output (Index, 2002=100)  
KLEMS Database

### Constructed Variables

**PKICT**  
PKK – PICT (million dollars) non-ict capital cost  
Non-ict capital inputs

**PFPK**  
(IFPK/100)*(RIR+CDR)*(1-CITR)  
Non-ict capital rental price index

**PFPL**  
IFPL/100  
Labour price index

**PFPE**  
IFPE/100  
Energy price index

**PFPM**  
IFPM/100  
Material price index

**PFPICT**  
IFPICT/100  
Ict capital price index

**PFPV**  
IFPV/100  
Gross output price index

**TEC**  
Index of exogenous technical change

**QK**  
PKICT/PFPK  
Quantity of non-ict capital input

**QL**  
PLL/PFPL  
Quantity of labour input

**QE**  
PEE/PFPE  
Quantity of energy input

**QM**  
PMM/PFPM  
Quantity of material input

**QICT**  
(PICT/1000000)/PFPICT  
Quantity of ict capital input

**QGO**  
PVV/PFPV  
Quantity of output

**DIFQK**  
QK(t)-QK(t-1)  
Internal non-ict capital adjustment cost (in terms of foregone output due to changes in quasi-fixed factors)
DIFQICT = QICT(t) - QICT(t-1)  
NIFPKICT = (IFPK/IFPM) * (CDR + RIR) * (1 - CITR)  
NIFPICT = IFPICT/IFPM  
NIFPL = IFPL/IFPM  
NIFPE = IFPE/IFPM

Normalized real rental price of non-ICT capital input
Normalized price of ICT capital input
Normalized price of labour input
Normalized price of energy input

Table 3. Industry Definitions and NAICS Codes

<table>
<thead>
<tr>
<th>Industry Definition</th>
<th>NAICS Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Transportation</td>
<td>4810</td>
</tr>
<tr>
<td>Water Transportation</td>
<td>4830</td>
</tr>
<tr>
<td>Transit and ground passenger Transportation</td>
<td>4850</td>
</tr>
<tr>
<td>Scenic and Sightseeing transportation and support activities for transportation</td>
<td>48B0</td>
</tr>
<tr>
<td>Arts, entertainment and recreation</td>
<td>7100</td>
</tr>
<tr>
<td>Accommodation and food services</td>
<td>7200</td>
</tr>
<tr>
<td>Rail Transportation</td>
<td>4820</td>
</tr>
<tr>
<td>Motion picture and sound recording industries</td>
<td>5120</td>
</tr>
<tr>
<td>Retail trade</td>
<td>4A00</td>
</tr>
<tr>
<td>Monetary authorities and depository credit intermediation</td>
<td>5A01</td>
</tr>
<tr>
<td>Insurance carriers</td>
<td>5A02</td>
</tr>
<tr>
<td>Lessors of real estate</td>
<td>5A03</td>
</tr>
<tr>
<td>Rental and leasing services and lessors of non-financial intangible assets</td>
<td>5A05</td>
</tr>
<tr>
<td>Other finance, insurance and real estate</td>
<td>5A06</td>
</tr>
<tr>
<td>and management of companies and enterprises</td>
<td></td>
</tr>
<tr>
<td>Health care services (except hospitals) and social assistance</td>
<td>62A0</td>
</tr>
</tbody>
</table>
Appendix B

**ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003**

**INDUSTRY= Accommodation and food services [7200]**

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

**TOTAL FACTOR PRODUCTIVITY**  
- Total Factor Productivity  
- Material  
- Energy  
- non-ICT Capital Services  
- ICT Capital Services

**ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003**

**INDUSTRY= Arts, entertainment and recreation [7100]**

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

**Figure 3.1**

**Figure 3.2**
Figure 3.3

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Health care services (except hospitals) and social assistance [62A0]

Source: Calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3.4

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Insurance carriers [5A02]

Source: Calculation from Statistics Canada KLEMS and CANSIM dataset
ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003

INDUSTRY= Lessors of real estate [5A03]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3. 5

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003

INDUSTRY= Monetary authorities and depository credit intermediation [5A01]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3. 6
ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Other finance, insurance and real estate and management of companies and enterprises [5A06]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3. 7

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Rail transportation [4820]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3. 8
ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003

INDUSTRY = Scenic and sightseeing transportation and support activities for transportation [48B0]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3.11

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003

INDUSTRY = Transit and ground passenger transportation [4850]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3.12
Figure 3. 13

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Water transportation [4830]

Source: Calculation from Statistics Canada KLEMS and CANSIM dataset

Figure 3. 14

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Air transportation [4810]

Source: Calculation from Statistics Canada KLEMS and CANSIM dataset
Figure 3. 15

ANNUAL GROWTH OF FACTOR DEMANDS AND TOTAL FACTOR PRODUCTIVITY: 1983-2003
INDUSTRY = Motion picture and sound recording industries [5120]

Source: calculation from Statistics Canada KLEMS and CANSIM dataset
Appendix C

Short-run elasticities are derived when quasi-fixed factors are fixed. Short-run own and cross-price elasticities for the variable inputs can be calculated as:

\[ \varepsilon_{V_j p^z}^{SR} = \left( \frac{p^z}{V_j} \right) \left( \frac{\partial V_j}{\partial p^z} \right) \bigg|_{K = K_{t-1}, A = A_{t-1}}, z, j = L, E, M \]

while the corresponding long-run own and cross-price elasticities are computed as:

\[ \varepsilon_{V_j p^z}^{LR} = \left( \frac{p^z}{V_j} \right) \left( \frac{\partial V_j}{\partial p^z} \right) \bigg|_{K = K_{t-1}, A = A_{t-1}} + \frac{\partial V_j}{\partial K^*} \frac{\partial K^*}{\partial p^z} + \frac{\partial V_j}{\partial A^*} \frac{\partial A^*}{\partial p^z}, \quad z, j = L, E, M \]

By assumption, short-run cross price elasticities between quasi-fixed factor and variable inputs are zero, while long-run cross price elasticities are defined as:

\[ \varepsilon_{X_k p^z}^{LR} = \left( \frac{p^z}{X_k} \right) \left( \frac{\partial X_k^*}{\partial p^z} \right), \quad z = L, E, M; \quad k = K, A \]

Long-run own and cross price elasticities for quasi-fixed factors can be calculated as:

\[ \varepsilon_{X_k c^r}^{LR} = \left( \frac{c^r}{X_k} \right) \left( \frac{\partial X_k^*}{\partial c^r} \right), \quad k, r = K, A \]

c^r is long rental price for quasi-fixed factor.

Short-run and long-run output elasticities for variable inputs are defined as:

\[ \varepsilon_{V_j Q}^{SR} = \left( \frac{Q}{V_j} \right) \left( \frac{\partial V_j}{\partial Q} \right) \bigg|_{K = K_{t-1}, A = A_{t-1}}, \quad j = L, E, M \]

while the corresponding long-run output elasticities are computed as:

\[ \varepsilon_{V_j Q}^{LR} = \left( \frac{Q}{V_j} \right) \left( \frac{\partial V_j}{\partial Q} \right) \bigg|_{K = K_{t-1}, A = A_{t-1}} + \frac{\partial V_j}{\partial K^*} \frac{\partial K^*}{\partial Q} + \frac{\partial V_j}{\partial A^*} \frac{\partial A^*}{\partial Q}, \quad j = L, E, M \]

The short-run output elasticities for the quasi-fixed factors are zero, while long-run elasticities are unity by assumption.
Appendix D

Total Factor Productivity Growth Decomposition

According to the Lemma developed in Nadiri and Prucha (1990), the relationships between the derivatives of the production function $F(V, X, AX, T)$ and the restricted cost function $G(p^V, X, AX, Q, T) = V_1 + p^{V_2}V_2 + p^{V_3}V_3$ can be expressed as followings:

\[
\begin{align*}
\frac{\partial F}{\partial V_1} &= \frac{1}{\partial G/\partial Q}, & \frac{\partial F}{\partial V_2} &= \frac{p^{V_2}}{\partial G/\partial Q}, & \frac{\partial F}{\partial V_3} &= \frac{p^{V_3}}{\partial G/\partial Q}, \\
\frac{\partial F}{\partial X_{1,-1}} &= -\frac{\partial G/\partial X_{1,-1}}{\partial G/\partial Q}, & \frac{\partial F}{\partial X_{2,-1}} &= -\frac{\partial G/\partial X_{2,-1}}{\partial G/\partial Q} \\
\frac{\partial F}{\partial AX_{1,-1}} &= -\frac{\partial G/\partial AX_{1,-1}}{\partial G/\partial Q}, & \frac{\partial F}{\partial AX_{2,-1}} &= -\frac{\partial G/\partial AX_{2,-1}}{\partial G/\partial Q}, \\
\frac{\partial F}{\partial T} &= -\frac{\partial G/\partial T}{\partial G/\partial Q} \tag{D.1}
\end{align*}
\]

Differentiating the production function $F(V, X, AX, T)$ with respect to time, and by dividing by output, we get the decomposition of output growth:

\[
\begin{align*}
\Delta lnQ_{l,t} &= \frac{1}{2} \left[ (\epsilon_{FL}(t) + \epsilon_{FL}(t-1))\Delta lnL_{i,t} + \left( \epsilon_{FE}(t) + \epsilon_{FE}(t-1) \right)\Delta lnE_{i,t} + \left( \epsilon_{FM}(t) + \epsilon_{FM}(t-1) \right)\Delta lnM_{i,t} + \left( \epsilon_{FK}(t) + \epsilon_{FK}(t-1) \right)\Delta lnK_{i,t-1} + \\
& \quad + \left( \epsilon_{F\lambda}(t) + \epsilon_{F\lambda}(t-1) \right)\Delta ln\lambda_{i,t-1} \right] + \\
& \quad + \frac{1}{2} \left[ \lambda_{Q}(t) + \lambda_{Q}(t-1) \right] \Delta lnA_{i,t} + (\epsilon_{FL}(t) + \epsilon_{FL}(t-1))\Delta ln\Delta L_{i,t} + \left( \epsilon_{FA}(t) + \epsilon_{FA}(t-1) \right)\Delta ln\Delta E_{i,t} + \\
& \quad + \left( \epsilon_{FA}(t) + \epsilon_{FA}(t-1) \right)\Delta ln\Delta A_{i,t} \tag{D.2}
\end{align*}
\]

The shadow prices of $X_{-1}$ and $\Delta X$ and the shadow cost $C^s$ are defined as
The total cost, $C$, shadow cost, $C^s$ and the returns to scale, $\varepsilon$ imply that $C^s = \varepsilon (\partial G / \partial Q) Q$.

From the relationships between the derivatives of the production function and the restricted cost function and decomposition of output growth, we can obtain:

$$
\Delta \ln Q_{l,t} = \varepsilon_t \left[ p_{l,t}^L \Delta \ln L_{l,t} + p_{l,t}^E \Delta \ln E_{l,t} + p_{l,t}^M \Delta \ln M_{l,t} + u_{K_i,t} \Delta \ln K_{l,t-1} + u_{A_l,t} \Delta A_{l,t-1} \right]/C_{l,t} + \lambda_Q(\tau)
$$

$$
\Delta \ln Q_{i,t} = \frac{1}{2} \left( \Delta \ln Q_{l,t}^t + \Delta \ln Q_{l,t}^{t-1} \right), \quad (D.4)
$$

where $\tau = t, t-1$.

The growth rate of a cost share weighted index of aggregate inputs can be expressed as

$$
\Delta \ln N_{l,t} = \left[ p_{l,t}^L \Delta \ln L_{l,t} + p_{l,t}^E \Delta \ln E_{l,t} + p_{l,t}^M \Delta \ln M_{l,t} + c_{l,t}^K \Delta \ln K_{l,t-1} + c_{l,t}^A \Delta A_{l,t-1} \right]/C_{l,t}
$$

$$
\Delta \ln N_{i,t} = \frac{1}{2} \left( \Delta \ln N_{l,t}^t + \Delta \ln N_{l,t}^{t-1} \right), \quad (D.5)
$$

where $\tau = t, t-1$.

From the definition of $\Delta$TFP Tornquist approximation, (D.4), and (D.5), we can obtain

$$
\Delta \ln Q_{l,t}^t - \Delta \ln N_{l,t}^t = (1 - 1/\varepsilon_{i,t}) \Delta \ln Q_{l,t}^t + (1/\varepsilon_{i,t}) \Delta \ln Q_{i,t}^t - \Delta \ln N_{l,t}^t = (1 - 1/\varepsilon_{i,t}) \Delta \ln Q_{l,t}^t + \Delta \ln Q_{l,t}^{t-1}
$$
\[ p_{i,t}^L \Delta \ln L_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ + p_{i,t}^E \Delta \ln E_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ + p_{i,t}^M \Delta \ln M_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ + u_{K_i,t} K_{i,t-1} \Delta \ln K_{i,t-1} - \Delta \ln N_{i,t}^T \] 
\[ + u_{A_i,t} A_{i,t-1} \Delta \ln A_{i,t-1} - \Delta \ln N_{i,t}^T \] 
\[ + \dot{u}_{K_i,t} \Delta K_{i,t} \Delta \ln K_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ + \dot{u}_{A_i,t} \Delta A_{i,t} \Delta \ln A_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ / C_{i,t}^s + \lambda_Q(\tau) / \epsilon_{i,t} = \left(1 - 1 / \epsilon_{i,t}\right) \Delta \ln Q_{i,t}^T + \] 
\[ \left[ (u_{K_i,t} - c_{i,t}^K) K_{i,t-1} \Delta \ln K_{i,t-1} - \Delta \ln N_{i,t}^T \right] \] 
\[ + (u_{A_i,t} - c_{i,t}^A) A_{i,t-1} \Delta \ln A_{i,t-1} - \Delta \ln N_{i,t}^T \] 
\[ + \dot{u}_{K_i,t} \Delta K_{i,t} \Delta \ln K_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ + \dot{u}_{A_i,t} \Delta A_{i,t} \Delta \ln A_{i,t} - \Delta \ln N_{i,t}^T \] 
\[ / C_{i,t}^s + \lambda_s(\tau) \]  \quad \text{(D.6)}

From (D.6), we can get equation (16), the decomposition of ΔTFP, \[ \Delta TFP = \frac{1}{2} \left[ (\Delta \ln Q_{i,t}^T - \Delta \ln N_{i,t}^T) + (\Delta \ln Q_{i,t}^{T-1} - \Delta \ln N_{i,t}^{T-1}) \right]. \]
Chapter Four  A Cross-section Time-series Analysis of Productivity in the Canadian Tourism Sector Using the Workplace and Employee Survey

4.1 Introduction

According to the report provided by Statistics Canada, the growth of real investment in computers in Canada was about 20 percent per year on average in the past two decades, and the growth of real investment in ICT was about 13.5 percent per year on average over the same period. ICT has been widely adopted in the workplace in tourism/hospitality sector over the past two decades. As we know, the core job tasks of Tourism/hospitality sector require a great deal of physical dexterity and interpersonal communication. Many scholars debated whether the adoption of ICT increases labour productivity in this sector. Also, the adoption of ICT increases the needs for human capital. How to train the employee to attain skills that are complementary to the newly adopted technology is another important point when we examine the relationship between ICT, human capital and productivity.

Even though, there is general consensus of the relationship between information and communication technologies (ICT), training, and productivity among the economists. However, because of the difficulty of accessing the micro-level data for Canadian industries, few studies were performed by investigating the impact of the ICT usage and investment on training on labour productivity. Canadian workplace and employee survey (WES) data is used in this study, which links workplace to its employees. Not only does the survey provide detailed information on the ICT usage, training and turnover in the firm and employees, it but also provides the data on both firm and employee characteristics.

This study mainly examines the impact of the usage on ICT on the labour productivity in
the Canadian tourism/hospitality sector. The other issues are examined as well, such as that the impact of different types of training, classroom training and on-the-job training, on the labour productivity and the relationship between education and labour productivity.

### 4.2 Literature Review

It has been a long time for the adoption of information and communication technologies (ICT) in tourism/hospitality. The role of ICT in tourism/hospitality industries’ development and productivity improvement has been pursued topic for many researchers. Drennan (1989) classified air transportation and transportation services as one of information intensive industries which are affected by advances in information and communication technology greatly. Information intensive industries are defined as the industries for which there is intensive use of telecommunication services, the information is often custom-made or non-standardized, and the output is information. Duffy (2006) investigated the relationship between the levels of ICT adoption and the size of the tourism enterprises. Even though, there is the increasing importance of ICT adoption in the drive towards improving productivity in the tourism industry, it found that the ICT usage is low and consequent exploitation of the benefits of ICT is on the whole unrealised by small-medium-tourism-enterprises in Ireland. Belorgey et. al (2006) studied the determinants of labour productivity growth, especially the role of ICT, using a panel data of 25 countries during the period 1992-2000. The empirical study showed that average ICT spending between 1992 and 2000 had a positive impact on labour productivity growth. Detail analysis on the impact of interaction between human capital and ICT use on labour productivity was studied by Turcotte and Rennison (2004). The analysis found that computer use, university education and computer skills development were associated with higher productivity.

Training can be distinguished as on-the-job training (OJT) or informal training, and
classroom training or formal training. According to Sleight (1993), OJT is a face-to-face, one-on-one kind of training at the job site, where someone with the knowledge of the task demonstrates it to another. Classroom training means that employees are trained in classrooms, and the classroom subjects are how to do the tasks required in the firm. Training is considered one of most crucial factors for raising productivity. Conti (2005) studied the relationships between training and productivity and between training and wages in Italy. It used a panel data covering all sectors of the Italian economy for the years 1996-1999 to do the analysis and found that training significantly boosts productivity. Dearden et. al (2005) investigated the effects of work-related training on direct measures of productivity, using a panel data of British industries between 1983 and 1996. The empirical results showed that training was associated with significantly higher productivity. One percentage point increase in the proportion of workers trained in an industry is associated with an increase in value added per worker of about 0.6 percentages. Colombo and Stanca (2008) investigated the effects of training on labour productivity using a panel of Italian firms during the period 2002-2005. The study not only found that training has a positive and significant effect on productivity, but also showed that effect of training on productivity is large and significant for blue-collars, but small and not significant for white collars. There are some previous studies distinguishing the impact of formal training and the impact of informal training on economic performance. Betcherman et al (1997) investigate the development of skills in the Canadian workplace with Ekos Workplace Training Survey. It found the evidence of a positive relation between formal training and economic performance. Liu and Batt (2007) examined the relationship between informal training and job performance in a large unionized U.S. telecommunication company. The results implied that the receipt of informal training was associated with higher productivity over time, when unobserved individual
heterogeneity is taken into account. Seplveda (2010) examined the role of formal training programs in productivity growth and wage growth by using a panel data of two digit US manufacturing industries in the period 1988-1997. It found evidence for that on-the-job training increases productivity at the industry level, while off-the-job training programs have no effects.

The effect of workforce turnover on productivity can be negative or positive. Hinkin and Tracey (2000) indicated that the learning curve, errors and waste, supervisory and peer disruption were the productivity-related cost of staff turnover. Davidson (2010) studied the impact of labour turnover on the performance of Australian four- and five- star hotels. It found the turnover rates on both managerial and operational employees were over 40 percent, which were higher than expected. The research results implied that the overall cost to the industry was much greater and runs into hundreds of millions of dollars in both tangible and intangible costs which included the loss productivity and service quality. Lynn (2002) examined the turnover’s relationship with sales, tips and service across restaurants in a chain. The results indicated that turnover was negatively correlated with sales and service among high-volume restaurants but not among low-volume restaurants. The study, however, implied that turnover was negatively correlated with tip percentages among low-volume restaurants but not among high-volume restaurants. Some studies found the explanations for the positive impact of workforce turnover on productivity. Ilmakunnas et. al (2005) investigated the relationships between worker turnover and plant productivity, using matched employer-employee data from Finnish manufacturing. The results implied that the positive influence of worker turnover on productivity supports the hypothesis that replacement hiring leads to better matching and productivity. A New Zealand productivity study on food and beverage service sector in 2007 noted that moderate turnover could help to replace unproductive employees, enable career progression, enhance job and
employee matching and is therefore viewed as enhancing productivity.

4.3 Empirical Model

A standard constant returns to scale Cobb-Douglas production model, which includes only the standard inputs like capital, labour, and technology, can be augmented to include the inputs which influence the labour productivity, such as working experience, education, ICT adaptation, training, turnover, and control variable size of the firm as well. According to the studies, Black and Lynch (2004), Hempell (2005), and Almeida and Carneiro (2009), the Cobb-Douglas production function, which expresses the relationship between the inputs and outputs, is assumed

\[ Y_{it} = \exp(\varphi' P_{it}) A_{it} K_{it}^{\alpha} L_{it}^{\beta} \]  

(1)

where \( Y_{it} \) denotes the output of firm \( i \) in the period \( t \), \( P_{it} \) is the vector of workplace practice and employee characteristics, \( K_{it} \) is physical capital input, and \( L_{it} \) is labour input. \( A_{it} \) is a Hicks neutral technological progress.

Suggested by Hempell (2005), the Hicks neutral technological progress \( A_{it} \) can be further decomposed into a common scale parameter \( \beta_0 \) and a time-variant part \( \varepsilon_{it} \) which captures short-term shocks

\[ \ln(A_{it}) = \beta_0 + \varepsilon_{it} \]  

(2)

Taking natural logarithm of both sides of equation (1) and inserting Equation (2), we can obtain

\[ \ln Y_{it} = \beta_0 + \alpha \ln K_{it} + \beta \ln L_{it} + \varphi' P_{it} + \varepsilon_{it} \]  

(3)

In order to investigate the labour productivity of the firms, Equation (3) can be modified by subtracted \( \ln L_{it} \) on both sides and expressed as

\[ \ln \left( \frac{Y}{L} \right)_{it} = \beta_0 + \eta_{it} + \alpha \ln \left( \frac{K}{L} \right)_{it} - (1 - \beta - \alpha) \ln L_{it} + \varphi' P_{it} + \varepsilon_{it} \]  

(4)
4.4 The Data Source

The Workplace and Employee Survey (WES) is the first survey developed by Statistics Canada and Human Resource Development Canada in 1999, and continue available till 2005. WES is the only data that links both the supply side and demand side of the labour market available in Canada. Not only it records the detail of the employer’s characteristics such as innovation, human resource practice, and business strategies, but also the employee’s details like technology use, training, job turnover, and earnings. WES gives potential researches several unique opportunities: one of the most important features is the link between events occurring in workplaces and the outcomes for workers, and allows for a clearer understanding of changes over time.

WES is a longitudinal survey, which asks employer about technology implementation, innovation, human resource practices, labour force turnover and business strategies etc.. And the survey also ask employee about classroom training participation, on job training participation, and use of new technologies etc.. Data in the WES also included sex, occupation, level of education etc… Employers were selected by their geographical location and employees were then selected randomly from a list provided by that location. The effective number of employees selected varied between 1 and 23 depending on the number of employees at that location, for an average of 5.5 employees surveyed per firm. As it is longitudinal, this will be repeated for four years with the same locations and for two years with the same workers.

One of the reasons for that the WES dataset is considered a high quality dataset is it's high response rates. The WES has response rates of 95.2% and 82.8% for workplace and employee respectively in 1999; 90.8% and 86.9% for workplace and employee respectively in 2000; 85.9% and 86.9% for workplace and employee respectively in 2001; 84.0% and 90.9% for workplace
and employee respectively in 2002; 83.1% and 82.7% for workplace and employee respectively in 2003; 81.7% and 85% for workplace and employee respectively in 2004. Even though, the response rates for the survey workplaces declined over time, they are still much higher than the surveys used in the many studies, such as Battel (1989) which used a survey with 6% response rate and Black and Lynch (1996) which used a survey with 64% response rate.

In order to obtain the employee information such as education, immigrant status and work experience, we link the WES workplace file to the employee file by using their location code. The sample used in this study is restricted to for-profit firms with more than one employee because non-profit firms do not have the same economic motivation (profit maximization) as for-profit firms. The WES has 6-digit NAICS which is the only variable allow us to create a sub-dataset for the Canadian tourism/hospitality industries on file but the NAICS variable is only in the head office of Statistics Canada in Ottawa. We have to run a remote data access\textsuperscript{18} (RDA) in order to obtain the sub-dataset for the Canadian tourism/hospitality industries. The dataset used in this study is 3-digits NAICS firm level data because anything beyond 3-digits NAICS is unreliable. In addition, we also dropped the firms that reported no revenue and with the firms imputed negative capital and material expense. All above constrains reduced our sample to approximately 600 locations with an unbalanced panel structure. We did not extract a balanced panel out of the unbalanced panel because it could lead to an enormous loss in efficiency.

4.5 Descriptive Statistics

The mean and standard deviations for key production variables, human capital, technology use and training, as well as data on other worker and firm characteristics are reported

\textsuperscript{18} Remote Data Access (RDA) is a pilot project of the Centre for Education Statistics. Under the program, researchers can write and test their own computer programs using a file with artificial data. Then they can send these programs via the Internet to Statistics Canada, where they will be run on the microdata file. The results are returned to the client.
in Table C.1, Table C.2, Table C.3, and Table C.4 in Appendix C. Table C.1 reports the summary statistics for productivity, non-labour expenses, average years of experience, and share of employees with post-secondary and post-graduate degrees and diplomas. Table C.2 includes the summary statistics for classroom training and on-the-job training. Table C.3 reports the summary statistics for the workforce characteristics, share of employee using computer, and share of employee using computer controlled or related technology. Table C.4 includes the summary statistics for innovation on new products and services introduced by firms, innovation on improving products and services introduced by firms, and size of the business establishment.

The highest level of education attained by the employee is used as a proxy measure for human capital. Table C.1 shows the share of employee with post-secondary and post-graduate degrees and diplomas. On average, the industries, such as performing arts, spectator sports, heritage institutions, and air transportation, have highest proportions of employee with post-secondary and post-graduate degrees and diplomas, which are 66.6 percent, 63 percent and 58.1 percent respectively. On average, transit and ground passenger transportation, water transportation, and accommodation services have lowest proportions of employee with post-secondary and post-graduate degrees and diplomas, which are around 15 percent, 16 percent and 20 percent respectively.

Firm’s investment on human capital includes sponsoring career-related training and development programs and providing on-the-job training and classroom training. Table C.1 also reports the share of employee working towards a degree or diploma or certificate or other career-related skills sponsored by employer. Accommodation services industry has the highest proportion of employee working towards a degree or diploma or certificate or other career-related skills sponsored by employer, which is around 3.9 percent. Table C.2 reports the share of
employee with classroom-training, on-the-job training, and specific skill training. Air transportation has the highest average share of employee with classroom training, which is around 57.3 percent, while accommodation services industry and food services and drinking places industry have lowest average shares of employee with classroom training, which is around 10.4 percent and 9.7 percent respectively. Scenic and sightseeing, amusement, gambling and recreation, and air transportation have high proportions of employee with on-the-job training, which are around 71.2 percent, 53.5 percent and 51.4 percent on the average respectively. The average shares of employee with on-the-job training in accommodation services industry and food services and drinking places industry are around 25.7 percent and 29.5 percent respectively. In terms of share of employee with classroom computer training, rail transportation is the industry with highest average proportion of employee with classroom computer training, which is around 12.3 percent. Food and services and drinking places industry has only around 2.6 percent employee with classroom computer training on the average. Air transportation, however, has around 42.9 percent employee with on-the-job computer training on the average, while transit and ground passenger transportation has only 5 percent employee with on-the-job training on the average. Dummy variables were created for the industries providing classroom managerial skills training and other types of classroom training (such as sales and marketing, team-building, leadership, communication, group decision-making or problem-solving). There are 75 percent of locations in air transportation providing other types of classroom training, while there are only around 6.1 percent of locations in food services and drinking places providing other types of classroom training.

The information and communication technology use includes using a computer and computer-controlled/assisted technologies. On average, scenic and sightseeing transportation, air
transportation and heritage institutions have over 76 percent of employee using computers as part of their normal working duties. Food services and drinking places industry has lower average proportion of employee using computer comparing with the other tourism/hospitality industries, which is around 15 percent. In turns of the average share of employee using computer controlled/assisted technology, water transportation has highest average share in 26.7 percent while scenic and sightseeing transportation has lowest average share in 3.2 percent.

The turnover rates of workforce are reported in Table C.4. Most of the Canadian tourism/hospitality industries have high workforce turnover rates. Air transportation industry, performing arts, spectator sports and related industries, heritage institutions, amusement, gambling and recreation industries, accommodation services, and food services and drinking places have above 63 percent turnover rate of workforce. Tourism/hospitality industries are well-known for their labour intensive and high labour turnover. Hinkin and Tracey (2000) and Aksu (2004) suggested that such high turnover could be explained by the facts, such as low-skilled and low-paying work, unsocial working hours, low job satisfaction, and the lack of career advancement within each establishment.

Dummy variables are created for the sizes of business establishment. The sizes of business establishment are categorized into the sizes of 1-19 employees, 20-99 employees, 100-499 employees, and 500 and up employees. The shares of the four categories of the business establishments during the period 1999 to 2005 are reported in Table C.4. In Canada, small-sized businesses are defined as establishments with fewer than 100 employees. Medium-sized businesses are defined as the establishments employ between 100 and 499 people, while large businesses hire 500 people or more. reported on Table C.4, the Canadian tourism/hospitality industries are dominated with small-sized businesses, except for rail transportation. In the rail
transportation, about 43.8 percent is small-sized businesses employing 20-99 people, about 40 percent is medium-sized businesses employing 100-499 people, and about 16.3 percent is large-sized businesses employing 500 and more people. In the rest of the industries, more than 90 percent of business establishments are small-sized.

The labour productivity measure, average value added per employee and average payroll per employee are presented in Figure D.1 and Figure D.2 respectively in Appendix D. The demographic characteristics of employees, such as average shares of female employees, immigrant employees and part-time employees are presented in Figure D.3 in Appendix D. The average share of on-the-job managerial training and average share of on-the-job other skills training are presented in Figure D.5 and Figure D.6 respectively.\(^{19}\) The average share of firms introducing innovation on services and products improvement and average share of firms introducing innovation on new services and products are presented in Figure D.4 in Appendix D. Figure D.1 and Figure D.2 show that labour productivity is highest in the transportation industries, such as which not only have employ experienced, well educated workers, but also have high average share of employees using computers. It is showed in Figure D.3 that the non-transportation industries, such as amusement, gambling and recreation industries, accommodation services and food services and drinking places hire more female employees and part-time employees comparing to the transportation industries.

4.6 Empirical Results

In order to sort out the key determinants of labour productivity, controlling for a various firm and worker characteristics, the section presents the empirical analysis. The labour productivity function in this study include the dependent variable which is value added per employee.

\(^{19}\) Other skills include group decision-making or problem-solving, team building, leadership, and communication.
employee because hours worked are not available. Explanatory variables include non-labour cost per employee, training expense per employee, average years of working experience, share of employees with post-secondary and post-graduate diplomas and degrees, workforce turnover rate, share of employees with classroom training, share of employees with on-the-job training, share of workers using computer, share of workers using computer-controlled/assisted technology, innovation on improving and new products and services, size of business establishment, share of employees with classroom training for computer, share of employees with on-the-job training for computer, and industrial dummy variables. The capital stock for the firms is unavailable in the survey, so the shares of workforce using computer/computer related technologies are the proxies for the capital stock. The regression disturbances for the equation are assumed to be heteroscedastic and serially correlated. Serial correlation is assumed to be equal across all firms, while heteroscedasticity is assumed to be present within and across firms. Breusch-Pagan LM test for Heteroskedasticity and Wooldrige test for AR(1) were conducted. The test results show the existence of heteroskedasticity and first order autocorrelation in the disturbances. The Breusch-Godfrey LM statistic for testing AR(2) errors cannot be computed. This is because of the fact that at least 5 periods are required to estimate an AR(2) specification in differences. The panel data in this study is strongly unbalanced panel data. Many groups do not span 5 years.

In order to account for the herteroscedastic and serial correlation in the regression disturbances and the unbalance panel data, this study estimates the labour productivity function with random effect Feasible Generalised Least Squares (FGLS) estimator as the hausman test result does not reject the null hypothesis that the individual effects are uncorrelated with other regressor in the model. Table 1 presents the random effect FGLS estimated parameters.
Column (2) of Table 4.1 reports the estimated parameters for the productivity production function without including the industrial dummy variables. As expected, the share of employees with post-secondary and post-graduate diplomas and degrees, using computers and computer controlled/assisted technology are all significant determinants of labour productivity. Computer use is found to make the largest contribution, with 1 percentage point increase in the share of employees using computers increasing labour productivity by 0.46 percent. Computer controlled/assisted technology use makes less contribution to labour productivity comparing to computer use, with 1 percentage point increase in the share of employees using computer controlled/assisted technology raising productivity by 0.12 percent. By type of training, computer training is distinguished between classroom computer training and on-the-job computer training. Both types of computer training have a statistically significant and positive effect on the labour productivity, with 1 percentage point increase in the share of employees with classroom training in computer use raising productivity by 0.18 percent and with 1 percentage point increase in the share of employees with on-the-job training in computer use raising productivity by 0.22 percent. One percentage point increase in the share of employees with post-secondary and post-graduate diplomas and degrees on labour increases productivity by 0.09 percent. In order to examine whether or not the estimated parameters in the first regression, which is the labour productivity function without industrial dummy variables, are partly picking up productivity variations associated with industry characteristics, the industrial dummy variables are introduced to the model, and the estimated parameters are reported in column (3) of Table 4.1.

4.6.1 Information and Communication Technology Use

The estimated impact of one percent point increase in share of employee using computer
on productivity falls from 0.46 percent in the regression without industry controls to 0.14 percent in the regression with industrial controls. The positive and significant impact of the share of employees using computer controlled/assisted technology on productivity in the regression without industry controls becomes insignificant when the industry dummy variables are introduced into the regression. The fall in the estimated parameters likely reflects the fact that the relatively more productive industries in the sample include high ICT-use industries, such as air transportation and scenic and sightseeing transportation. The higher estimated parameters in the regression without industry controls were likely picking up some of these industry effects. According to Autor and Dorn (2010), the core job tasks of service occupations heavily depend on manual tasks such as physical dexterity and flexible interpersonal communication. There, however, are still many routine tasks existing in the occupations of service sector, such as repetitive goods and service production, monitoring activities and clerical work. ICTs, such as computers, are substitutes for low skilled workers performing routine tasks. The decline in ICT cost reduces the cost of computerizing routine tasks and improves the efficiency of performing routine tasks. The productivity is improved by adopting ICT to substitute for low skilled workers performing routine tasks. The results on computer use and computer controlled/assisted technology use imply that the more intensely ICT is used within the firm, the higher is labour productivity.

4.6.2 Education and Training

The impact of higher education remains positive and significant on the labour productivity in the regression with industry controls. One percentage point increase in the share of employees with post-secondary and post-graduate diplomas and degrees generates around 0.13 percent higher labour productivity. The human capital embodied in labour is an indicator of
the quality of labour. In the production processes, it is not only the quantity of labour that matters but also the quality of labour. Rao et al (2004) suggests that a faster pace of human capital accumulation relative to the United States, as measured by growth in the proportion of workers with a university degree, cultivated the labour productivity of Canada’s service industries convergence to the United States level. Kimenyi (2011)

Training plays an important role on developing human capital which is considered as a critical input to production. Classroom training is a formal training which is typically defined as structured, planned instruction by definition. On-the-job training is an informal training which is defined as unstructured training often delivered by a colleague or supervisor. In the regression without industry controls, classroom training has statistically insignificant impact on labour productivity, and on-the-job training has negative impact on labour productivity. With the introduction of industry dummy variables into the regression, both classroom training and on-the-job training have negative impact on the labour productivity. Our findings are consistent with the findings of Black and Lynch (1996) which found that number of workers trained had no apparent impact on productivity in US manufacturing sector. The current training lowered productivity, while past training raises current productivity. Consistent with previous research, as the training in this study is a measure in current year instead of a measure of the accumulated stock of training for the employees, the estimates of impact of both classroom training and on-the-job training on the labour productivity are possible underestimated.

Both classroom computer training and on-the-job computer training remain significant determinants of the labour productivity in the regression with industry controls, with 1 percent point increase in the share of employees with classroom computer training and 1 percent point increase in the share of employees with on-the-job computer training raising labour productivity
by 0.18 percent and 0.15 percent respectively. According to Turcotte and Rennison (2004), the positive and significant impact of on-the-job and classroom computer training on labour productivity but not general on-the-job and classroom training is that this type of training can be adapted to use more easily than other types of training, so the benefit of training can be seen earlier. Another explanation can be due to the unobserved ability, as those employees learning computer skills on-the-job or in classroom have a higher ability for learning in general.

The estimated impact of 1 percent point increase in training expense per employee on productivity drops from 0.14 percent in the regression without industry controls to 0.12 percent in the regression with industrial controls and remains a significant determinant to the labour productivity. The empirical results imply that there is a positive relationship between training expenditure per employee and the labour productivity and are consistent with Cassidy et al (2005). The empirical literature found that 1 percent increase in the training expenditure per employee improved the total factor productivity by 0.05 by using a plant level panel data for Irish manufacturing from Annual Business Survey during the period 2000-2001. Investments in training allow the firms to enhance their competitiveness, meet the challenges of rapid innovation, and adapt economic restructuring.

4.6.3 Workforce Turnover

The estimated parameter of workforce turnover rate in the regression without industry controls indicates that 1 percentage point increase in the workforce turnover rate is associated with 0.02 percent higher labour productivity. The workforce turnover rate remains a positive and significant determinant of the labour productivity in the regression with industry controls, with 1

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20 The training expense is the workplace’s total training expenditure for in-classroom job-related training in the survey year.
percentage point increase in turnover rate generating 0.02 percent higher productivity. These findings are contrast with the findings of Black and Lynch (2004). The job matching theory founded by Burdett (1978) and Jovanovic (1979) can possibly explain this phenomenon, which predicts that workers less suitable for the firm leave earlier; hence there is room for labour turnover to improve performance by clearing the workforce of poor worker-job-matches. A regular workforce turnover helps both employees and employers avoid being constrained in suboptimal matches permanently. According to Borland (1997), involuntary turnover can be used as a mechanism to maintain employees’ incentives to work.

4.6.4 Other Determinants of Labour Productivity

The estimated parameters of average years of work experience in both regressions implies that work experience significantly improves labour productivity, with 1 percentage point increase in average years of work experience generating 0.11 percent higher labour productivity in the regression without industry controls and 0.12 percent higher labour productivity in the regression with industry controls. For jobs where experience and verbal abilities are important, older individuals maintain a relatively high productivity level. The empirical result shows that the firms with 500 or more employees tend to have lower productivity relative to the firms with less than 500 employees. Small and medium size firms which are with less than 500 employees serve as the bench mark in the regression. The empirical finding is consistent with Dhawan (2001). Dhawan (2001) used firm level data from primary, supplementary and tertiary sectors and found that small firms are significantly more productive than large firms. Even though small firms face market uncertainties, capital constraints and other challenges but take actions which make them more efficient than large firms. Diaz and Sanchez (2002) suggest that small and medium firms tend to be more efficient than the large firms due to the managerial ability to use
and adjust properly capital and labour. In tourism/hospitality industries, most services and products require physical dexterity and flexible interpersonal communication, which are more easily served by small businesses. Furthermore, the negative coefficient of dummy variable for firm size with 500 and more employees, -0.278, indicated a diminishing returns to labour input and a decreasing returns to scale to the production function, which means the sum of capital share and labour share to the output ($\beta + \alpha$) is less than 1.

Table 4. 1- The Estimated Parameter of Labour Productivity Function with Dependent Variable, Value Added Per Employee (1999-2005)

<table>
<thead>
<tr>
<th>Variables</th>
<th>FGLS</th>
<th>FGLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln (Value added per employee)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Independent Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln(nonlabour expense per employee)</td>
<td>0.063332***</td>
<td>0.105199***</td>
</tr>
<tr>
<td></td>
<td>(0.0178867)</td>
<td>(0.0179296)</td>
</tr>
<tr>
<td>Ln(training expense per employee)</td>
<td>0.117702***</td>
<td>0.13563***</td>
</tr>
<tr>
<td></td>
<td>(0.0132049)</td>
<td>(0.0101223)</td>
</tr>
<tr>
<td>Ln(average years of experience)</td>
<td>0.126995***</td>
<td>0.109696***</td>
</tr>
<tr>
<td></td>
<td>(0.0209604)</td>
<td>(0.0251784)</td>
</tr>
<tr>
<td>Workforce turnover rate</td>
<td>0.018371**</td>
<td>0.020327***</td>
</tr>
<tr>
<td></td>
<td>(0.008189)</td>
<td>(0.0056644)</td>
</tr>
<tr>
<td>Share of employee with post-secondary and post-</td>
<td>0.090728*</td>
<td>0.125667***</td>
</tr>
<tr>
<td>graduate diplomas and degrees</td>
<td>(0.0487144)</td>
<td>(0.0473028)</td>
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<tr>
<td>Share of computer user</td>
<td>0.457203***</td>
<td>0.142991**</td>
</tr>
<tr>
<td></td>
<td>(0.0540318)</td>
<td>(0.060022)</td>
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<tr>
<td>Share of computer controlled/assisted tech user</td>
<td>0.118333**</td>
<td>0.02635</td>
</tr>
<tr>
<td></td>
<td>(0.0571263)</td>
<td>(0.0911212)</td>
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<tr>
<td>Share of employee with classroom training</td>
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<td>-0.10506***</td>
</tr>
<tr>
<td></td>
<td>(0.0436586)</td>
<td>(0.040273)</td>
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<tr>
<td>Share of employee with on-the-job training</td>
<td>-0.13133***</td>
<td>-0.18313***</td>
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<tr>
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<td>(0.038791)</td>
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<td>Share of employee with computer training in class</td>
<td>0.175185***</td>
<td>0.178122***</td>
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<td>(0.0509582)</td>
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<tr>
<td>Share of employee with computer training on-the-</td>
<td>0.215276***</td>
<td>0.149568***</td>
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<tr>
<td>job</td>
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<td>(0.0522846)</td>
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<td>Innovation on improved services and products</td>
<td>0.034501</td>
<td>0.037871</td>
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<td>(0.0267475)</td>
<td>(0.0307474)</td>
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<td>Innovation on new services and products</td>
<td>-0.03699</td>
<td>0.018993</td>
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<tr>
<td>----------------------------------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td>(0.0272104)</td>
<td>(0.0337298)</td>
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<tr>
<td>Business Establishment with 500 and more employees</td>
<td>-0.20104***</td>
<td>-0.2782***</td>
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<tr>
<td></td>
<td>(0.0741185)</td>
<td>(0.0557449)</td>
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<tr>
<td>constant</td>
<td>8.539151***</td>
<td>9.013207***</td>
</tr>
<tr>
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<td>(0.18878)</td>
<td>(0.2447819)</td>
</tr>
<tr>
<td>air_D</td>
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| Number of Observations                  | 529       | 529       |
| Breusch-Pagan LM for Heterskedasticity:p-value | 0         | 0         |
| Wooldrige test for AR(1):p-value          | 0         | 0         |

Note: Values in parenthesis are standard errors. Statistical significance level: ***1%; **2%; *10% level.

### 4.7 Conclusion

This paper examines the impact of information and communication technology use, training, education, and workforce turnover on firm’s labour productivity within the Canadian tourism/hospitality industries by using the Workplace and Employee Survey. The survey is a seven-year panel data set that links firm and employee information during the period 1999-2005. This study applies feasible generalised least squares estimator to the labour productivity model which is based on an extended Cobb-Douglas production function framework in order to control
for unobserved heterogeneity and autocorrelation.

Computer use and computer controlled/assisted technology use are served as measures for information and communication technology use. The analysis reveals that computer use, classroom training on computer use and on-the-job training on computer use are associated with higher labour productivity. An extensive literature suggests that the revolution in ICT accounts for a significant proportion of productivity growth during the past 30 years, particularly in the service industries. The empirical results imply that there exists a return to computer adoption in the Canadian tourism/hospitality industries during the period 1999-2005. However, the empirical results show that the classroom training and on-the-job training lower the labour productivity. As the training in this study is a measure in current year instead of a measure of the accumulated stock of training for the employees, the estimates of impact of both classroom training and on-the-job training on the labour productivity are possible underestimated.

The empirical results show that the workforce turnover has positive impact on the labour productivity in Canada’s tourism/hospitality sector. The study found that one percentage point increase in the workforce turnover rate leads around 0.02 percent increase in the labour productivity. That workforce turnover promotes labour productivity is possible due to the job matching effects. The employees with low productivity left the job, and the firms hire more productive workers.

Human capital is measured by the share of employees with post-secondary and post-graduate diplomas and degrees. The impact of higher education are positive and significant on the labour productivity, with 1 percentage point increase in the share of employees with post-secondary and post-graduate diplomas and degrees raising around 0.13 percent higher labour productivity. Human capital, same as information and communication technology use, is an
important determinant of labour productivity in the Canadian tourism/hospitality sector.
Appendix A

Variables Used in the Study

1. Revenue per employee \([\text{REVENUE}/\text{TTL\_EMP}]\): Gross operating revenue divided by the number of employees in the location

2. Value Added \([\text{REVENUE}\,-\,\text{EXPNDTR}\,-\text{GRSPAYRL}\,-\text{SAL\_EXPN}\,-\text{TRNG\_EXP}]\): Gross operating revenue minus the gross operation expenditures and then plus the sum of total gross payroll, expenditure on non-wage benefits and training expenditure

3. Average Labour Cost \([(\text{GRSPAYRL}\,\,\text{SAL\_EXPN}\,\text{TRNG\_EXP})/\text{TTL\_EMP}]\): The sum of Total gross payroll, total expenditure on non-wage benefits and training expenditure divided by the number of employees in the location

4. Non-labour Cost \([(\text{EXPNDTR}\,-\text{GRSPAYRL}\,-\text{SAL\_EXPN}\,-\text{TRNG\_EXP})/\text{TTL\_EMP}]\): This proxy of non-labour cost is the gross operation expenditures minus sum of total gross payroll, expenditure on non-wage benefits and training expenditure and then divided by the number of employees in the location

5. Average Training Expense \([\text{TRNG\_EXP}/\text{TTL\_EMP}]\): The total training expenditure divided by the number of employees in the location

6. Average Years of Experiences: This proxy is obtained by the sum of years of experience divided by the number of employees surveyed in the location

7. Share of Immigrant Workers: This proxy is obtained by the total number of employees not born in Canada divided by the number of employees surveyed in the location

8. Share of female Workers \([\text{TTL\_FEM}/\text{TTL\_EMP}]\): The total number of female employees divided by the total number of employees in the location

9. Share of Employees with Higher Education: This proxy is obtained by the total number of employees with college or above education divided by the number of employees surveyed in the location
10. Share of Part-time Employees [PART_TIM/TTL_EMP]: The total number of part-time employees working less than 30 hours per week divided by the total number of employees in the location

11. Share of Managerial Employees [TTL_MGR/TTL_EMP]: The total number of employment in the category of management divided by the total number of employees in the location

12. Ratio of Managerial Employees to Non-Managerial Employees [TTL_MGR/TTL_NCMN]: The total number of employment in the category of management divided by the total number of employment in the category of non-management in the location

13. Turnover rate

\[
\frac{((TTL\_LYFF+TTL\_DSMS+TTL\_QUIT+TTL\_RDCT+TTL\_RTMT+TTL\_OTHR+TTL\_NWHR)}{((TTL\_EMP+EMP\_YER)/2)}
\]\: Sum of number of new employees hired and employees permanently left divided by the average of the total number of employees in the location in the beginning and end of the survey year.

14. Sponsor Formal Education: This proxy is obtained by the sum of employees working toward a trade or vocational certificate or diploma, working toward a degree or diploma, or toward a professional designation divided by the number of employees surveyed in the location

15. Share of Classroom Training [TRN_EMP1/TTL_EMP]: The number of employees receiving classroom training divided by the total number of employees in the location

16. Classroom Training on Computer: This proxy is the number of employees receiving classroom training for computer/software or hardware use divided by the number of employees surveyed in the location

17. Classroom Training on Managerial/supervisory Skills: This proxy is the number of employees receiving classroom training for managerial/supervisory skills divided by the number of employees surveyed in the location

18. Share of On-the-Job Training [TRN_EMP2]: The total number of employees receiving on-the-job training divided by the total number of employees in the location
19. Share of On-the-Job Training on Computer: This proxy is the number of employees receiving on-the-job training for computer/software or hardware use divided by the number of employees surveyed in the location.

20. On-the-Job Training on Managerial/supervisory Skills: This proxy is the number of employees receiving on-the-job training for managerial/supervisory skills divided by the number of employees surveyed in the location.

21. Share of Computer User [CPU_USER/TTL_EMP]: The number of employees using computer as part of their normal working duties divided by the total number of employees in the location.

22. Share of Technology User Computer-Controlled or assisted Technology: This proxy is obtained by dividing the total number of employees using the computer-controlled or computer assisted technology divided by total number of employees in the location.

23. Innovation: Introduction of improved products/services or new products/services in the location.

24. Size of the Firm: The standard size based on business labour market analysis definition, 1-19 employees, 20-99 employees, 100-499 employees, and 500 employees or more.

25. Source of Funding: The source of funding for classroom training of employees in the location.

   The sources are identified as Federal government programs, provincial government programs, or none.
Appendix B

The specific 3-digit level NAICS tourism/hospitality industries:

- air transportation (481)
- rail transportation (482)
- water transportation (483)
- transit and ground passenger transportation (485)
- scenic and sightseeing transportation (487)
- performing arts, spectator sports and related industries (711)
- heritage institutions (712)
- amusement, gambling and recreation industries (713)
- accommodation services (721)
- food services and drinking places (722)
<table>
<thead>
<tr>
<th>Industry</th>
<th>Revenue/employee</th>
<th>Value-added/employee</th>
<th>Payroll/employee</th>
<th>Nonlabour cost/employee</th>
<th>Average years of experience</th>
<th>% of employer sponsoring education</th>
<th>% of employee with post-secondary and post-graduate</th>
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<tr>
<td>Air</td>
<td>Mean</td>
<td>256680.2</td>
<td>64203.28</td>
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<td>17407.75</td>
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<td>Rail</td>
<td>Mean</td>
<td>215241</td>
<td>106869.9</td>
<td>51838.72</td>
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<td>Water</td>
<td>Mean</td>
<td>131399.6</td>
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<td>55457.41</td>
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Table 4.2 – Descriptive Statistics (1999-2005)
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<th>Industry</th>
<th>% of employee with classroom training</th>
<th>% of computer use training in class</th>
<th>% of employee with on-the-job training</th>
<th>% of computer use training on-the-job</th>
<th>% with managerial training on-the-job</th>
<th>% with other skills training on-the-job</th>
<th>% of firms with managerial classroom training</th>
<th>% of firms with other skills classroom training</th>
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Table 4. 3-Descriptive Statistics (1999-2005)
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<th>Industry</th>
<th>Mean % of part-time employee</th>
<th>Mean % of immigrant employee</th>
<th>Mean % of female employee</th>
<th>Mean % of managerial workers</th>
<th>Mean % of non-managerial workers</th>
<th>Mean % of computer users</th>
<th>Mean % of computer controlled/assisted tech users</th>
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<td>Air</td>
<td>0.348372</td>
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<td>0.3415433</td>
<td>0.6389744</td>
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<td>Std. Dev.</td>
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<td>0.4173153</td>
<td>0.2208485</td>
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<td>0.1421048</td>
<td>0.2942069</td>
<td>0.2044775</td>
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<td>0.02243</td>
<td>0.1604296</td>
<td>0.1303236</td>
<td>0.1205058</td>
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<td>0.1208089</td>
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<td>0.0185902</td>
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<td>0.2672316</td>
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<td>0.0843124</td>
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<td>0.7607026</td>
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<td>performing arts, spectator sports</td>
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<td>0.1322914</td>
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<td>0.6621931</td>
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<td>0.1168586</td>
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<td>0.0374793</td>
<td>0.7017498</td>
<td>0.1599763</td>
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<tr>
<td>Std. Dev.</td>
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<td>food services and drinking places</td>
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**Table 4.4- Descriptive Statistics (1999-2005)**
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<th>Mean</th>
<th>Std. Dev.</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<td>0.4637956</td>
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</table>

Table 4.5- Descriptive Statistics (1999-2005)
Appendix D

Source: calculated from Canada’s Workplace and Employee Survey

Figure 4. 1— Average Payroll per Employee (1999-2005)

Figure 4. 2— Average Value Added per Employee (1999-2005)
Source: calculated from Canada’s Workplace and Employee Survey

**Figure 4.3 – Demographic Characteristics of Employees (1999-2005)**

**Figure 4.4 – Average Share of Firms Introducing Innovation (1999-2005)**
Source: calculated from Canada’s Workplace and Employee Survey

Figure 4. 5– Average Share of On-the-job Managerial Training (1999-2005)

Figure 4. 6– Average Share of On-the-job Other Skills Training (1999-2005)
References


http://www.pinkmagazine.com/career/development/wired_winning.html


