A longitudinal study on the Return on Training to support innovation in the workplace

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The Longitudinal Return on Investment on Training to Support Innovation in the Workplace

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Executive Summary

Given the pace of technological change and the strong forces to innovate from the global market place, the need to invest in human capital continues to increase as does the requirement for high return on investment (ROI) in training. One of the obstacles of measuring the ROI of training is that many of the benefits of training may not be immediately visible for measurement and it may be impossible to allocate the improvements exhibited by the firm to a particular training event. The lack of longitudinal studies to measure the ROI of training, particularly with respect to supporting the use of technology and intensity of innovation, is an area that will be addressed in this study.

The pace of innovation and technological change in the global market place make it imperative that companies constantly look at improving the skills of their workforce (Bresnahan, Brynjolsson and Hitt, 1999). The investment in human capital through the use of relevant and targeted training is critical in order to keep a business competitive (Rabemananjara and Parsley, 2006). One of the key components to an organization's competitive advantage is the development of knowledge workers and increasing the value of their human capital.

Training and its return on investment, is a difficult but necessary thing for human resources (HR) professionals to understand and be able to demonstrate (Tomlinson, 2002). HR managers find themselves trying to "prove that training is worthwhile" during hard economic times, and that it has a good ROI, to senior management (Tomlinson, 2002). Management tends to analyze how to minimize the costs of doing business, and for many, that means reducing the money spent on training. In order to keep training expenditures at an effective level, the HR department must be able to show the benefit to the bottom line. Depending on the position of the employee, relating an increase in profitably to training can be very complex. It's been discovered recently that employers' ROI on training is greater than previously believed (Barten, 2000). Since so many factors can impact the perceived ROI, it is very difficult to find and analyze all the variables defining the business working environment. This study will attempt to extend the current knowledge on the ROI of training as it relates to improved profitability and labour productivity by demonstrating which types of training initiatives are complementary thus offering a greater ROI when they are done together.

The purpose of this project is to determine the cumulative return on investment that diverse types of workplace training provide with respect to profitability, labour productivity, probability of innovation, and intensity of innovation in the workplace. The project goes on to investigate which forms of workplace training are complementary to one another in order to help organizations maximize their return on training to meet strategic goals such as increased innovation in the workplace.

The project used data from Statistics Canada's Workplace and Employee Survey (WES) from 1999 to 2005 in order to get a comprehensive longitudinal dataset of Canadian firms. In particular, Michie and Sheehan (1999) noted that there is little known about the interaction between innovation and training since most information datasets do not contain both sets of variables. The intensity of innovation was measured using the types of innovation conducted by the firm (world-first, Canada-first, industry-first, or firm-first) as defined in the WES by Statistics Canada. A world-first innovation is an innovation that the respondent believes they are the first in the world to develop and implement. A Canada-first innovation is an innovation that the respondent believes they are the first to develop and implement in Canada. Similarly, industry-first and firm-first innovations are innovations that the respondent believes they are the first in the industry or firm respectively to implement. The analysis used control variables for the size of the organization, the industry in which it operates, and its initial level of innovative activity. By using the longitudinal dataset, the cumulative effect of training will be able to be accounted for, as well as any time lag that may exist from increased training to an impact on the improvement of productivity or intensity of innovation. .

After using factor analysis to reduce the number of training variables, we provide a constrained regression model to determine complementary and substitute practices to increase the profitability or labour productivity in an organization. Both a 3 factor model (Management general) training, Professional and Technology Training, and Apprenticeship) and a more refined 5 factor model (In-class general training, On-the-job general training, Technology training, Occupational Health and Safety training, and Apprenticeship) have been developed to support the analysis. Additional regression analysis was completed to determine the impact that workplace training methods have on changes in profitability, labour productivity, probability of innovation, and the intensity of innovation at the organization. The constrained regression models were used to test hypotheses regarding the pair-wise complementarities between training practices and the ROI these combinations of practices will have in supporting other business strategies such as increased labour productivity and increased intensity of innovation.

This study tested the following set of questions:

- Is there a positive relationship between training and workplace productivity?
- Is there a positive relationship between training and innovation output?
- What types of training practices are complementary or substitutes with respect to increases in labour productivity?
- What types of training practices are complementary or substitutes with respect to increases in profitability?

Each industry displayed unique sets of training practice usage as well as regression results for the importance of these practices on the various performance measures. Based on the constrained regression results, we identify that, depending on the industry where a firm operates and the size of the firm, the combination of training practices which should be implemented simultaneously to support innovation differs widely. By implementing the proper fit of training practices, managers can significantly increase the profitability and labour productivity of their firm.

This study has found that there is a significant longitudinal effect of training on innovation output and that simply considering the current or previous year's investment is insufficient to describe the impact. We also were surprised to find that when all establishments are aggregated together, the impact of training to support profitability is negated between the current and previous year's investments, but when analysis is conducted at the industry level, the results demonstrate a different picture of training impact. These results imply that there are significant drawbacks to aggregating analysis at the macro level and that more research is required at the industry and establishment level to determine the organizational variables impacting the return on training. When we calculate the elasticities (the ratio of the percentage of change in productivity due to a dollar investment in training) and the internal rate of return of training investments over time, we find that there is support for significant positive return in some industries (e.g., information and cultural, forestry, etc.), but there is minimal or no returns in others (e.g., business services). This may be due to the higher turnover rates in some industries, or the differences in the skill level of employees entering that particular industry making employer training more (or less) important.

With respect to innovation, all variables (research and development investments, foreign ownership, union, information and communication technologies investment costs, training investment in the current year, previous year, and two years previous) in the regression model (Section 4.2) were found to be statistically significant except training investment in the previous year. This means that training investment two years before the innovation seems to provide the general skills required to create the higher-order innovations (world-first and

Canada-first) and the training investment in the current year may be responsible for idea generation or the implementation of firm-first innovations.

Of the 14 industries, training investment was found to have an effect on the probability of a new/improved product and/or process in eight. It would seem logical to hypothesize that the effects would be most pronounced in the industries with higher investments in training but this is not the case. Training was found to be a significant factor in four of the five industries with the least investment in training. Interestingly, secondary product manufacturing, transportation and warehousing, and retail trade demonstrate a positive effect of training on innovation quality but not on the probability to innovate. Real estate and labour intensive tertiary industries demonstrate a training effect with respect to the probability to innovate and not with respect to the quality of innovations. It is therefore important for managers to understand the innovation strategy of the organization so that the training strategy can support these objectives.

When we consider the complementarity analysis, there are significant levels of complementarities between various types and forms of training practices. When all establishments are aggregated by size, the results are fairly consistent with respect to improved labour productivity with all but two of the practices being complementary to each other. But in the analysis by size class with respect to profitability, the results are completely unique for each segment. Similarly, when conducted by industry, the analysis shows some consistency with respect to labour productivity but each industry displays its own unique set of complementary and substitute training practices with respect to profitability. The results from this analysis do support the possibility of developing a global government policy and/or programs to improve labour productivity in the service sector through comprehensive training incentive programs for organizations. The large number of significant results with respect to labour productivity demonstrates the high level of correlation between training practices and labour productivity output. Unfortunately, there are much fewer significant results with respect to profitability due to the number of external factors effecting profitability other than training practices.

Using the plots of the changes in labour productivity and profitability, we can see that there is strong support for the complementarity and substitute findings determined through the constrained regression analysis. We can also use these plots (as demonstrated in the interactive online website) to enable managers to visually see the impact that making changes in their training investments may have. In particular, we apply principles of lattice theory (a mathematical theory applied to determine an optimal one-step movement path through a graph) to support the analysis and determination of optimal one-step movements through the solution lattice determined by the constrained regression models. The explanation of the mathematically theory of lattice theory is outside the scope of this study.

The results of the constrained regression analysis support the need for further research at the establishment level by industry to ensure that there is less confounding of the impacts of training on performance measures. The level of detail in the economic and training variables needs to be increased to enable a more thorough analysis of the key drivers and contributors to successful innovation and productivity outputs in the firm. This should help to address the issue of a reduced number of significant findings with respect to profit if we can develop a profitability measure that is more inclusive of direct results from training initiatives. The type of detailed variables needs to be supported by new analysis methods that can integrate a large set of possible combinations of variables into modelling constructs so that analysis can be conducted with statistical significance even in smaller industry segments.

Human resources (HR) managers and senior management can use the findings of the study to engage in discussion about the design of their training strategy. The results from the various regression models (sections 4.1 and 4.2) demonstrate that a long term investment in training is critical to support increases in labour productivity and innovation output. These results provide HR managers with strong evidence that the return on training cannot be consider by looking only an annual results but that the effect of training investment will remain with the organization for at least a three year period. By considering the longitudinal effect of training, this may enable HR manager to better support their argument for increased training investment to support both productivity gains as well as innovation capacity.

HR managers and senior management can also use the results from the complementarity and substitute testing (section 4.3 and 4.4) to analyze the composition of elements provided as training to employees. Both the size of the organization as well as the industry in which it operates has a significant effect on the set of training practices that should be implemented simultaneously by the organization. For example, if the manager were in the forestry, mining, oil, and gas industry then they would see that they should invest in both general training and apprenticeship programs simultaneously as these are complements but that investing simultaneously in general training and technology and professional training is not a good idea as these are substitutes. The plots of the average profitability and labour productivity with respect to the set of strategic training practices implements can be used by senior administrators to support discussion and decisions concerning the existing set of strategic training options provided at the organization and any changes they would like to make. The managers are able to look on the graph for where they currently sit and then compare their internal results to the industry average for that strategic combination as well as other possible combinations they might be considering.

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1. Introduction

One of the central problems in innovation and managing technological change in business is improving the skills of the workforce through the investment in human capital and a variety of training practices. In many industries, relevant and effective training programs have been important factors driving the growth of firms and improving their performance. Guest (1997) argued that more progress needs to be made on understanding the link between human resource management (HRM) and firm performance. Many researchers have found that there exists a positive relationship between workplace training and profitability, and workplace training and productivity (Barren & Loewenstein; 1989, Bartel, 2000). While some studies discovered that increases in training can improve labour productivity and offer increased return on investment (ROI), few papers have addressed the cumulative ROI provided by complementary training practices with respect to profitability and productivity.

Many governments are anxious to improve the level of innovation, and therefore the competitiveness, of the organizations in their economic regions (MacDonald et al., 2007). In order to help stimulate innovation, governments have created incentives for research and development (R&D) expenditures, programs to support training of skilled workers, and organizations to promote networking, dissemination, and sharing of knowledge. Although these programs are in operation, it is unclear which type of incentive leads to the largest impact on innovative activity and whether the quality of the innovation (world-first, nation-first, or establishment-first) is a driver in determining the optimal type of investment in knowledge creation.

Given its importance to economic development and competitive advantage, there has been a significant amount of research conducted into innovation activities of establishments (Wolfe, 1994; Siguaw et al., 2006). Establishments conduct various types of innovation activities including new business models, products, services, production methodologies, processes, and distribution channels (Carr, 1999). To date, the focus has been on differentiating between product and process innovations (Damanpour & Gopalakrishnan, 2001); there has been limited research conducted into differences based on the quality of innovations produced. Much of the results have been inconclusive, inconsistent, or have had limited application due to small sample sizes (Wolfe, 1994). Our knowledge about the impact that internal knowledge creation has on innovation is also limited, as typically external sources of knowledge and R&D expenditures have been the primary knowledge variables considered (Freeman, 1994, Marsili and Salter, 2005). Moorman and Slotegraaph (1999) found that innovation research has not focused on the interaction dynamics between functional capabilities of the establishment. Siguaw et al. (2006) describes a need for better understanding of the innovation orientation of the establishment. In their study, they define innovation orientation as:

> "A multidimensional knowledge structure composed of a learning philosophy, strategic direction, and transfunctional beliefs that, in turn, guide and direct all organizational strategies and actions, including those embedded in the formal and informal systems, behaviours, competencies, and processes of the establishment to promote innovative thinking and facilitate successful development, evolution, and execution of innovations." (p.560)

Having a clear knowledge structure is important (under either a resource-based or knowledge-based theory of the establishment) in order for an establishment to obtain a competitive advantage in the industry.

This study will extend the understanding of the impact on internal knowledge creation, including R&D expenditures, as well as total on-the-job and classroom training expenditures over each of three years on the highest quality of innovation produced by the establishment. The long-term impact of sustained training investments will demonstrate the importance that an establishment places on knowledge creation. This level of investment, combined with R&D expenditures, should also act as an indicator of the establishment's absorptive capacity for new knowledge. It is expected that establishments that exhibit higher levels of investment in training over all three periods, as well as high levels of R&D expenditures, will generate higher quality of innovations (e.g., world-first). By analyzing the longitudinal impact of training expenditures, this study will provide a deeper understanding into the types of internal and industry-wide policies and practices which support the various levels of innovative activity.

In this paper, we use a comprehensive dataset, the Workplace and Employee Survey (WES) from Statistics Canada, to investigate the relationship between various forms of training practices in the Canadian service sector to determine the impact of implementing multiple training initiatives simultaneously in a firm. We will identify which training practices are complementary or substitutes based both on firm size and industry classification. By simultaneously investing in complementary training practices, managers will be able to increase the ROI of their training investments both with respect to improved labour productivity and improved overall profitability of the firm.

2. Background

2.1 Return on Investment in Human Resource Management Practices

Given the importance of skilled workers due to technological change and increased competition, there have been a number of studies which have tried to analyze the impact of human resource management practices on the performance of a firm (Bresnahan et al., 1999; Ichniowski & Shaw, 2003; Paauwe & Boselie, 2005; Wright et al., 2003). Boselie et al. (2005) conducted an exploratory analysis of the literature from 1994 to 2003 and found that there remains a deficiency in understanding the link between HRM and firm performance. Most studies focus on HRM systems or bundles of HRM practices of which training is one of the top four included HRM practices (Paauwe and Boselie, 2005). In particular, Delaney and Huselid (1996) found support for a positive impact of HRM practices (including training) on the perception of firm performance. Betcherman et al (1998) found that firms that pursued training programs were more likely to perform better in terms of productivity, profitability, and future prospects that those that did not.

Given the importance of the service sector in the "knowledge based" economy, it is important to understand specifically how knowledge accumulation through the investment in training can lead to a competitive advantage for firms. This is particularly important as knowledge accumulation has been determined to be a leading characteristic for innovative activity (Nelson and Winter, 1982). Laursen and Foss (2003) also found that HRM practices (including training) were an indicator of innovation. Therrien and Leonard (2003) extended the previous results and found support for complementarities between various human resource practices to support first-to-market innovations as those firms with coherent HRM systems had significantly more innovations than those with few or no high HRM practices.

Despite the number of studies completed, there is still a limited understanding of the importance of training in the service sector as well as a limited understanding of factors influencing decisions to choose between type of training activities and modes of implementation (on-the-job or in the classroom). Training has often been criticized as being too expensive, not transferring to specific job tasks, and not improving the profitability of the firm (Caudron, 2002, Wright and Geroy, 2001). Turcotte et al (2003) found that employers tend to believe that the modes of training (on-the-job vs. classroom) are complementary. They also found that the size of the firm has a significant impact on the incidence and intensity of training provided. Small businesses also tend to invest in a different set of training practices and modes than their larger counterparts (Leckie et.al, 2001). This could be due to the constraints on small firms to absorb the possible temporary reduction in productivity that can occur during in classroom training periods resulting in a higher proportion of on-the-job training practices in smaller firms. Cost is also a major constraint to small firms investing in training as they do not enjoy the economies of scale of larger firms for offering formal in classroom training initiatives (Rabemananjara and Parsley, 2006).

The majority of previous studies have focused on macro-level analysis or the impact of training on individuals. Tharenou et al. (2007) conducted a thorough literature review and analysis of the existing evidence of the effects of training on organizational-level outputs. They found that there is little theoretical development on the impact of training on organizational effectiveness and that the measure of training varied widely in the studies. Tharenou et al. (2007) also found that many of these studies rely on perceptual outcome variables where the number of significant results is much greater that when objective outcome measures are used. This suggests that managers' perceptions of the impact of training may be much higher than the measurable effects. The authors also express concern that just under 60% of the studies rely on the same surveys to measure training and productivity which may be inflating the number of significant findings. This study will extend the current set of results (and address many of the limitations expressed by Tharenou et al (2007)) by using a different dataset as well as have a relatively large sample size over seven consecutive years.

There are a few studies which focus on the impact of training investments on objective organizational outcomes. Cassidy et al (2005) studied knowledge accumulation at the plant or firm level in the Irish manufacturing industries. Using only two years of data, they found that productivity enhancing effects of knowledge accumulation are only found in domestic firms and not in foreign multinationals. Holzer et al (1993) found that firm sponsored training aided in reducing the scrap rate in manufacturing plants. Using date from 1983 and 1986, Bartel (1994) found that investment in training in 1983 did result in improved productivity in 1986. Using data from the US National Employers' Survey for 1993, Black and Lynch (1996) find support for investments in training being positively related to productivity. Aw and Batra (1998) considered both R&D and training in Taiwan. Due to the limitations of their data set, they were unable to differentiate between training and R&D investment amounts. They did however find a positive relationship between R&D and/or training investment and productivity. Aragon-Sanchez et al (2003) found support for training positively impacting future productivity but that the impact in the subsequent year is small. They hypothesize that the effect will continue and might grow but leave this analysis for future research as their dataset only contained data for one year. This study will extend our understanding on the impact of training on productivity by analyzing the link between multiple years of training investment and R&D investment in order to determine the impact of accumulated knowledge investment on productivity in both Canadian manufacturing and service sectors. It will also analyze the impact of training and R&D investment on the quality of innovation (World-first, Canada-first, Firm-first).

Tharenou et al. (2007) found in their review of the literature (67 studies on the effect of training on firm outcomes) that training more has a small positive effect on performance. They also found that earlier training expenditures still showed up in current period performance measures. This indicates that training has long-lived benefits. In terms of financial effects, however, they found little evidence of impact

2.2 Complementarity Analysis

Fundamentally, the impact of complementarity means that there is a marked benefit for making changes in groups. This implies that implementing a new "cost saving" measure may result in the opposite effect, as the fit between the new method and existing practice does not match. In particular, it has been shown that managers working independently, and whose decisions are not co-ordinated, will systematically under respond to external changes and may never find the global optimum set of policies (Milgrom and Roberts, 1995).

The first definition of complementarity was by Fisher in 1893. This is a polar definition because only two goods are involved. If you selected only one of the goods then they were substitutes (like coffee and tea) or you selected both and they were complements (like bread and butter). The second definition is the Edgeworth-Pareto complementarity based on introspective utility's cross derivative. This method presupposes that the consumer has in mind one cardinal indicator of utility and that it is known. The third definition is to define complementarity using the sign of the cross-elasticities, $\partial q_i / \partial p_j$ [1] or by $\partial q_j / \partial p_i$. This method is intuitive but suffers from the problem that the cross-elasticities may not be the same, so for example lemon might be complementary to salt and salt a substitute for lemon (Samuelson, 1974).

Hicks and Allen (1934) established a framework for complementary goods, which revolutionized demand theory. This definition, based on the work of Slutsky, Hicks, Allen, and Schultz in the 1930s, was created to deal with the inconsistency of previous definitions. Instead of using the sign of the cross-elasticity, $\partial q_i / \partial p_j$ a compensated price change was used. In effect, increasing p_j, there is a simultaneous increase in money income by an amount just sufficient to keep the consumer on the same indifference contour and then determine the sign of the change in q_i, namely of $(\partial q_i / \partial p_j)_{\bar{u}} = (\partial q_i / \partial p_j) + q_j \partial q_i / \partial income = s_{ij} = s_{ji}$. If $s_{ij} > 0$ this implies i and j are substitutes, $s_{ij} < 0$ this implies i and j are complements, and $s_{ij} = 0$ then i and j are independent (Samuelson, 1974). Since then, the notions of complements and substitutes have become widely used in demand theory.

The elasticity of substitution is often used instead of the cross-elasticity of demand. This is primarily because the most common measure is symmetric, thereby allowing the use of theorems and operations relating to symmetric matrices (Cahill, 1999). There are three principal definitions for the elasticity of substitution (σ). The first (1) is for two inputs x1 and x_2, where f is the production function and σ is the elasticity of the input ratio with respect to the marginal rate of technical substitution (Hicks, 1970).

$$\sigma \equiv \frac{\partial(x_2 / x_1)}{\partial(f_1 / f_2)} \cdot \frac{f_1 / f_2}{x_2 / x_1} \quad (1)$$

The second definition is the Allen partial elasticity of substitution (σ_{ij}^{A}) and is defined by

[1] pj is the price for item j, q_i is the quantity of iterm i. The elasticity of substitution is a unitless measure

(2), where F is the bordered Hessian[2] determinant, and F_{ij} is the cofactor associated with f_{ij} (the ijth element of the Hessian matrix). Goods are complements if the elasticity of substitution is negative and substitutes if it is positive (Chambers, 1988).

$$\sigma_{ij}{}^{A} = \frac{\sum_i x_i f_i}{x_i x_j} \cdot \frac{F_{ij}}{F} \qquad (2)$$

Uzawa (1962) applied Allen's elasticity of substitution measure to a cost function dual to an n-input technology. This created the Allen-Uzawa form of $\sigma_{ij}{}^{AV}$ (3), $i \neq j; i, j \in N$, where C is the total minimum cost and is evaluated at some vector of prices w and output level y; $C_k = \frac{\partial C(w,y)}{\partial w_k}, k = i, j$; and $C_{ij} = \frac{\partial^2 C(w,y)}{\partial w_i \partial w_j}$ (Cahill, 1999).

$$\sigma_{ij}{}^{\text{AV (w, y)}} = \frac{C \cdot C_{ij}}{C_i C_j} \qquad (3)$$

The Allen and Allen-Uzawa elasticities of substitution measure only the change in one input due to a change in price in one other input, this means that one should not use it to measure changes in input ratios (Cahill, 1999). It does show that a factor of production cannot be a complement for all other factors of production in terms of the Allen measure (Chambers, 1988). This coincides with the results for the two-good case by Hicks (1970).

The final measure is the Morishima elasticity of substitution (σ_{ij}^{M}). This measure was derived in 1967 in Japanese and has not been translated into English (Cahill, 1999). This is a two factor, one price measure and is defined as (4). Using this definition, one can relate σ_{ij}^{M} directly to the corresponding Allen measure $\sigma_{ij}{}^{A}$ ($\sigma_{ij}^{M} = \frac{f_j x_j}{f_i x_i}(\sigma_{ij}{}^{A} - \sigma_{jj}{}^{A})$) (Chambers, 1988).

[2] A bordered Hessian is the (n+1) * (n+1) matrix defined as having the upper left cell as 0, the remainder of the first row and column containing the first derivatives and the lower quadrant containing the usual Hessian matrix.

$$\sigma_{ij}^{M} = \frac{f_j}{x_i} \cdot \frac{F_{ij}}{F} - \frac{f_j}{x_j} \cdot \frac{F_{jj}}{F} \quad (4)$$

This formulation demonstrates two facts, σ_{ij}^{M} is not symmetric, and a pair of goods that are complements in terms of the Allen measure could be substitutes using the Morishima measure. According to Chambers (1988), this highlights the somewhat arbitrary nature of any elasticity of substitution in the many-input case.

2.3 Complementarities in Organizational Practices

Complementarity has seen the greatest application in the domain of dynamic capabilities (Teece et al., 1997). Dynamic capabilities explain how to achieve and allow the firm to maintain a competitive advantage. Teece et al. (1997) argued that a new entrant into the market cannot imitate a complex strategy overnight but will take time to piece together the policies required to match the incumbent. The authors also stress the path dependencies involved in attaining a complex strategy where many of the policies are intertwined and complementary to one another. Tyler (2001) stated three reasons for complexities related to imitation: the historical path taken to achieve the current state, the causal linkages between resources and a firm's competitive advantage is ambiguous, and the resource generating the advantage is socially complex (e.g., there are many complementary policies).

Rivkin (2000) also argued that complexity due to a high level of complementarity between strategies and internal policies creates a competitive advantage. He argues that due to the complexity of the problem, there is no polynomial-time algorithm that a competitor can use to imitate the incumbent's success. The problem under consideration by the imitator is NP-Complete, and thus all the competitor can do is to iteratively alter his strategy to be more like the incumbent. Using simulation, Rivkin (2000) showed that the majority of firms will become trapped at a local maximum but not replicate the strategy profile of the incumbent. Even the incumbent may not reach a global maximum due to the complexity of the problem (if

N is the number of variables or policies, there are 2^N possible solutions to check in order to find the optimum policy set).

Argyres (1995) examined the success of new technology strategy implementation with two different case studies, IBM and General Motors (GM). He determined that the firm's governance structure had to be complementary to the incentive structure in order for the strategy to be successful. The GM case demonstrates that when incentives and governance are not aligned then the strategy will be a failure. Conversely, IBM implemented a cooperative structure with team bonus incentives, and the technology strategies were a success. The knowledge of the type of governance structure that complements a given type of incentive policy gave IBM a great advantage over many of its competitors. The lack of this knowledge was a major reason for GM's problems. Massive losses occurred from 1980 to 1987 until this issue was recognized and resolved (Argyres, 1995).

Drake et al. (1999) examined one of the contributing factors to the success of implementing activity-based costing – having complementary human resource incentive policies. It is believed that this new costing policy will provide more information that can lead to an increase in process improvements. The authors showed that there is complementarity between activity-based costing and the incentive structure of the firm. If an incentive structure based on cooperation is not in place, then the effect of implementing activity-based costing will be negative. Moreover, it has been shown that performance-based incentives are also complementary to information asymmetry (Seidmann and Sundararajan, 1997). The recognition of this complementarity is important for the redesign of human resource policies when new technologies are implemented.

Negotiated transfer prices are an important aspect of many corporate policies, especially for large corporations. The negotiation process is often slow and takes a significant portion of managers' time. Once again, the knowledge of complementary factors has been shown to create significant advantages for aiding in this process. Ghosh (2000) showed that internal sourcing is complementary with a division manager having his/her compensation based on the performance of the entire organization. However, external sourcing is complementary with divisional performance compensation (the division is given a bonus based on their performance and not based on individual or company wide performance). He also showed that complementary arrangements between organizational factors (e.g., human resource policies, organizational design, and communication procedures) increased the perception that the transfer pricing was fair, reduced conflict between the trading partners, and significantly reduced the time taken to negotiate the contract. All of these benefits equate to an increase in productivity and a reduction in costs for all divisions involved in the price transfer negotiations.

Chenhall and Langsfield-Smith (1998) examined the fit between strategic priority (differentiation or low price), and human resource and management policies (e.g., quality systems, integration, team-based structures) using cluster analysis methods. The study found that different human resource and management policies cluster with the different strategic priorities. The results showed that there were some management policies that were required for either differentiation or low price strategies to be successful, and others only related to the success of one of the strategic types.

Complementarities in various areas including innovation policy, research and development strategies, and innovative employment practices have recently been analyzed. Gerhart (2004) conducted an evaluation of systems approaches that built on the concept of internal fit (a version of complementarity analysis) and found that these approaches do not outperform the other approaches in which individual HR practices are not aligned. Ichniowski et al. (1997) investigated the impact of innovative employment practices on productivity using 36 steel production lines in 17 companies. This study was one of the first to consider complementarities in organizational practices. Their results demonstrated that production lines using innovative work practices achieve significantly higher productivity than lines only adopting traditional approaches. In this study, a couple of different bundles of organizational practices were analyzed. MacDuffie (1995) found similar support for bundles of advance HRM practices in automobile manufacturing firms. Freeman et al(2000) found that firms which used more advanced HRM practices also demonstrated a higher use of overall HRM practices. In particular Freeman et. al (2000) found that complementarities existed between shared decision making practices and the sharing of financial rewards. Paauwe and Boselie (2005) conclude that both best practice and best fit analysis are important in understanding the link between firm performance and HRM. This study will extend previous work by considering complementarities between different types of training practices in order to highlight the additional ROI of implementing sets of training practices. In particular, the study will help identify the optimal bundling of training practices and mode of implementation in order to obtain the highest level of ROI as measured by increase labour productivity and profitability of the firm.

There have also been a number of studies which focused on complementary aspects to support research and development (R&D) activities and innovation in the firm. Belderbos et al. (2006) assessed the performance of R&D firms using different cooperation strategies with different partners. They demonstrated that whether firm performance improves or recesses with joint adoption of cooperation strategies varied by firm size and particular strategy integrations. In particular, the productivity of small firms will decline due to high costs and management difficulties if multiple partnerships are adopted simultaneously. Cassiman and Veugelers (2006) combined a productivity approach and an adoption approach with a two-step model; they not only tested the complementarities among internal R&D and external knowledge acquisition but investigated the drivers for joint adoption of these innovation activities. Their results suggest that external knowledge acquisition and internal knowledge acquisition are complementary. However, the success of innovation also depended on the strategic context of firms.

Mohnen and Röller (2005) used European data to test complementarities in innovation polices. They identified the existence of complementarities between various government innovation policies and organizational obstacles to innovative activity. They found that the existence of complementarity in innovation depended on the phase of innovation (e.g. the propensity and intensity of innovation in firms), as well as on the innovation policies pursued by the firm. Their results also demonstrated that the two phases of innovation were subject to different constraints; some policies are complements in with the propensity to innovate, but are substitutes with respect to the intensity of innovation.

The majority of previous studies used a limited number of the independent variables in their regression models for testing complementarities in training practices, for example, in the study by Cassiamn and Veugelers (2006) there were only 2 variables considered for complementarities. This paper will expand the depth of knowledge on the ROI of training by demonstrating the forms of training which are complementary or substitutes for each other using a comprehensive dataset. In this study, 26 training variables are used to better understand the impact that implementing multiple forms of training practices has on the cumulative ROI of training investments with respect to both improved labour productivity and increased profit margins of the firm.

2.4 Impact of Knowledge Transfer on Innovation

This study focuses on the human and organizational factors that affect innovation, in particular the quality of innovation that the establishment is able to produce. The underlying concepts for the model are that it is the human element and its ability to create new knowledge from existing sources through R&D, union information networks, and prolonged training are the primary factors in determining not only if an innovation can be created, but the quality of any such innovations. The level of training investment and R&D expenditures demonstrates a commitment of management for the transfer of knowledge and innovation activity in the establishment. Fiol (2001) argues that the potential for a establishment to generate innovations is directly dependent on the investment of the establishment in the prior accumulation of knowledge and the level to which it has been absorbed by the employees. Prajogo and Ahmed (2006) state that organizations need to stimulate and improve the knowledge and skills of their human capital by providing them with the necessary means to share information and communicate new knowledge with each other. This study will focus on knowledge transfer variables to provide greater insight into the longitudinal impact of investment in absorptive capacity and human capital and its impact on the quality of innovation of a establishment.

Many studies have examined the role of R&D intensity as a measure of input into the innovation process (Adam et al, 2006, Parthasarthy and Hammond, 2002). These studies have observed that there exists strong relationship between innovation performance and R&D intensity. Bougrain and Haudeville (2002) argue that R&D intensity does not influence future prospects for innovation and is an imperfect measure of innovation activity. R&D is also only one of many inputs into the innovation process and is less effective as a proxy as the size of the establishment decreases as small and medium sized organizations have limited funds to invest in formal R&D processes (Kleinknetch, 1987). A similar issue exists when considering innovation in the service sector where formal R&D processes are less common and therefore the level of R&D intensity is typically low (Hipp and Grupp, 2005). This study will include R&D expenditures as an input into the innovation function in order to add further insight into the impact of these expenditures on innovation in the service sectors as well as on the quality of the innovation generated.

Training has often been criticized as being too expensive, non-transferable, and in particular not having a direct effect on establishment productivity (Tharenou et al., 2007, Boselie et al, 2005, Kraiger et al, 2004, Wright et al, 2003). In their review of recent literature on training and firm productivity, Boselie et al. (2005) found that although financial performance measures respesent over half of the articles published, these measures are problematic as there are many environmental variables that impact these indicators which confound the analysis of the effects of training. Tharenou et al (2007) argue that there is little evidence on the effects of training on results criteria, particularly at the organization level. This study will focus on increasing the understanding of the impact of training at the organizational level, in particular on the quality of innovation produced by the establishment.

Few studies have been able to investigate the linkage between training and innovation. Some time ago Baldwin and Johnson (1995) found that training was directly related to innovation due to the specificity of knowledge and the rate of technological change associated with innovation. Recent work summarizing the effects of training on performance by Boselie et al. (2005) and Tharenou et al. (2007) report on financial performance, productivity, profit, sales, and quality. However, innovation was not mentioned.

Some studies have viewed product innovation as a direct outcome of knowledge mobilization in the establishment (Eisenhardt and Martin, 2000; Helfat and Raubitschek, 2000). There is a perception that increases in human capital will result in a greater innovation capacity and therefore a greater number of innovations (Subramaniam and Youndt, 2005). This is particularly important as knowledge accumulation has been determined to be a leading characteristic for innovative activity (Nelson and Winter, 1982). Laursen and Foss (2003) also found that HRM practices (including training) were an indicator of innovation. Therrien and Leonard (2003) extended the previous results and found support for complementarities between various human resource practices to support first-to-market innovations as those establishments with coherent HRM systems had significantly more innovations than those with few or no high HRM practices. Hayton (2005) found that the level of human capital in the establishment had a significant impact on innovations by high-technology new ventures. Baldwin and Johnson (1995) found that training was directly related to innovation due to the specificity of knowledge and the rate of technological change associated with innovation. This study also found that the size of the establishment has a direct impact on the amount of training provided per employee (with large establishments providing both more overall training and in particular more formal training than small establishments). Laplagne and Bensted (1999) considered the impact of training and innovation on labour productivity growth in Australia. They found that the timing effects of training on innovation depended on the type of innovation. They also found that both innovation and training were more prevalent in establishments experiencing a high level of labour productivity growth.

This study will extend previous knowledge on the impact of internal knowledge creation on the quality of innovation produced by the establishment. By understanding the impact that investing in training and R&D has on the quality of innovation produced, both governments and organizations will be able to develop appropriate policies to stimulate world-first and country-first innovations. By considering the analysis by industry, general trends will be identified as will industry specific needs. By including establishment variables such as unionization and foreign ownership we hope to be able to account for some of the effects of knowledge entering from external information networks.

3. Methodology

This study uses the Statistic Canada's Workplace and Employee Survey (WES) (Statistics Canada, 2004) which contains results from over 6000 Canadian establishments[3] over 7 year period from1999-2005. The WES is designed to explore a broad range of issues relating to employers and their employees. The survey aims to shed light on the relationships among competitiveness, innovation, technology use, and human resource management practices. In

[3] An establishment represents the lowest unit of observation—i.e. a firm could have multiple establishments, and so too could a business unit. Normally, we would call establishments "plants", but since this survey covers 14 industries, including nine which are services, we use the term "establishment" instead.

this study, we focus on the data provided by the workplace survey with respect to variables relevant to training, labour productivity, and profit. Because the survey is mandatory, response rates are consistently above 80% reducing the concern due to sample size in previous studies expressed by Tharenou et al (2007). From its inception the WES was designed to be a longitudinal survey conducted over multiple years. As such, the questionnaire has undergone only minor changes since its inception. It is a multifaceted survey with two components: an employer questionnaire and an employee questionnaire. For this study we are only concerned with the employer (establishment) version of the survey. The surveys from 1999-2005 were linked via an establishment level identifier variable called DOCKET. Establishments were sorted by DOCKET in each of the seven surveys and the files were then merged (not-for-profit establishments were excluded). Only establishments that had remained in the sample frame for the full seven years were retained in the linked data file. After cleaning, the number of establishments was 3,528 with 24,696 observations.

There are two types of training practices studied in the survey: in-classroom training (ICT) and on- the-job training (OTJT); each training method has 13 sub-categories representing various training practices. In classroom training was any training provided or supported by the organization, taking place either inside or outside the company, conducted in a formal classroom environment intended to develop employee skills or knowledge. On-the-job training encompasses any informal training provided to the employee while they are completing their work duties. The 13 sub-categories are the same for both in-classroom and on-the-job training methods. These include basic orientation, literacy, health and safety training, apprenticeship, problem-solving skills, and specific equipment and computer training (refer to Table 1 for the complete list of training practices analyzed in this study). Chief Executive Officers (CEOs) were asked which types of training practices were implemented and through which method at the organization. The responses were coded as a yes or no for each training practice and method. This resulted in 26 binary training variables for each organization for a given year.

TABLE 1 TRAINING PRACTICES

Training Practices in the WES Survey
Orientation for new employees
Managerial/supervisory training
Professional training
Apprenticeship training
Sales and marketing training
Computer/hardware
Computer/software
Other office and non-office equipment
Group decision-making or problem-solving
Team-building, leadership, communication
Occupational health and safety, environmental protection
Literacy or numeracy
Other training

Before we investigate the data in detail, we need to filter and tailor the data to make it fit the constrained regression of the model. Studies show that small firms perform differently from large firms due to their organizational structure, cash-flow, and the economies of scale they can generate (Chaykowski and Slotsve, 2005). Therefore, firms in different size classes may implement different training practices or similar training practices but on a different scale. For example, small firms in general have a more flexible organizational structure, less specialists dedicated to a specific task in the organization, and less budget to allocate to training than large firms. Therefore, they may focus on a few specialized training practices or a small amount on a number of practices rather than the diverse set of training practices that one would expect to find in a large firm. On the other hand, large firms typically have systematic training in every area due to their traditional organizational structure and the need for focused skills for each area of the firm. Not-for-profit firms were determined to be outside the scope of this study as their motivation for training and strategic priorities as significantly different from those of for profit firms. As a result, all not-for-profit firms and firms with less than 5 employees were removed from the dataset. For firms that completed the survey more than one particular year, the data from the most recent year was used in the regression analysis. The distribution of in-classroom training and on-the-job training among the firms is shown in Table 2.

TABLE 2 DISTRIBUTION OF TRAINING AMONG FIRMS

Training Types	Frequency	% of All Firms
No Training Practices	4741	15.43%
In-class Training only	2455	7.99%
On-the-job Training only	5587	18.18%
Both In-class tTraining and On-the-job Training	17941	58.39%
Total	30724	100%

For the regression analysis to analyzes the impact of training investments and knowledge accumulation on innovation, this portion of the study incorporates data collected over a six year period from 1999 – 2004. In order to analyze a time lag effect for training investments, training expenditures over the previous three-year period were lagged. After all establishment linkages were complete, 3,810 establishments remained, constituting 22,209 observations. The means and standard deviations for all variables used in the study can be found in Table 1. The manager or CEO of the establishment was asked whether they had introduced a new or improved product or process in the past three years. Approximately 38% said they had a product innovation, while 27% said they had a process innovation. About 42% of establishments had a new product and/or process innovation or both. Then managers were asked to identify the “most important innovation” i.e. based on which one cost the most to implement in the past year. Managers were then asked to rate their most important innovation as a world-first, or a first in Canada, or as a first in the local market or none of these.

TABLE 3 – VARIABLE DEFINITIONS FOR TRAINING AND INNOVATION REGRESSION ANALYSIS

Variable	Description	Mean	Standard Deviation
Quality of Innovation	Self-identified field specifying if the innovation is world-first '3', Canada-first '2', first in local market '1', none '0'	0.5512	0.0118
R&D	Coded as '1' if strategic importance of R&D was critical, very important, or important otherwise it was coded as '0'	0.2136	0.0061
Foreign Ownership	Percentage of assets held by foreign interests	0.0401	0.0025
Union	Percentage of unionized employees	0.0763	0.0033
Information and communication technology Investment Costs	Investment in information and communication technology (software and hardware) per employee ($/person)	573.95	45.613
Training Cost (t=0)	Training investment per employee in current year ($/person)	158.53	6.4582
Training Cost (t-1)	Training investment per employee in previous year ($/person)	167.47	6.8272
Training Cost (t-2)	Training investment per employee two years previously ($/person)	179.09	6.7723

This paper will focus on the results for the entire sample as well as analysis conducted by industry. As shown in the Table 4, mean training expenditures from 1999-2004 are highest in the finance and insurance industry - $425 per employee, second highest in the communication and other utilities - $322 per employee, and lowest in retail trade at $84 per employee. The distribution of establishments by industry sectors are for the linked dataset from 1999 to 2004 are: forestry, mining, oil, and gas extraction (971); labour intensive tertiary manufacturing (1624); primary product manufacturing (1314); secondary product manufacturing (1274); capital intensive tertiary manufacturing (1522); construction (2409); transportation, warehousing and wholesale trade (2906); communication and other utilities (1248); retail trade and consumer services (2332); finance and insurance (1795); real estate, rental, leasing operations (1082); business services (1771); education and health services (1012); information and cultural industries (949).

TABLE 4 – TRAINING EXPENDITURES FROM 1999 - 2005

	1999	2000	2001	2002	2003	2004	2005	**99-05**
	Training costs ($/employee)							**Mean**
All industries	155	152	149	153	181	191	169	**164**
Finance, insurance	452	463	351	300	516	468	460	**430**
Communication, utilities	336	306	226	321	340	405	353	**327**
Forestry, mining, oil, gas	198	201	189	268	358	495	385	**299**
Information, culture	130	258	337	227	403	293	203	**264**
Primary product mfg	228	261	212	176	221	312	270	**240**
Capital intensive tertiary	269	239	169	253	377	174	147	**233**
Secondary product mfg	108	201	311	157	226	213	215	**204**
Business services	158	168	181	243	269	225	184	**204**
Transport, warehousing	218	214	168	152	163	143	151	**173**
Construction	137	162	154	153	124	257	187	**168**
Education, health	147	80	118	120	197	187	205	**151**
Labour intensive tertiary	90	115	75	134	119	137	155	**118**
Real estate	151	69	136	107	87	134	117	**114**
Retail trade	72	75	81	87	77	113	84	**84**

Is there a positive relationship between training and workplace productivity? Productivity can be measured as firm output or labour productivity (output per employee). The logical choice for a conceptual model is a production function.

$$Y_{it} = f(K_{it}, L_{it}, E_{it}, M_{it}, TS_{it}) \tag{1}$$

Where *i*, *t* represents firm *i* observed at time *t*. *Y* is the firm's output in physical units, *K* is the firm's capital stock, *L* is the number employed, *E* is energy use measured in KWh but more often in terms of expenditure, *M* is materials use most often in expenditure form. The term *TS* is the capital stock of training, which is different from simple investment in training each year. The capital stock measures the total existing value of training expenditures past and present. Unfortunately, we do not have a training capital stock variable (no one does). The best we can do is to model the annual investment in training at a given location. This is modeled below in *2* where, *TRN* represents the annual investment in training. The lagged terms indicate that investments may require time to affect productivity (i.e. learning and integration into existing system effects).

$$Y_{it} = f(K_{it}, L_{it}, E_{it}, M_{it}, TRN_{it}, TRN_{it-1}, TRN_{it-n}) \quad (2)$$

The effects on productivity are conditional on firm specific factors such as whether a union is present, and whether the firm is foreign-owned. It is expected that foreign ownership should have a positive effect on productivity because most multinationals operate at a larger scale than domestic firms. Our hypothesis is that training investments, current and past should increase labour productivity within the workplace. Below is the empirical equation we used for estimation of training's effect on productivity:

$$\begin{aligned} Y_{it} &= \alpha_{it} + \beta_{it} * Union + \delta_{it} * \Pr of\_Tech + \phi_{it} * R\&D + \varphi_{i0} * TRN_{i0} + \varphi_{i1} * TRN_{it-1} \\ &+ \varphi_{i2} * TRN_{it-2} + \varphi_{i3} * TRN_{it-3} + \varphi_{i4} * TRN_{it-4} + \varphi_{i5} * TRN_{it-5} + \varphi_{i6} * TRN_{it-6} + \varepsilon_{it} \quad (3) \end{aligned}$$

Where Union is the percentage of employees who are under union contract, Prof_Tech is the proportion of the total workforce who are considered as professional or technical employees, R&D is a binary variable for whether the workplace conducts research and development, and the variables TRN represent current year expenditures on training (*t*=0) all the way back to training expenditures made six years ago (*t*-6).

In order to determine the impact of internal knowledge creation methods on the quality of innovation, responses to questions about the importance of R&D, investment in training, and investment in information and communication technologies were used as independent variables. To account for knowledge generated from an organization's network of resources two additional independent variables were also included. The percentage of foreign ownership was used as a proxy for international influences and the percentage of unionized workers was used as a proxy of organization structure and industry knowledge networks. Foreign ownership was shown by (Belderbos, Carree, Lokshin, 2006) to be significant in all models of R&D strategic complementarities. Two dependent variables were used—"innovation" composed of a new or improved product and/or process over the past year, and "quality of innovation" comprised of ordinal responses (world-first innovation, first in Canada, first to the local market). Innovation quality is only assessed for the innovation which "cost the most to implement".

A conditional fixed effects logistic regression was conducted for the entire sample, as well as for each specific industry. The dependent variable was a new/improved product and/or process innovation in the past year coded as one otherwise as zero. The general model is:

$$Innovation = \beta_1 * R\&D + \beta_2 * Foreign + \beta_3 * Union + \beta_4 * ICT + \beta_5 * Train_{t=0} + \beta_6 * Train_{t=-1} + \beta_7 * Train_{t=-2}$$

An ordered logistic regression (OLR) was conducted for the entire sample, as well as for each specific industry. The dependent variable innovation quality was coded such that the highest category was world-first, the second highest was first in Canada, followed by first in the local market and finally "none of these" was last. The general model is:

$$QualityofInnov = \beta_1 * R\&D + \beta_2 * Foreign + \beta_3 * Union + \beta_4 * ICT + \beta_5 * Train_{t=0} + \beta_6 * Train_{t=-1} + \beta_7 * Train_{t=-2}$$

All models rejected the hypothesis that the coefficients of the independent variables were zero and converged after four iterations.

In order to determine complementary and substitute training practices, a constrained regression model as in (Milgrom and Roberts, 1995, Mohnen and Roller, 2005) is used due to the discrete nature of the training variables. The constrained regression model is shown as follows.

$$
\begin{aligned}
&L^k(z_j^k, x_n^k, \alpha_{m_1 \ldots m_M}, \varepsilon^k) \\
&= \sum_{m_M=0}^{1} \ldots \sum_{m_1=0}^{1} \alpha_{m_1 \ldots m_M} [\prod_{j=1}^{M} (1 - m_j - (-1)^{m_j} z_j^k)] \\
&+ \sum_{n=1}^{N} \alpha_n^k x_n^k + \varepsilon^k
\end{aligned}
$$

where *k* refers to firm *k* and *j* represents training practice, from 1 to *M*. z_j^k are the binary independent variables which indicate the state of training practice *j*; 1 if the training *j* is available, 0 otherwise. m_j is the state of training practice j, 1 available; 0 otherwise. x_n^k, running from 1 to N, is a vector of other variables that may have impact on the dependent variable, labour productivity or profit, which are represented by $L^k(z_j^k, x_n^k, \alpha, \varepsilon^k)$. ε^k is the error term. $\alpha_{m_1 \ldots m_M}$ are coefficients relevant to their training practice states.

The complementary between any two training practices, i, $i+1$, is tested by following constraints $\alpha_{m_1 \ldots, 1, 1, \ldots m_M} + \alpha_{m_1 \ldots, 0, 0, \ldots m_M} \geq \alpha_{m_1 \ldots, 0, 1, \ldots m_M} + \alpha_{m_1 \ldots, 1, 0, \ldots m_M}$. If the constraints are strictly satisfied for any other m_j, training practices, i, j are perceived as complementary to each other. Unbiased estimation of the coefficients will be tested in later section to prove the existence of the complementarities.

However, conditional on the number of the types of training practices, the size of the model increase exponentially; we have 2^{M-1} constraints for each pair-wise complementarity or substitute comparison. This will increase the computation cost and causes a constraint on the number of variables due to the sparseness of the data matrix. We therefore needed to perform factor analysis to group different trainings with similar characteristics into one category in order to reduce the number of training variables from 26 to a more manageable number. Through factor analysis, we initially reduced the number of factors from 26 to three training variables and then completed a second analysis based on feedback from colleagues and the community partner reduced the number of training variables from 26 to five. The results of the factor analysis for the 3 factor model are presented in Table 5 and for the 5 factor model on the training practices are presented in Table 6.

TABLE 5 VARIANCE EXPLAINED BY FACTOR ANALYSIS FOR ALL TRAINING PRACTICES – 3 FACTOR MODEL

Factor	Variance Explained (Weighted)	Variance Explained (Unweighted)
1-GeneralTraining	52.53%	53.31%
2-Professional and Technology Training	29.87%	19.67%
3-Apprentice & Analysis	17.60%	27.02%

After factor analysis, the 26 training practices can be grouped into 3 categories:

Factor 1: Management (general) training: Orientation, management, sales & marketing, office and non-office equipment, group decision making, team building & leadership, and health and safety
Factor 2: Technology training: professional training, computer hardware, and computer software
Factor 3: Apprenticeship and analysis: apprentice, literal and numerical

All the training practices that have a factor coefficient greater than or equal to 0.3 were grouped into that particular factor. This resulted in the following factors:

Factor 1: In-class training general training: Orientation for new employees; Managerial/supervisory training; Professional training; Sales and marketing training; Computer/hardware; Computer/software ; Other office and non-office equipment; Group decision-making or problem-solving; and Team-building, leadership, communication

Factor 2: On-the-job training general training: Managerial/supervisory training, Sales and marketing training, Group decision-making or problem-solving, Team-building, leadership, communication, and Literacy or numeracy.

Factor 3: Technology training: In-class training: Computer/hardware; Computer/software; On-the-job training: Computer/hardware; Computer/software, Other office and non-office equipment.

Factor 4: Occupational health and safety: In-class training: Occupational health and safety, environmental protection;

On-the-job training: Orientation for new employee, and Occupational health and safety, environmental protection.

Factor 5: Apprenticeship: both In-class training and On-the-job training Apprenticeship.

TABLE 6 FACTOR ANALYSIS FOR ALL TRAINING PRACTICES – 5 FACTOR MODEL

Categories	Training Practices	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
In-class Training	Orientation for new employees	0.550	-0.033	-0.018	0.229	-0.004
	Managerial/supervisory training	0.609	0.039	0.033	0.165	-0.045
	Professional training	0.452	-0.047	0.127	-0.078	0.141
	Apprenticeship training	0.224	-0.012	-0.016	0.007	0.643
	Sales and marketing training	0.598	0.052	0.135	-0.051	-0.123
	Computer/hardware	0.450	-0.150	0.365	-0.071	0.088
	Computer/software	0.545	-0.179	0.373	0.042	-0.016
	Other office and non-office equipment	0.334	0.019	0.119	0.066	0.048
	Group decision-making or problem-solving	0.613	0.308	-0.136	-0.080	0.043
	Team-building, leadership, communication	0.732	0.245	-0.113	-0.032	-0.030
	Occupational health and safety, environmental protection	0.379	-0.179	-0.116	0.583	0.069
	Literacy or numeracy	0.207	0.129	0.017	-0.089	0.108
	Other training	0.068	-0.034	0.058	0.114	-0.016
On-the-job training	Orientation for new employees	-0.029	0.236	0.153	0.349	-0.078
	Managerial/supervisory training	0.087	0.359	0.175	0.204	-0.006
	Professional training	0.135	0.145	0.253	-0.044	0.151
	Apprenticeship training	-0.084	0.146	0.085	0.013	0.660
	Sales and marketing training	0.139	0.346	0.307	0.009	-0.124
	Computer/hardware	0.044	0.108	0.571	-0.021	0.096
	Computer/software	0.045	0.107	0.630	0.155	-0.044
	Other office and non-office equipment	-0.095	0.235	0.335	0.167	0.001
	Group decision-making or problem-solving	0.079	0.717	-0.013	0.009	0.079
	Team-building, leadership, communication	0.109	0.703	0.034	0.087	-0.014
	Occupational health and safety, environmental protection	-0.127	0.180	0.022	0.712	0.068
	Literacy or numeracy	-0.076	0.317	0.065	-0.020	0.121
	Other training	-0.007	0.014	0.040	0.086	-0.039

We then created binary variables for each firm for each of the training factors. Based on the survey dataset, the sum score of each factor for each observation was calculated. In order to control for the size of the firm as a proxy for the size of the training budget specific size class means for training usage were determined for each factor. If a respondent's use of training practices for that factor was greater than or equal to the group average score for its respective size class, it would be coded as '1', otherwise it was coded as '0' (refer to Table 7) for mean cut-off values). As the survey only requested if the firm conducted a specific type of training, there is no way to use a weighted analysis based on investment in a particular type of training. This is a limitation of the study which should be addressed in future research with a more comprehensive survey set which includes investment in each type of training practice.

The ROI on the training usage is measured by two different metrics; labour productivity or profit. Independent variables include binary variables representing the training practice factors and other variables that may have impact on perceived ROI such as if there is a union, in the firm is multi-national, and if the firm has an innovation in the year of analysis.

TABLE 7. SIZE CLASS FACTOR MEANS

Factor	Small Firms	Medium Firms	Large Firms
Factor 1: In-class General Training	1.04	3.37	5.26
Factor 2: On-the-job General Training	0.53	1.28	1.99
Factor 3: Technology Training	0.76	1.79	2.61
Factor 4: Occupational Health and Safety Training	0.70	1.65	2.13
Factor 5: Apprenticeship	0.20	0.49	0.71

Analysis was conducted based on firm size and industry. These were not included as dummy variables in order to limit the amount of confounding of the results due to organizational structure, and industry specific labour issues. We classify the size of firms into 3 groups: small firms (5 to 50 employees), medium firms (51 to 250 employees), and large firms (greater than 250 employees). The distribution of the data by the size class for the complementarity analysis is 4 215 large firms, 10 262 medium firms, and 15 541 small firms. There are 1 624 large service firms, 5 693 medium sized service firms, and 10 145 small service firms, for a total sample size of service firms of 17 462. There are a total of 14 industry sectors, 8 service industries and 6 manufacturing industries analyzed in this study. The descriptive statistics by industry are shown in Table 8.

TABLE 8 DESCRIPTIVE STATISTICS OF LABOUR PRODUCTIVITY AND PROFIT BY INDUSTRY

	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
Business services	1334	12.0699(5.6496)	-0.0119(7.969)
Capital intensive tertiary manufacturing	2132	11.5677(5.4489)	0.1373(2.5179)
Communication and other utilities	1778	11.8849(3.9523)	0.1071(2.0245)
Construction	1685	11.8642(4.4857)	0.1153(5.6123)
Education and health services	2062	11.8734(4.0874)	0.2054(3.0378)
Finance and insurance	3456	11.7402(5.473)	0.0865(6.8838)
Forestry, mining, oil, and gas extraction	4271	12.1424(9.0051)	0.1166(6.6465)
Information and cultural industries	1786	11.7959(3.9668)	-0.0233(10.3826)
Labour intensive tertiary manufacturing	3382	11.2317(14.3309)	0.1057(12.9271)
Primary product manufacturing	2541	11.791(5.3801)	0.1651(13.2144)
Real estate, rental and leasing operations	1399	11.6348(6.9254)	0.1135(2.6579)
Retail trade and consumer services	2636	11.4377(9.3795)	0.1119(10.2983)
Secondary product manufacturing	853	11.0279(10.1327)	0.156(9.5308)
Transportation, warehousing, wholesale	1409	11.4639(4.2924)	0.0771(3.7966)

Constrained regression models are used to estimate the coefficients relevant to the binary variables, based on the model previously described. Furthermore, two sets of hypothesis were conducted to test supermodularity (complements) and submodularity (substitutes) respectively. Using the results of the hypothesis tests for supermodularity we can determine which pairs of training practices should be adopted simultaneously so that the firms can obtained a higher marginal return on the investment of the additional training practice. Meanwhile, we can also determine which set of training practices should not be adopted simultaneously as they are substitutes for one another and the additional investment does not generate sufficient ROI. Therefore, there are two sets of hypothesis tests which must be analyzed; supermodularity for complementarity and submodularity for substitutability. The supermodularity (submodularity) test has the following set of constraints for the hypothesis testing (where M is the number of factors, in this case 5):

$$\text{H}_0\text{: } \alpha_{m_1...,1,1,...m_M} + \alpha_{m_1...,0,0,...m_M} = \alpha_{m_1...,0,1,...m_M} + \alpha_{m_1...,1,0,...m_M}$$

$$\text{H}_{1\ (\text{Supermodularity})}\text{: } \alpha_{m_1...,1,1,...m_M} + \alpha_{m_1...,0,0,...m_M} > \alpha_{m_1...,0,1,...m_M} + \alpha_{m_1...,1,0,...m_M}\ ,$$

$$\text{H}_{1\ (\text{Submodularity})}\text{: } \alpha_{m_1...,1,1,...m_M} + \alpha_{m_1...,0,0,...m_M} < \alpha_{m_1...,0,1,...m_M} + \alpha_{m_1...,1,0,...m_M}\ .$$

Using the constrained regression method forces a strict definition of complementarity or substitutability on the variables as the pairs must be complementarity (substitutes) from every possible initial set of training practices. These restrictions mean that eight constraints must be simultaneously satisfied for each pair wise comparison. In particular, the complementarity constraints for the pair wise comparison of factor 4, occupational health and safety (OcHS), and factor 5, Apprenticeship (App), would be the following (Note: In-class general training is ICT, on-the-job general training is OTJT, and technology training is Tech):

$$-\gamma_{00000(NoFactors)} + \gamma_{00001(App)} + \gamma_{00010(OcHS)} - \gamma_{00011(App\&OcHS)} > 0$$
$$-\gamma_{00100(Tech)} + \gamma_{00101(Tech\&App)} + \gamma_{00110(Tech\&OcHS)} - \gamma_{00111(Tech,App\&OcHS)} > 0$$
$$-\gamma_{01000(OTJT)} + \gamma_{01001(OTJT\&App)} + \gamma_{01010(OTJT\&OcHS)} - \gamma_{01011(OTJT,App\&OcHS)} > 0$$
$$-\gamma_{01100(OTJT\&Tech)} + \gamma_{01101(OTJT,Tech\&App)} + \gamma_{01110(OTJT,Tech\&OcHS)} - \gamma_{01111(OTJT,Tech,App\&OcHS)} > 0$$
$$-\gamma_{10000(ICT)} + \gamma_{10001(ICT\&App)} + \gamma_{10010(ICT\&OcHS)} - \gamma_{10011(ICT,App\&OcHS)} > 0$$
$$-\gamma_{10100(ICT\&Tech)} + \gamma_{10101(ICT,Tech\&App)} + \gamma_{10110(ICT,Tech\&OcHS)} - \gamma_{10111(ICT,Tech,App\&OcHS)} > 0$$
$$-\gamma_{11000(ICT\&OTJT)} + \gamma_{11001(ICT,OTJT\&App)} + \gamma_{11010(ICT,OTJT\&OcHS)} - \gamma_{11011(ICT,OTJT,App\&OcHS)} > 0$$
$$-\gamma_{11100(ICT,OTJT\&Tech)} + \gamma_{11101(ICT,OTJT,Tech\&App)} + \gamma_{11110(ICT,OTJT,Tech\&OcHS)} - \gamma_{11111(AllFactors)} > 0$$

Firms may have different sets of training or lay more emphasis on some training practices than others based on the nature of the industry which they belong. Therefore, individual labour productivity and profitability models were created for each size class and industry. A likelihood ratio (LR) test was used in order to determine if we should reject the null hypothesizes (Kodde and Palm, 1986). For example, this resulted in 110 tests for complementarity and 110 tests for substitutes for each dependent variable in the 5 factor analysis (e.g. 440 total constrained regression models and LR tests).[4]

[4] The likelihood ratio test statistic is of the form LR = 2 [L(θ_U) - L(θ_R)], where θ_U is the unrestricted Maximum Likelihood estimate of θ, and θ_R is the restricted Maximum Likelihood estimate of θ. To implement the test we use the following: LR = n log (SSR_U)/ log (SSR_R), where SSR_U is the unrestricted sum of squared residuals and SSR_R is the restricted sum of squared residuals. Given the large number of results, individual regression model results are available from the authors upon request.

4. Results and Discussion

4.1 Longitudinal Impact of Training on Performance

In order to analyze the longitudinal impact of training on performance, the linked Workplace and Employee Survey dataset from 1999 – 2005 was used. Table 9 summarizes average training expenditures from the highest to lowest for each year and industry as well as the averages for the dependent variable of productivity. Interestingly, average productivity is not perfectly correlated with average training expenditure, since their correlation coefficient is only 27.5 percent.

TABLE 9. TRAINING EXPENDITURES FROM 1999-2005

	1999	2000	2001	2002	2003	2004	2005	Training 1999-05	Productivity 1999-05
	($ per employee)								
All industries	155	152	149	153	181	191	169	164	203,122
Finance, insurance	452	463	351	300	516	468	460	430	195,743
Communication, utilities	336	306	226	321	340	405	353	327	165,968
Forestry, mining, oil, gas	198	201	189	268	358	495	385	299	476,044
Information, culture	130	258	337	227	403	293	203	264	163,184
Primary product mfg	228	261	212	176	221	312	270	240	201,759
Capital intensive tertiary	269	239	169	253	377	174	147	233	174,122
Secondary product mfg	108	201	311	157	226	213	215	204	195,905
Business services	158	168	181	243	269	225	184	204	163,771
Transport, warehousing	218	214	168	152	163	143	151	173	306,504
Construction	137	162	154	153	124	257	187	168	205,552
Education, health	147	80	118	120	197	187	205	151	101,052
Labour intensive tertiary	90	115	75	134	119	137	155	118	143,357
Real estate	151	69	136	107	87	134	117	114	230,058
Retail trade	72	75	81	87	77	113	84	84	120,692

Stepwise regression results performed by industry are reported in Table 10. Because the regression for business services had no significant variables, it is not reported in the table. As in Table 9, for ease of interpretation, industries are ordered from highest to lowest average training expenditures (from 1999-2005). All equations except for information and culture, and construction are significant at the 0.0001 level. The Union variable is significant in five out of 14 industries and negative in two. Prof_Tech, the proportion of professional and technical trades in the workplace, is significant in three out of 14 industries and negative in two. R&D is only significant in one industry. If we make the assumption that employers will only invest in training to the point where the marginal cost of training is equal to the increase in the marginal value product of each employee, then it would make sense that the returns to higher investing industries should be greater than lower investing industries. It may also be surmised that the higher investing industries should exhibit a greater number of positive and significant coefficients on the training variables. As expected as we move from left to right in Table 2, (from the highest training expenditure in finance and insurance, to the lowest training expenditure in retail trade) the number of significant coefficients on the training variables decreases.

TABLE 10. STEPWISE REGRESSION OF LABOUR PRODUCTIVITY & TRAINING, 1999 - 2005

Dependent variable: Labour Productivity ($/employee)							
	Finance, insurance	Communication, utilities	Forestry, mining, oil, gas	Information, culture	Primary product mfg	Capital intensive tertiary	Secondary product mfg
Intercept	153,330***	168,588***	482,530***	229,252***		179,687***	179,926***
	(16,119)	(20,298)	(146,650)	(52,657)		(10,636)	(13,346)
Union		59,863#		-359,187***		119,880***	
		(41,278)		(178,122)		(38,372)	
Prof_Tech					118,232*	-71,944***	
					(69,767)	(26,222)	
R&D					121,421***		
					(39,648)		
Trn_Cst	47.02*		-586.33#			-158.34***	-121.33***
	(26.53)		(373.33)			(28.01)	(44.98)
Trn_Cst(-1)	102.88***	109.64***	1284.93***			249.85***	469.85***
	(27.68)	-28.68	(286.11)			(22.27)	(29.24)
Trn_Cst(-2)	104.38***	-125.04***				-58.66**	-162.82***
	(20.27)	(35.58)				(24.88)	(39.78)
Trn_Cst(-3)		125.36***	-630.53**		187.65***		
		(37.81)	(310.61)		(30.94)		
Trn_Cst(-4)	-37.91#	-129.13		-181.62**			
	(26.04)	(49.84)		(76.10)			
Trn_Cst(-5)	-37.24**	98.44***		476.41***			
	(16.64)	(21.76)		(130.62)			
Trn_Cst(-6)		-50.91**	439.94#				
		(19.97)	(275.32)				
N	2081	1350	1065	1074	1444	1706	1401
R-Squared	0.6756	0.2250	0.1728	0.0883	0.2115	0.3744	0.5754
F-Value	120.37	7.43	7.57	4.74	16.99	27.05	90.81
Pr>F	<0.0001	<0.0001	<0.0001	0.0034	<0.0001	<0.0001	<0.0001
Standard errors in parentheses							
*** significant at 0.01, ** significant at 0.05, * significant at 0.10, # significant at 0.15							
Note: Business services is omitted. No variables were significant in the regression.							

TABLE 10 (CON'T). STEPWISE REGRESSION OF LABOUR PRODUCTIVITY & TRAINING, 1999 - 2005

Dependent variable: Labour Productivity ($/employee)						
	Transport, warehousing	Construction	Education, health	Labour intensive tertiary	Real estate	Retail trade
Intercept	253,450***	315,922***	112,300***	109,106***	201,453***	121,239***
	(18,265)	(40,284)	(6,273)	(9,810)	(17,078)	(7,740)
Union			-55,847**	381,678***		
			(26,024)	(44,900)		
Prof_Tech		-212,211***				
		(72,128)				
R&D						
Trn_Cst					305.67***	
					(77.77)	
Trn_Cst(-1)	505.76***		20.85*	115.00***	-75.28*	
	(45.28)		(10.92)	(29.14)	(43.99)	
Trn_Cst(-2)				-111.61**		147.88***
				(48.29)		(25.89)
Trn_Cst(-3)	-300.65***		53.092***	102.71***		
	(56.78)		(15.95)	(34.10)		
Trn_Cst(-4)	114.57***					
	(39.25)					
Trn_Cst(-5)						
Trn_Cst(-6)			-27.19**			
			(10.68)			
N	3262	2637	1157	1757	1196	2584
R-Squared	0.2259	0.0224	0.1306	0.3248	0.1334	0.0783
F-Value	46.89	8.66	6.16	28.62	8.21	32.63
Pr>F	<0.0001	0.0035	0.0001	<0.0001	<0.0001	<0.0001
Standard errors in parentheses						
*** significant at 0.01, ** significant at 0.05, * significant at 0.10, # significant at 0.15						
Note: Business services is omitted. No variables were significant in the regression.						

Since the productivity (dependent variable) and training variables are all in dollars per employee, the regression coefficients are easy to interpret. For instance, in the finance and insurance industry one extra dollar spent per employee on current training will increase labour productivity by $47.02 (see Table 10).

Decision makers are ultimately concerned with a financial or capital budgeting interpretation of the impact of training. So below, we outline how the regression output was transformed into net present value and internal rate of return calculations. Out of 14 industries we were able to use regression results to calculate total training elasticities for 12. The elasticity is measured as the percentage change in productivity due to the investment of one dollar in training. Two industries—business services, and construction, did not yield a training impact on productivity. The total training elasticities in Table 11 represent the impact on per employee productivity of spending one extra dollar (per employee) on training. In the regressions shown in Table 10, the coefficients from t=0 to t-6 are used to create the elasticity. To calculate the net present value of training investment some assumptions are necessary. Starting in 1999 an establishment decides to invest in training. The relevant discount rate in 1999 is the prime rate which was 6.44% (Bank of Canada, 2009). We also assume that training benefits depreciate on a straight line bases to zero after 10 years.

TABLE 11. RATE OF RETURN ON TRAINING INVESTMENT

Industry	**Elasticity***	**NPV****	**IRR*****
Finance, insurance	0.42	0.53	23%
Communication, utilities	0.06	-0.73	#
Forestry, mining, oil, gas	0.41	0.49	22%
Information, culture	0.37	0.34	18%
Primary product mfg	0.25	-0.06	4%
Capital intensive tertiary	0.03	-0.84	#
Secondary product mfg	0.20	-0.23	-2%
Business services	n/a	n/a	n/a
Transport, warehousing	0.16	-0.39	-8%
Construction	n/a	n/a	n/a
Education, health	0.09	-0.61	-18%
Labour intensive tertiary	0.12	-0.54	-15%
Real estate	0.12	-0.53	-14%
Retail trade	0.10	-0.58	-17%

*Effect on productivity of spending one dollar on training.

**Net present value of $1 spent on training in 1999. Prime rate for 1999 is 6.44 percent. Assume straight 10-year straight line depreciation of training benefits.

***Internal rate of return (IRR) assumes 10-year straight line depreciation of training benefits.

[#]IRR not feasible.

As shown in Table 11, with a discount rate of 6.44 percent only three industries—finance-insurance, forestry-mining-oil-gas, information-culture, have a positive net present value for training investment. The internal rates of return for training investment range from -18 percent to positive 23 percent. Finance-insurance has the highest internal rate of return (IRR) at 23 percent, followed by forestry-mining-oil-gas at 22 percent, information-culture at 18 percent and primary product manufacturing at four percent.

4.2 Longitudinal Impact of Training on Innovation

The results from the logistic regression for new product and/or process are shown in Table 12. Foreign ownership and unionization are not significant, however, R&D, IT investments and current year's training expenditures are significant at the one percent level. Training lagged one and two years is significant at the 10 percent level, yet they tend to cancel each other out. This is a very important finding as including only one of these variables in a regression analysis could result in misleading findings on the impact of training on innovation. This regression analysis is completed at the macro-level with all industries combined. This aggregation causes confounding of the results and masks the value of training perceived at the industry and establishment level which will be discussed later in this section.

TABLE 12. CONDITIONAL FIXED EFFECTS LOGISTIC REGRESSION, DEPENDENT VARIABLE - INNOVATION

New_PP	**B**	**Standard Error**	**z**	**P>|z|**
R&D	0.376379	0.04847	7.77	0.000
Foreign	-0.07388	0.111956	-0.66	0.509
Union	-0.07757	0.10022	-0.77	0.439
ICT_Cost	5.48E-05	7.42E-06	7.4	0.000
Train_t(0)	0.000111	3.37E-05	3.29	0.001
Train_t(1)	-5.7E-05	3.04E-05	-1.86	0.062
Train_t(2)	5.59E-05	3.02E-05	1.85	0.064
N=16932; Groups = 2884; LR Chi2(7) = 157.5; Prob>Chi2 = 0.0000; Log Likelihood = -6754				

The results from the ordered regression of innovation quality (world-first, Canada-first, first in local market) using the entire sample are presented in Table 13. We can see that all variables except the expenditures per employee on training in the previous year are statistically significant. Although the coefficients for the information and communication technology and training variables are small, this is because the increments are in individual dollars. Given that the average investment level per employee for training is over $150 per year and in information and communication technology is over $570 these variables have an important impact on the quality of innovation created by an establishment. In particular, both the training expenditures in the current year, as well as those two years previously are significant. These results are different from those of Black and Lynch (1996) who found no effect for training on productivity and Bauernschuster et al. (2008) who specify that there is a known time lag in training on the creation of innovations. The results do support the idea that there is a time lag for new skills to impact the innovation process but that by having training occur in an organization this also brings in new ideas which can immediately result in innovative activity. It may be that training in the current year is associated more with process innovations that may be faster to implement. Incorporating new skills (training two years previously) may aid in the creation of more complex product innovations that take 1-2 years to materialize.

TABLE 13. ORDERED LOGISTIC REGRESSION,
DEPENDENT VARIABLE – INNOVATION QUALITY (1999-2004)

Imp_Inn	**B**	**Standard Error**	**z**	**P>|z|**
R&D	0.841599	0.02739	30.73	0.000
Foreign	0.559058	0.040646	13.75	0.000
Union	0.11675	0.036964	3.16	0.002
ICT_Cost	3.12E-05	3.15E-06	9.92	0.000
Train_t(0)	0.000159	0.00002	7.95	0.000
Train_t(1)	7.83E-06	2.23E-05	0.35	0.726
Train_t(2)	0.000067	1.97E-05	3.40	0.001
N = 22209; LR Chi2(7) = 1673.79; Prob>chi2 = 0.0000; Log Likelihood = -24320				

Table 14 shows the logistic regression results for 14 industries. For ease of interpretation both tables reporting industry results have industries ordered by training investment—from highest (finance and insurance) to lowest (retail trade). Of the 14 industries, training has an effect on the probability of a new/improved product and/or process in eight. It would seem logical to hypothesize that the effects should be most pronounced in the high investment industries, dropping off as we progress to those with the lowest investment. This, however, is not the case. Training has an effect in the following industries (rank of training investment is in brackets): finance and insurance (1), information and culture (4), capital intensive tertiary (5), business services (7), construction (10), education and health (11, negative), real estate (12, negative) and labour intensive tertiary (13).

The results in Table 15 shed more light onto the ability of firms to translate training into innovations—the training investments appear to be more important than for simply "innovation" as shown in Table 14. Establishments reporting a world-first innovation would appear to use training in such a way that it facilitates novel/valuable innovations. Interestingly, secondary product manufacturing, transportation and warehousing, and retail trade show positive impact of training on innovation quality but not on the probability of innovating. Real estate and labour intensive tertiary show a training effect with respect the probability of innovating but not with respect to the quality of innovation.

TABLE 14. CONDITIONAL FIXED EFFECTS REGRESSION BY INDUSTRY (1999-2004)

Dependent variable is new or improved product and/or process Innovation							
Industry	Research	Foreign	Union	Ict_Cst	Trn_L(0)	Trn_L(1)	Trn_L(2)
Finance, insurance	0.3616	0.2359	-0.2565	8.29E-05	2.65E-04	-1.28E-04	1.40E-04
P>|z| (N=1795)	0.03	0.54	0.45	0.00	0.01	0.10	0.18
Communication, utilities	0.3262	1.4226	0.3547	3.51E-05	1.19E-04	3.35E-05	-2.01E-05
P>|z| (N=1248)	0.10	0.01	0.34	0.11	0.31	0.73	0.83
Forestry, mining, oil, gas	-0.1012	1.2357	0.5393	4.43E-05	-5.56E-05	5.52E-06	8.17E-05
P>|z| (N=971)	0.65	0.03	0.26	0.10	0.43	0.94	0.35
Information, culture	0.5608	-0.1697	0.0778	3.16E-04	4.99E-04	6.31E-05	4.47E-04
P>|z| (N=949)	0.02	0.77	0.91	0.00	0.06	0.75	0.02
Capital intensive tertiary	0.0403	-0.5587	-0.2509	1.13E-04	8.98E-04	-1.41E-04	3.10E-05
P>|z| (N=1522)	0.84	0.26	0.59	0.01	0.00	0.34	0.80
Primary product mfg	0.5133	-0.0326	0.1404	1.79E-04	2.93E-05	1.91E-05	-1.76E-04
P>|z| (N=1314)	0.01	0.94	0.75	0.00	0.83	0.88	0.12
Business services	0.6022	-0.2949	-0.7841	9.62E-05	3.86E-04	-7.23E-05	-4.55E-05
P>|z| (N=1771)	0.00	0.43	0.04	0.00	0.00	0.54	0.69
Secondary product mfg	0.4133	-0.2466	0.5286	-5.17E-06	1.94E-04	-1.72E-04	5.97E-05
P>|z| (N=1274)	0.05	0.56	0.23	0.56	0.33	0.28	0.70
Transport, warehousing	0.5123	-0.1630	-0.2224	6.50E-05	3.13E-05	-7.32E-06	4.56E-05
P>|z| (N=2906)	0.00	0.50	0.43	0.01	0.75	0.94	0.63
Construction	0.4893	-0.3142	0.2514	6.52E-05	2.33E-04	7.35E-05	1.58E-04
P>|z| (N=2409)	0.01	0.58	0.39	0.05	0.05	0.48	0.12
Education, health	0.4101	939.5264	-0.7478	3.22E-04	1.73E-04	-1.03E-03	5.55E-05
P>|z| (N=1012)	0.10	0.94	0.16	0.00	0.40	0.00	0.82
Real estate	0.2219	0.9334	-0.8777	9.41E-05	-2.33E-05	-2.75E-04	-4.70E-04
P>|z| (N=1082)	0.33	0.18	0.07	0.04	0.83	0.22	0.04
Labour intensive tertiary	0.2970	-0.6704	0.3863	1.35E-05	-2.10E-04	9.88E-05	2.18E-04
P>|z| (N=1624)	0.09	0.10	0.36	0.39	0.18	0.47	0.10
Retail trade	0.2908	-0.6430	-0.2908	2.47E-04	2.70E-04	-1.15E-04	-9.17E-05
P>|z| (N=2332)	0.07	0.16	0.31	0.00	0.27	0.58	0.57

Research and development, foreign ownership and unionization are positive and significant for most industries (refer to Table 15). In the business services sector, however, unionization has a negative correlation with innovation quality. Per employee investment in information technology is significant in most regressions, although its magnitude is quite small. In nine out of 14 industries the current year's training expenditure is positive and significant and thus has a positive effect on the probability of creating a world-first innovation. While in six out of 14 industries the two-year lagged training expenditure is positive and significant. In general, training costs lagged one year are not significant (for 10 out of 14 industries).

What do the results signify to industries where training investment does not correlate with higher probability of innovating or more importantly with innovation quality? It could simply be that training investments are so low that they have no way of affecting innovation. Or the results may indicate that there are some other factors at work other than training. It could be that training interacts with HR practices or strategy. Some authors advocate that in some cases increased training investment is a response to high separations. High separations in turn could be due to poor pay relative to competitors, low morale, poor options for advancement etc. Training as an HR policy facilitates intellectual growth while simultaneously signaling a willingness to promote from within (thereby increasing loyalty). Finally, it may be practical for some industries to "under invest" in training because of historically high turnover and low employee loyalty (i.e. fast food). This may help explain the lack of results in real estate and labour intensive tertiary. However, retail trade remains a mystery, since in general the industry is synonymous with low wages, few benefits and high turnover. And yet, innovation quality is positively affected by the current year's expenditure on training.

TABLE 15. ORDERED LOGISTIC REGRESSION BY INDUSTRY (1999-2004)

Dependent variable is quality of innovation (world-first, Canada-first, first in local market, none)							
Industry	Research	Foreign	Union	Ict_Cst	Trn_L(0)	Trn_L(1)	Trn_L(2)
Finance, insurance	0.4475	0.6419	0.2420	2.05E-05	2.32E-04	-1.25E-04	1.26E-04
P>|z| (N=1795)	0.00	0.00	0.09	0.00	0.00	0.05	0.04
Communication, utilities	0.6666	0.7838	0.8988	2.32E-05	6.37E-05	-2.23E-05	4.72E-05
P>|z| (N=1248)	0.00	0.00	0.00	0.01	0.29	0.76	0.43
Forestry, mining, oil, gas	0.3368	0.3561	0.9192	3.50E-05	1.20E-05	2.28E-06	5.69E-05
P>|z| (N=971)	0.01	0.07	0.00	0.02	0.78	0.97	0.26
Information, culture	0.7777	0.1199	0.2963	7.37E-05	1.35E-04	7.93E-06	1.96E-04
P>|z| (N=949)	0.00	0.59	0.08	0.00	0.31	0.95	0.08
Capital intensive tertiary	0.9080	0.3632	0.0302	4.93E-05	4.04E-04	1.01E-04	3.85E-05
P>|z| (N=1522)	0.00	0.01	0.84	0.00	0.00	0.29	0.65
Primary product mfg	0.8128	0.5739	-0.0829	6.51E-05	7.42E-05	8.54E-05	-5.17E-05
P>|z| (N=1314)	0.00	0.00	0.58	0.00	0.33	0.17	0.32
Business services	0.9715	0.7546	-0.5205	4.32E-05	2.83E-04	1.75E-05	2.85E-05
P>|z| (N=1771)	0.00	0.00	0.01	0.00	0.00	0.84	0.73
Secondary product mfg	0.9501	0.5238	0.3306	-8.89E-06	5.70E-04	-9.92E-05	1.24E-04
P>|z| (N=1274)	0.00	0.00	0.04	0.20	0.00	0.27	0.23
Transport, warehousing	0.7307	0.4110	-0.2277	2.28E-05	1.63E-04	5.40E-05	1.18E-04
P>|z| (N=2906)	0.00	0.00	0.03	0.00	0.01	0.44	0.06
Construction	0.9037	0.4987	-0.1646	8.95E-05	3.25E-04	1.54E-04	2.21E-04
P>|z| (N=2409)	0.00	0.05	0.20	0.00	0.00	0.03	0.00
Education, health	0.7685	1.5684	0.7726	2.21E-04	5.78E-04	-2.09E-04	3.95E-04
P>|z| (N=1012)	0.00	0.04	0.00	0.00	0.00	0.27	0.01
Real estate	0.8247	1.0884	0.1646	2.04E-05	2.23E-04	1.76E-04	-5.80E-05
P>|z| (N=1082)	0.00	0.00	0.55	0.06	0.13	0.27	0.71
Labour intensive tertiary	0.7931	0.1561	0.2831	4.21E-06	-1.08E-04	1.08E-04	5.09E-05
P>|z| (N=1624)	0.00	0.30	0.03	0.65	0.28	0.26	0.55
Retail trade	0.7194	-0.0589	0.1283	1.28E-04	4.25E-04	1.35E-05	2.44E-05
P>|z| (N=2332)	0.00	0.73	0.27	0.00	0.00	0.91	0.83

4.3 Complementarities between Training Practices– 3 Factor model

A constrained regression model for each pair-wise comparison of the 3 factors by both size of company and by industry were analyzed with respect to both labour productivity and profit as the dependent variables. In order to determine the likelihood ratio statistics, unconstrained regression model for each size class and industry was also calculated. In this section, the results of the supermodularity (complementarity hypothesis) and submodularity (substitute hypothesis) tests are first presented by size class and then by industry.

4.3.1 *Results and analysis by size of firms*

Table 16 displays the hypothesis test results for the analysis by size class. From these results we can tell that for large firms, with a significance level of 0.1 and 0.01, training factor 2 (Professional and Technology) and training factor 3 (Apprenticeship) should not be adopted simultaneously with respect to labour productivity and profit since the null hypotheses are rejected. This means that the additional return for investments in both training types simultaneously is less than the return on investing in either one individually. There is not a significant amount of return for investing in both of these types of training together.

Medium firms have one pair of complements with respect to labour productivity, i.e. general training and technology, and have one pairs of substitutes with respect to labour productivity, i.e., technology and apprenticeship. We find that general training and apprentice training is inconclusive with respect to profit and independent with respect to labour productivity.

TABLE 16 LIKELIHOOD RATIOS FOR TRAINING FACTORS-BY SIZE OF FIRMS[5]

Firms	Factor Pairs	Supermodularity Test		Submodularity Test	
		Labour Prod	Profit	Labour Prod	Profit
Large	1&2	0.503	0.000	0.067	1.186
	1&3	0.000	0.000	1.599	1.278
	2&3	2.382*	21.812+	0.000	0.000
Medium Firms	1&2	0.004	0.343	10.034+	0.000
	1&3	2.377*	0.182	2.244*	0.000
	2&3	5.406+	0.000	0.496	0.010
Small	1&2	2.015*	9.742+	1.373	0.000
	1&3	3.824+	5.228+	0.436	0.250
	2&3	6.813+	1.259	0.000	2.717**

*Significant at 0.1 level **Significant at 0.05 level + Significant at 0.01 level

Small firms seem to be able to improve their labour productivity and/or increase their profit by separately adopt most of the three training factors, although profit increases with a significance

[5] Factor 1: General Management Training; Factor 2: Technology and Professional Training; Factor 3: Apprenticeship

level of 0.05 if factor 2 (Professional and Technology) and factor 3 (Apprenticeship) are adopted together. This can be explained as the small firms in the dataset come from different industry, and perform training practice given their individual needs, i.e. these firms usually focus on certain of business areas and do not adopt complex interdisciplinary training programs.

4.3.2 *Results and analysis by industry of firms*

Each industry tends to adopt its own unique set of training practices. The nature of the industry may determine which training it may adopt more extensively than others. Here we analyze some representative industries to show the insights behind the results of the hypothesis tests (refer to Table 17 for test result values).

Business services only show a pair of complementary practices with respect to profit: general training and apprenticeship and analysis training. This result is due to the fact that business service generally involves with experience-relevant skills such as sales & marketing, group decision making, office equipment using, so apprenticeship and analysis relevant training practices can be easily incorporated into them.

Not surprisingly, capital intensive manufacturing exhibits a complementary pairing between management training and technology training. Among capital intensive manufacturing firms, in general, manufacturing processes are highly automatic, and employees are required to be able to use computers and other high technologies which are combined with general management training practice in order to improve labour productivity. Meanwhile, apprenticeship, basic analysis training, and management training are not typically adopted simultaneously within capital intensive manufacturing with respect to labour productivity because apprenticeship is usually a prerequisite requirement in labour intensive manufacturing industry.

The education and health services industry seems to show complements between general training and apprenticeship, and between general training and apprentice and analysis. In this case, apprenticeship would include continuing education requirements as well as internships and clinical rotations. Due to the somewhat distinct nature of two industries in this category, education and health service, the analysis for this industry may be confounded by the government regulatory requirements and structural differences between the industry components.

The finance and insurance industry grouping can benefit from separately adopting general management and technology training with respect to labour productivity and profit. Finance and insurance is a complicated industry; big financial firms require all training practices relevant to teamwork, sale and marketing, group decision making, as well as technology side: information system, database etc. Running a comprehensive training program for so many employees can lead to low efficiency and high costs. However, there are a lot of small financial institutions. In these firms, probably only some of training practices are performed, depending on need. In addition, the roles within a big firm may be very fine; some of the roles may require more professional & technology training or more apprenticeship and analysis training, but not both. That is why factor 2 (Professional and Technology) and factor 3 (Apprenticeship) are not complements with respect to labour productivity and profit.

General training and apprenticeship are complements in forestry, mining, gas and oil industry. This is due to nature of jobs in this industry: these jobs require a lot of field operations. As a result, apprenticeship should be incorporated into general training, e.g., teamwork, safety, health and leadership, so that new employees can be trained and tutored by experienced employees.

TABLE 17 LIKELIHOOD RATIOS FOR TRAINING FACTORS-BY INDUSTRY[6]

Industry	Factor	Supermodularity Test		Submodularity Test	
	Pairs	Labour Prod	Profit	Labour Prod	Profit
Business	1&2	2.509**	2.182*	0.000	0.280
Service	1&3	0.073	0.487	0.635	2.052*
	2&3	1.338	1.181	0.000	0.598
Capital	1&2	0.000	5.420^{+}	3.310**	0.000
Intensive	1&3	142.929^{+}	1.467	0.000	0.000
Manufacturing	2&3	0.007	0.592	0.251	0.000
Communication	1&2	0.195	0.117	0.000	0.000
&	1&3	0.351	0.000	0.000	0.071
Utilities	2&3	0.020	1.002	0.045	0.000
	1&2	1.974	0.000	0.000	12.981^{+}
Construction	1&3	2.769**	9.188^{+}	0.166	0.000
	2&3	0.000	0.000	10.036^{+}	5.774^{+}
Education	1&2	0.838	0.000	0.000	3.472**
& Health	1&3	0.000	0.099	2.115*	0.000
Services	2&3	0.411	0.266	0.000	0.000
Finance	1&2	2.606**	8.922^{+}	0.000	0.359
& Insurance	1&3	0.000	4.721^{+}	2.169*	0.144
	2&3	2.481**	2.149*	0.000	2.420*
Information	1&2	0.415	0.000	0.000	0.535
& Cultural	1&3	0.000	0.216	2.060	0.000
Services	2&3	0.000	0.000	0.068	0.128
Labour	1&2	0.000	0.007	1.364	0.001
Intensive	1&3	0.000	0.103	0.714	0.000
Manufacturing	2&3	0.060	0.028	0.000	0.000
Forestry,	1&2	20.239^{+}	0.072	0.000	0.640
Mining,	1&3	0.089	0.006	3.706^{+}	1.665
Oil, and Gas	2&3	0.512	0.580	1.609	0.159
Primary	1&2	4.589^{+}	0.000	0.000	0.850
Product	1&3	0.466	0.000	0.327	4.585^{+}
Manufacturing	2&3	0.585	2.303*	0.139	0.000
Real estate	1&2	0.000	0.000	3.532**	13.696^{+}
Rental and	1&3	0.149	0.147	0.338	2.062
Leasing	2&3	1.513	5.262^{+}	0.000	0.000
Retail	1&2	0.091	11.118^{+}	5.773^{+}	0.087
and Consumer	1&3	2.497**	6.114^{+}	0.248	1.029
Service	2&3	3.439**	1.485	0.583	4.423^{+}
Secondary	1&2	0.000	0.599	7.207^{+}	2.241*
Product	1&3	0.000	4.204^{+}	0.685	0.000
Manufacturing	2&3	0.000	0.014	0.783	4.691^{+}
Transportation	1&2	1.155	4.557^{+}	8.126^{+}	0.020
Warehousing	1&3	6.904^{+}	8.932^{+}	2.134*	0.000
Wholesale	2&3	6.681^{+}	0.122	1.780	3.058**

*Significant at 0.1 level **Significant at 0.05 level + Significant at 0.01 level

[6] Factor 1: General Management Training; Factor 2: Technology and Professional Training; Factor 3: Apprenticeship

Retail and consumer service firms can perform better with respect to profit if general training and technology training are adopted separately. However, combining these two training factors can improve labour productivity because employees' efficiency can improve by using computers or Internet, for example, online shopping and delivery, and online reservations. In addition, retail and consumer service may highly count on experience and sales and marketing; that is why apprenticeship is so important and should be adopted separately from other training practices in order to improve labour productivity.

Firms in transportation, warehousing and wholesale can improve labour productivity by adopting technology training and general training simultaneously. For example, a powerful software system can help build up a reliable supply chain network and an efficient logistic system, with the help of efficient management, communication and teamwork, labour productivity can be improved. However, an advanced software system and relevant training can be expensive; therefore, combining factor 1 (General Management) and factor 2 (Professional and Technology) cannot increase profit. Meanwhile, literal and numerical training is also very important; employees in this industry need to have strong literal and numerical skills; the jobs may include, for example, inventory management, database maintenance, stock record update. The common sense may explain why factor 2 and factor 3 are complements with respect to profit; managers purchase computer systems and software packages, and train their employees to use them through apprenticeship while improving their employees' literal and, particularly, numerical skills given the working context.

4.4 Complementarities between Training Practices in the Service Sector – 5 Factor model

A constrained regression model for each pair-wise comparison of the 5 factors by both size of company and by industry were analyzed with respect to both labour productivity and profit as the dependent variables for each service sector industry. In order to determine the LR statistics, unconstrained regression model for each size class and industry was also calculated. In this section, the results of the supermodularity (complementarity hypothesis) and submodularity (substitute hypothesis) tests are first presented by size class and then by industry.

4.4.1 *Results and analysis by size of firms*

In this section, we analyze and discuss the results of the hypothesis tests for the complementarity and substitutability of training factors among firms by their size class (refer to Table 18). The results for labour productivity and profit are not always similar so in some cases training practices may be complements with respect to labour productivity but substitutes with respect to increased profitability (e.g. implementing the pair together will cause an increase in the marginal ROI of the training practices to support labour productivity but the marginal return to implementing the pair together with respect to increased profitability is not justified). Similar results with respect to increases in labour productivity were found for most pair-wise comparisons for all size classes. There is a decreasing trend in the number of significant results with respect to profit increases as the size of the firm increases. Also, there are significantly more substitute results with respect to increases in profitability, particularly in large plants.

The results for large plants with respect to labour productivity demonstrate that all training factors are complementary except for in-class general training and either on-the-job general training or technology training which results in both hypotheses being rejected. The rejection of both hypotheses implies that further investigation is required and that there is some confounding due to the large number of variables in the in-class general training factor. Also, the nature of this general training will change depending on the industry and the strategic focus, technology implementations, etc. that are being pursued by the firm which adds to the confounding effects. Occupational health and safety and apprenticeship training practices are complementary with all forms of training.

The results for large firms with respect to increased profitability are quite different than those observed for labour productivity. With respect to increased profitability, in-class general training and both on-the-job general training and technology training are complements. In-class general training and apprenticeship training are substitutes. This may be due to the fact that most of the skills that can be obtained in the classroom environment can also be obtained and reinforced through apprenticeship in the industries in which apprenticeship programs are common. This results in a duplication of training effort which is both financially capital intensive as well as time consuming on the human resources of the firm. On-the-job general training is also found to be a substitute for apprenticeship training with respect to profit as well as a substitute with occupational health and safety. Once again, the majority of the concepts that would appear in the on-the-job general training would also be found in the on-the-job occupational health and safety, as well as the apprenticeship training programs at the firm. By investing in only one of these two types of training practices the firm is able to properly train their employees at a higher level of marginal returns which results in a better return on investment with respect to increased profitability.

When we consider the results for medium sized plants, we find the exact same results as those for large plants with respect to labour productivity. With respect to increased profitability, the results between large and medium plants differs significantly. Medium plants once again only have five significant results with respect to increased profitability. In this case, all results demonstrate complementary pairings. In medium plants, apprenticeship training is complementary with in-class general training, on-the-job general training, and technology training. The reinforcement of the theoretical practices, organizational policies, and service methodologies found in the apprenticeship training has a significant impact of the effectiveness and efficiency of the firm resulting in increased profits. These results also demonstrate the importance of apprenticeship training to medium sized firms as it has a significant improvement on the marginal returns of most all other training practices pursued by the firm. Also, occupational health and safety training is complementary to both technology training and on-the-job general training. By providing employees with a clear understanding of the occupational health and safety issues, the firm is able to reduce costs associated to employee injuries from new practices, procedures, and technologies resulting in increased profitability.

TABLE 18 LR TESTS FOR TRAINING FACTORS-BY SIZE OF FIRMS[7]

Firms	Factor Pairs	Complementarity Tests		Substitute Tests	
		Labour Prod	Profit	Labour Prod	Profit
Large Firms	1&2	2.053**	0.431	2.611+	2.965+
	1&3	1.745*	0.826	2.143**	20.735+
	1&4	0.000	1.629	10460.384+	0.421
	1&5	0.000	2.070**	10140.486+	1.225
	2&3	0.000	0.956	10131.690+	0.744
	2&4	0.000	1.987**	10101.774+	0.458
	2&5	0.000	2.070**	10339.317+	1.473
	3&4	0.000	0.281	10581.195+	0.642
	3&5	0.000	0.026	6545.614+	1.322
	4&5	0.000	0.667	10535.428+	1.056
Medium Firms	1&2	3.320+	0.243	1.774*	0.222
	1&3	5.311+	0.222	4.153+	0.247
	1&4	0.000	0.030	46025.820+	1.691
	1&5	0.000	0.004	43888.821+	1.734*
	2&3	0.000	0.019	49094.315+	1.584
	2&4	0.000	0.034	44795.635+	1.806*
	2&5	0.000	0.023	47339.605+	2.058**
	3&4	0.000	0.000	47746.085+	1.774*
	3&5	0.000	0.000	36676.462+	1.286
	4&5	0.000	0.000	48247.634+	1.797*
Small	1&2	0.156	0.091	5.324+	1.398
	1&3	2.551+	0.322	1.762*	2.045**
	1&4	0.000	0.181	106533.071+	17.746+
	1&5	0.000	0.407	72868.269+	11.269+
	2&3	0.000	0.395	55302.117+	8.949+
	2&4	0.000	0.143	87453.633+	15.530+
	2&5	0.000	0.300	65782.359+	9.560+
	3&4	0.000	0.124	114607.964+	18.222+
	3&5	0.000	0.629	36950.573+	5.437+
	4&5	0.000	0.102	80207.700+	11.955+

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

[7] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs

The results of small firms suggest that all the training factors should be adopted simultaneously in order to improve labour productivity except for on-class general training and technology training where both hypotheses are rejected. The greatest number of significant results with respect to increased profitability occurs with small firms. This is due to the significant impact that training has as a proportion of capital investments for small firms when compared to the larger firms. In small plants, all training practices remain complementary to one another except for in-class general training and on-the-job general training which have inconclusive results. These results demonstrate a consistency between increased labour productivity and increased profitability strategic objectives and that in small plants all forms of training are beneficial. Small firms should invest in as many forms of training as possible for their employees as the increase in the marginal returns to increased investment in training are significant.

4.4.2 *Results and analysis by industry of firms*

In section 4.2.1 we analyzed and discussed the results of hypothesis test by size of firms. However, there are various industries in each size class which may impact the results. In order to understand if industry specific effects might be confounding the results, analysis was then conducted for each of the eight service industries. The size of the firm is still included in the analysis as all factor variables were determined based on size class means. The results based on industry demonstrate that there is some industry effect which does affect the return on training investments but that results for many of the pair-wise comparisons remain consistent for all industries. These results imply that it is possible to create global government policies and programs to improve labour productivity and firm profitability in the service sector through comprehensive training incentive programs.

There were four industries (Education and health care; Capital intensive manufacturing; Forestry, mining, and oil extraction; and Secondary product manufacturing) which due to the distribution of establishments in the various strategic training states had the data for means of productivity and performance values withheld for privacy reasons. In these industries the majority of establishments were only in a handful of states and the rest of the states were very sparsely populated. The remaining ten industry sectors had only a few strategic states where the population size was less than ten (refer to Table 19). The strategic training states are binary representations of the set of training practices that an organization is engaged in. The left-most digit represents the first factor (in-class general training), the second left-most digit represents factor 2 (on-the-job general training), the third digit represents factor 3 (technology training), the fourth left-most digit represents factor 4 (occupational health and safety training), and the right-most digit represents factor 5 (apprenticeship). For example, if an organization does not engage in any of the training practices to demonstrate one of the factors then it would be in strategic training state 00000. If an organization is engaged in on-the-job general training, technology training, and apprenticeship then it would be in strategic state 01101. A complete listing of each strategic training state code and the factors it represents is included in Appendix A.

TABLE 19 DISTRIBUTIONS OF ESTABLISHMENTS IN EACH STRATEGIC TRAINING STATE BY INDUSTRY[8]

FIRM STATE	BUSINESS SERVICE	COMMUNICATION AND OTHER UTILITIES	CONSTRUCTION	FINANCE AND INSURANCE	INFORMATION AND CULTURAL INDUSTRIES	LABOUR INTENSIVE TERTIARY MANUFACTURING	PRIMARY PRODUCT MANUFACTURING	REAL ESTATE, RENTAL AND LEASING OPERATIONS	RETAIL TRADE AND CONSUMER SERVICES	TRANSPORTATION, WAREHOUSING, WHOLESALE
00000	19.8%	20.5%	23.7%	29.4%	*	23.8%	13.4%	31.1%	24.4%	24.7%
00001	3.7%	6.4%	5.6%	6.9%	2.7%	3.4%	1.6%	2.7%	2.1%	4.5%
00010	11.1%	8.2%	9.0%	11.7%	13.7%	11.8%	1.8%	6.8%	8.1%	3.9%
00011	3.9%	4.9%	4.2%	7.6%	3.1%	1.6%	*	0.8%	0.6%	0.7%
00100	1.7%	1.1%	2.0%	1.9%	3.0%	2.0%	4.7%	5.2%	6.1%	5.9%
00101	*	1.1%	1.5%	1.1%	*	0.9%	1.0%	0.7%	0.8%	1.4%
00110	2.0%	1.7%	2.5%	2.0%	3.8%	2.3%	1.9%	4.8%	3.9%	3.2%
00111	1.6%	2.3%	2.1%	2.6%	1.5%	0.7%	*	0.8%	0.4%	1.1%
01000	0.8%	*	0.8%	*	1.1%	1.4%	1.0%	1.0%	1.3%	1.6%
01001	*	0.8%	*	*	*	0.6%	*	*	*	*
01010	1.5%	1.4%	1.2%	0.6%	2.1%	4.0%	0.6%	1.4%	1.1%	1.5%
01011	1.6%	1.5%	0.7%	0.7%	1.0%	0.4%	*	*	*	*
01100	*	0.7%	0.8%	0.3%	*	1.8%	3.5%	1.6%	2.1%	3.8%
01101	*	*	*	*	*	0.5%	*	0.7%	*	*
01110	2.1%	2.3%	2.3%	0.8%	4.7%	6.5%	3.2%	6.1%	4.4%	4.5%
01111	2.1%	1.9%	2.0%	1.1%	1.3%	1.9%	1.0%	*	0.6%	1.2%
10000	1.4%	*	0.8%	0.4%	1.9%	1.3%	3.0%	1.4%	2.0%	2.6%
10001	1.2%	1.4%	1.0%	*	1.6%	0.8%	1.3%	*	0.5%	0.9%
10010	2.2%	1.4%	3.2%	4.4%	5.6%	2.0%	1.0%	1.2%	2.2%	1.2%
10011	3.3%	2.2%	2.0%	3.1%	1.7%	0.8%	*	*	0.7%	*
10100	1.5%	1.3%	1.3%	1.0%	1.7%	1.1%	8.0%	4.2%	4.8%	5.1%
10101	1.8%	1.1%	1.0%	0.6%	1.2%	1.5%	2.8%	1.3%	1.1%	1.3%
10110	1.0%	3.2%	4.1%	5.3%	6.0%	3.2%	4.8%	4.1%	6.9%	3.9%
10111	5.3%	6.0%	6.0%	5.2%	6.0%	2.5%	1.2%	2.5%	1.8%	1.3%
11000	*	*	*	*	*	*	1.1%	*	0.6%	*
11001	*	0.7%	*	*	*	*	0.4%	*	*	*
11010	2.5%	1.3%	1.1%	1.3%	1.6%	3.0%	0.6%	1.1%	1.5%	1.2%
11011	2.9%	2.3%	1.6%	1.5%	1.0%	1.5%	*	*	*	*
11100	*	0.9%	1.2%	0.4%	1.7%	0.7%	9.3%	2.9%	4.8%	5.2%
11101	1.4%	1.0%	1.0%	0.5%	*	0.7%	3.6%	1.0%	1.4%	2.9%
11110	7.6%	6.1%	6.0%	3.6%	17.6%	9.3%	19.0%	9.7%	11.4%	8.7%
11111	15.9%	16.2%	11.3%	6.2%	14.5%	7.9%	10.4%	7.0%	4.3%	7.6%

* indicates that there were less than 10 firms in the state and the information was withheld by Statistics Canada to ensure privacy

We can see from the distribution of establishments that there are some commonalities across the majority of industries. In particular, a combination of on-the-job – general training and apprenticeship as well as a combination of on-the-job-general training, apprenticeship, and technology training are not very popular. This could be due to the lack of success of companies pursuing these types of training practices together or simply because there is another type of training (e.g. occupational health and safety) that the majority of establishments practice if they

[8] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs

demonstrate any of the training factors. It is important to note that when analyzing the distribution table, the variables were all created using size class mean comparisons so those establishments in state 0 (who exhibit none of the factors) still practice some training strategies they simply do not have above average training investments in any particular factor.

In the business services sector (refer to Table 20), the majority of the significant results are with respect to improved labour productivity. All training types are found to be complementary with respect to increased labour productivity except in-class general training and either on-the-job general training or technology training which exhibit inconclusive results. With respect to improved profitability though, the results are very different. There are only 3 significant findings. The first is that in-class general training and on-the-job general training are substitutes. This may be due to the nature of the industry such that the skills taught in general training are so similar whether they are done on the job or in the classroom there is no added benefit due to the training costs and time commitment involved by the employees to provide an increased marginal return to firm profitability from participating in both forms of training simultaneously. Occupational health and safety training is also found to be complementary with technology training and apprenticeship training with respect to increased profitability. These results demonstrate the importance of proactive training to prevent employee injuries and ensure that all equipment is being used properly at the firm.

TABLE 20. LR-TEST FOR TRAINING FACTORS-BUSINESS SERVICE[9]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour	Profit	Labour Prod	Profit
Business Service	1&2	0.235	8.374+	1.175	0.350
	1&3	0.481	1.144	0.545	0.069
	1&4	0.000	0.000	18231.153+	2.111**
	1&5	0.000	0.000	9227.050+	0.835
	2&3	0.000	0.001	11061.909+	1.249
	2&4	0.000	0.003	12554.827+	1.173
	2&5	0.000	0.129	8762.588+	0.575
	3&4	0.000	0.000	24491.109+	4.523+
	3&5	0.000	0.000	6895.099+	1.071
	4&5	0.000	0.052	12080.968+	1.195

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

If we consider the plots of the changes in labour productivity by state (refer to Figure 1), we can see that the better performing states primarily support the complementarity analysis as the majority of the better performing states do not exhibit both the in-class and on-the-job general training factors. Analyzing Figure 2 we see that the state which exhibits the in-class general training and the technology training performs very poorly. This is not surprising as the results are almost to the required significant level in the complementarity analysis for these factors to be substitutes.

[9] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs

FIGURE 1. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-BUSINESS SERVICE[10]

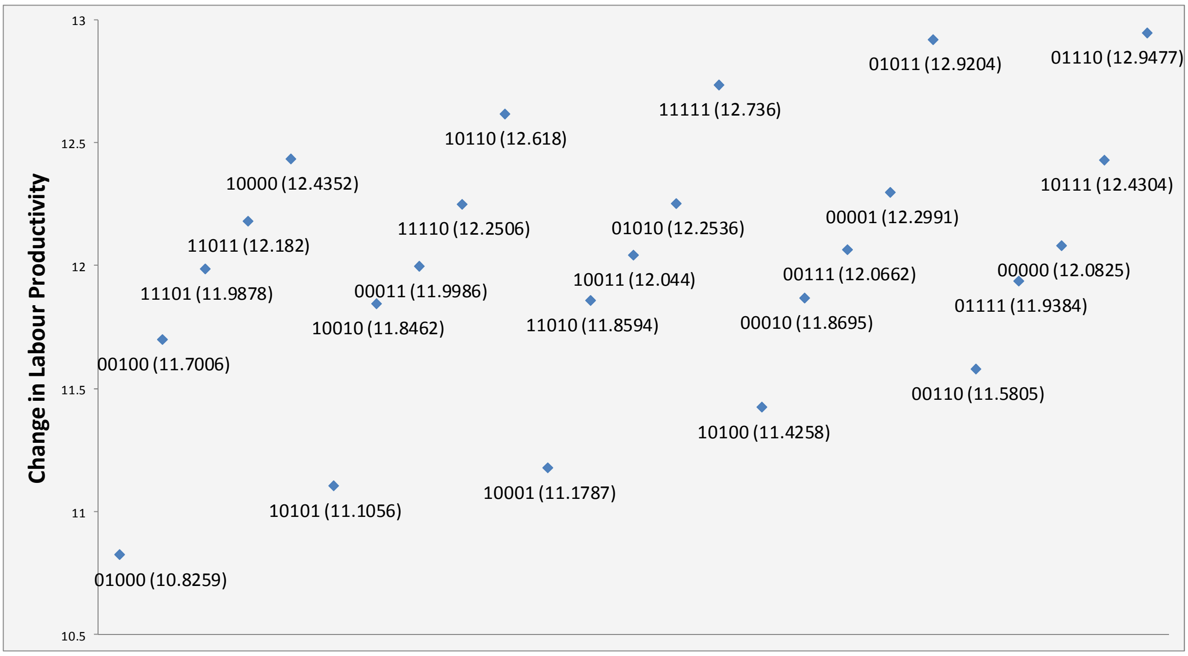
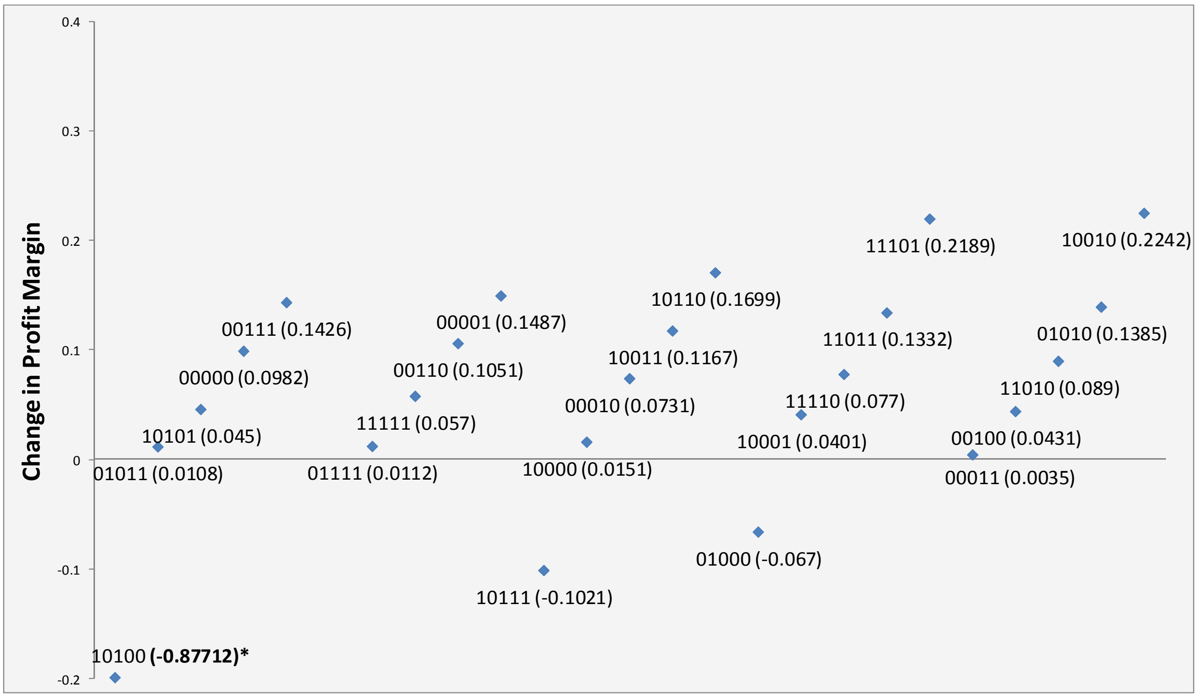


FIGURE 2. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE-BUSINESS SERVICE[11]



The results for the communication and other utilities sector are shown in Table 21. The results with respect to increased labour productivity are the same as those found in the business services sector. There are no significant results with respect to improved profitability. These results demonstrate the issues with considering only the profitability measure of return on

[10] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

[11] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

investment for training programs.

TABLE 21. LR-TEST FOR TRAINING FACTORS-COMMUNICATIONS[12]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Communication and other utilities	1&2	0.489	0.031	0.092	0.001
	1&3	1.074	0.038	0.107	0.025
	1&4	0.000	0.000	13266.428+	0.756
	1&5	0.000	0.000	10542.729+	0.799
	2&3	0.000	0.000	4939.909+	0.203
	2&4	0.000	0.000	9711.971+	0.652
	2&5	0.000	0.000	8657.709+	0.832
	3&4	0.000	0.000	12135.103+	0.329
	3&5	0.000	0.000	4498.957+	0.146
	4&5	0.000	0.000	11033.396+	0.761

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

The plots of the average performance measures for the communication and other utilities sector are shown in Figure 3 and 4. The plot of the labour productivity values demonstrates the small amount of variability in this industry. It also supports the complementarity analysis as none of the lower performing states exhibit all of factors 3, 4, and 5 (technology, occupational health & safety, and apprenticeship). The plot of the results for productivity aid in understanding why there are no significant results in the complementarity analysis for this dependent variable as we can easily see that there are no real patterns for training measures correlating with higher profit margins.

[12] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

FIGURE 3. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-COMMUNICATIONS[13]

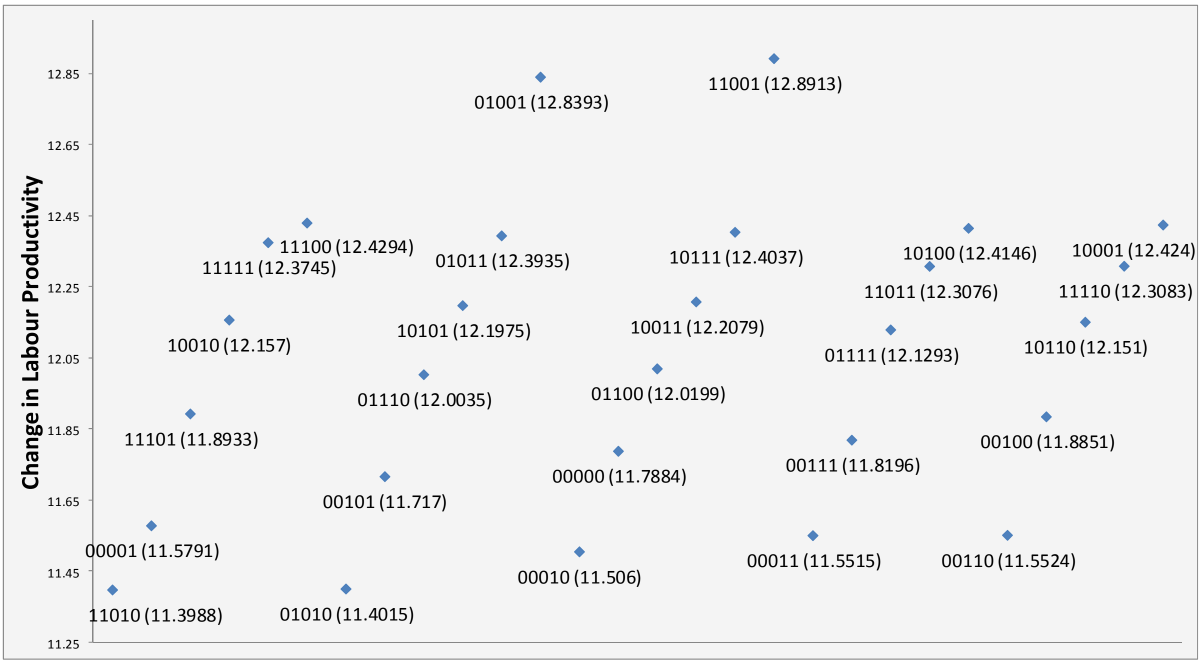


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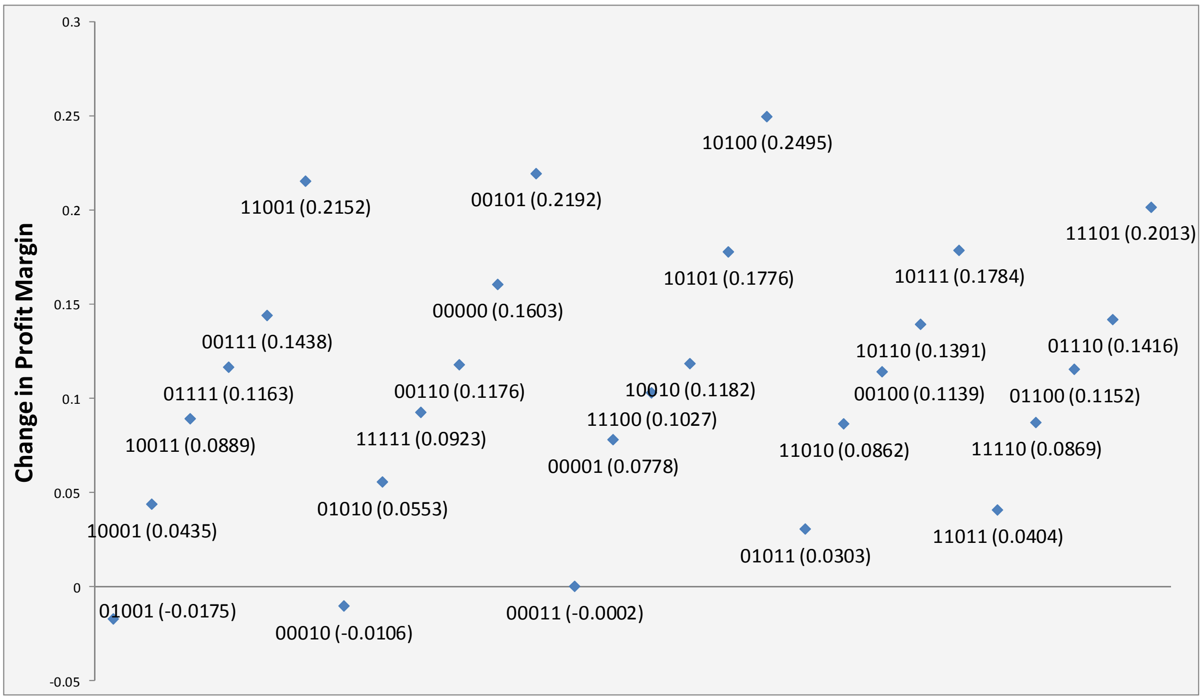
FIGURE 4. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- COMMUNICATIONS [14]



The results for the construction sector demonstrate some differences with respect to both increases in labour productivity and profitability (refer to Table 22). As in large and medium

[13] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.
[14] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

firms, both hypotheses are rejected for the pair-wise comparison of in-class general training and on-the-job general training. This implies that further analysis of these training practices are required in the construction industry. This is most likely due to the limited amount of general training done in this industry due to their heavy reliance on apprenticeship programs, particularly in the trades areas. In-class general training is also found to be a substitute with technology training in this sector with respect to increased labour productivity. As there is not a heavy reliance on computer skills in this sector, it is not surprising that there is not a significant increase in the marginal returns for including multiple types of in-classroom training of technology and problem solving skills. As in the previous two industries, all other pair-wise comparisons are found to be complementary with respect to increased labour productivity. The only significant results with respect to increase profitability of the firm is that in-class general training and on-the-job general training are found to be complementary. This implies that in the construction industry, having workers with a higher level of problem solving, literacy, and general communication skills results in improved profitability for the firm. The results also demonstrate that both theoretical skills taught in the classroom, and the application of those skills at the job site through on-the-job training, are both important in order to ensure the optimal benefit from the general skills training.

TABLE 22. LR-TEST FOR TRAINING FACTORS-CONSTRUCTION[15]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Construction	1&2	78.167+	0.034	3.772+	1.723*
	1&3	74.516+	0.464	0.891	0.129
	1&4	0.000	0.000	24005.055+	0.810
	1&5	0.000	0.000	28135.012+	0.844
	2&3	0.000	0.000	8756.900+	0.392
	2&4	0.000	0.010	17327.835+	0.520
	2&5	0.000	0.000	18436.722+	0.967
	3&4	0.000	0.000	18974.482+	0.694
	3&5	0.000	0.000	11732.302+	0.326
	4&5	0.000	0.003	27737.956+	1.057

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

The plots of the average performance measures for the construction sector are shown in Figure 5 and 6. The plot of the labour productivity values demonstrates support for the complementarity analysis as none of the lower performing states exhibit all of factors 3, 4, and 5 (technology, occupational health & safety, and apprenticeship) and most of the top performing states exhibit at least three factors. The plot of the results for productivity aid in understanding why there are no significant results in the complementarity analysis for this dependent variable as we can easily see that there are no real patterns for training measures correlating with higher profit margins. One interesting observation is the significantly better performance of firms exhibiting the on-the-job general training and occupational health & safety training factors.

[15] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

FIGURE 5. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-CONSTRUCTION[16]

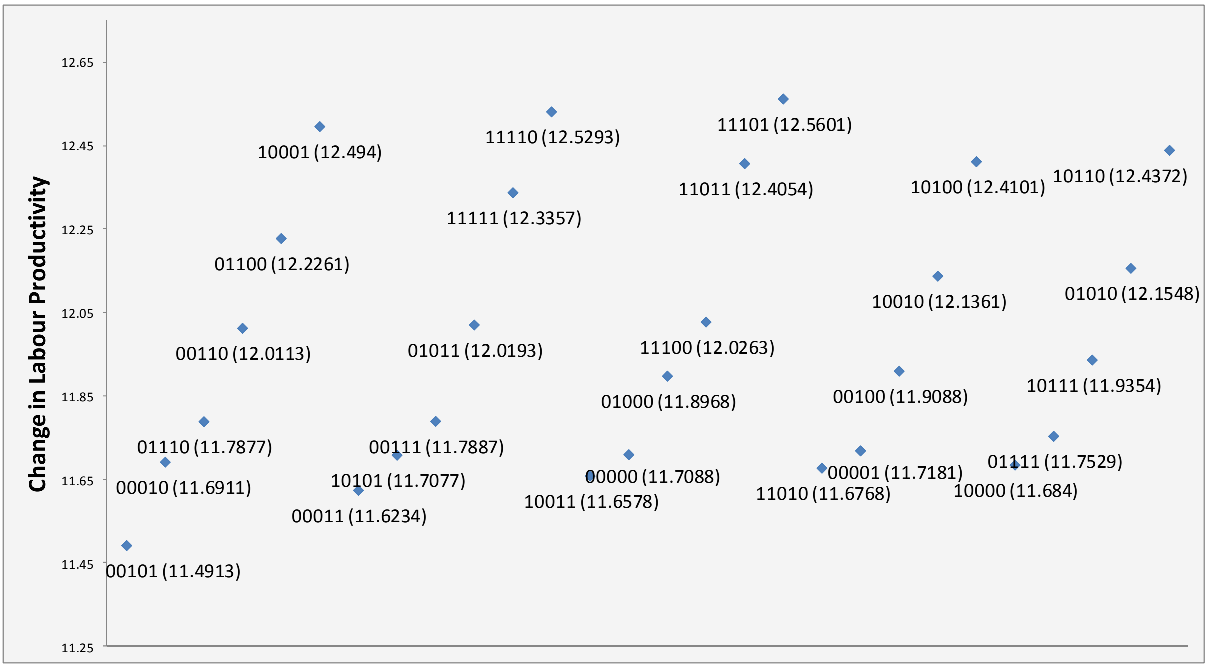
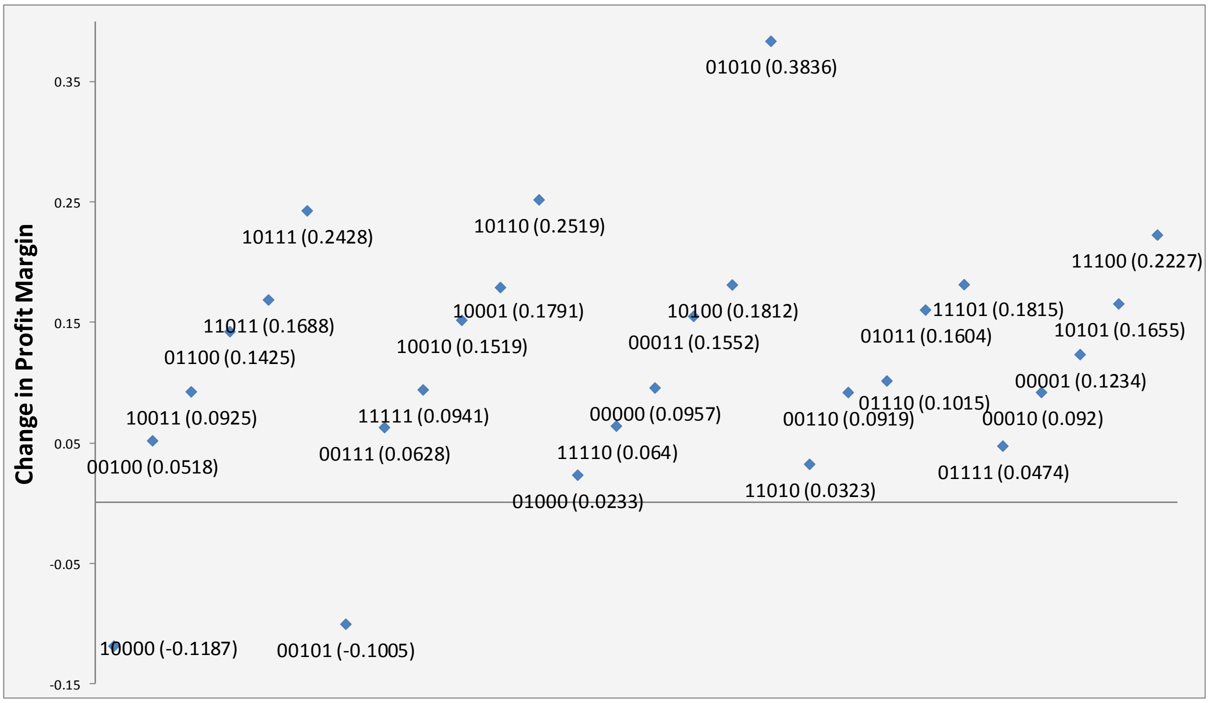


FIGURE 6. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- CONSTRUCTION [17]



The results in the education and health services sector have a large number of significant findings (refer to Table 23). In-class general training is found to be a substitute with on-the-job general training and technology training with respect to labour productivity. As much of the

[16] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.
[17] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

technology implemented into education and health care enhances the quality of the services provided but does not directly reduce labour needs these results are not surprising. With respect to increased profitability, there are four significant findings. Occupational health and safety training is found to complement in-class general training, on-the-job general training, and technology training demonstrating the importance of health and safety in these industries. On-the-job general training and technology training is also found to be complementary with respect to improved profitability. This result demonstrates that in education and health care the training that takes place on-the-job, particularly for integrating technology and organizational policies is extremely important. The increase in the marginal returns from providing both types of training generates significantly improved return for the training investment as this is how the employees are able to identify how to integrate the policies, procedures, and technologies into their everyday activities.

TABLE 23. LR-TEST FOR TRAINING FACTORS-EDUCATION[18]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Education and Health Services	1&2	36.258+	0.005	0.049	0.437
	1&3	102.444+	0.242	0.000	0.048
	1&4	0.000	0.000	7558.624+	2.922+
	1&5	0.000	0.009	4454.835+	1.395
	2&3	0.000	0.000	5937.420+	2.781+
	2&4	0.000	0.004	5613.615+	2.656+
	2&5	0.000	0.000	3848.174+	1.489
	3&4	0.000	0.001	8956.844+	4.799+
	3&5	0.000	0.000	1475.730+	0.623
	4&5	0.000	0.117	3926.849+	1.549

\+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

In the finance and insurance sector all types of training are found to be complementary with respect to increased labour productivity except in-class general training and technology training which have inconclusive results (refer to Table 24). These two training factors are the

[18] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

only two to have significant results with respect to increased profitability though and are found to be complementary. Therefore, it is in the best interest of companies in the finance and insurance industry to pursue a broad base of training practices both on-the-job and in the classroom.

TABLE 24. LR-TEST FOR TRAINING FACTORS-FINANCE[19]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Finance and Insurance	1&2	0.030	0.292	2.664+	0.792
	1&3	0.354	0.073	0.489	3.989+
	1&4	0.000	0.089	24428.559+	1.333
	1&5	0.000	0.187	13966.908+	0.948
	2&3	0.000	0.023	21021.898+	1.150
	2&4	0.000	0.073	16499.124+	1.244
	2&5	0.000	0.073	16128.784+	1.149
	3&4	0.000	0.053	25192.555+	1.214
	3&5	0.000	0.386	8102.532+	0.406
	4&5	0.000	0.256	11805.572+	0.780

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

In the finance and insurance sector the labour productivity plot (refer to Figure 7) does not seem to strongly support the complementarity findings as the average performance of establishments which exhibit all the training factors is nowhere near the top performing state. It is important to note the very small range in variability of the labour productivity outcomes which explains some of the complementarity results as many of the states are tightly bunched in the performance range of 11.7 to 12.05. The plot of the average profitability measures does support the complementarity analysis as 60% of the top performing states exhibit both the in-class general training and the technology training factors (refer to Figure 8).

[19] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

FIGURE 7. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-FINANCE & INSURANCE[20]

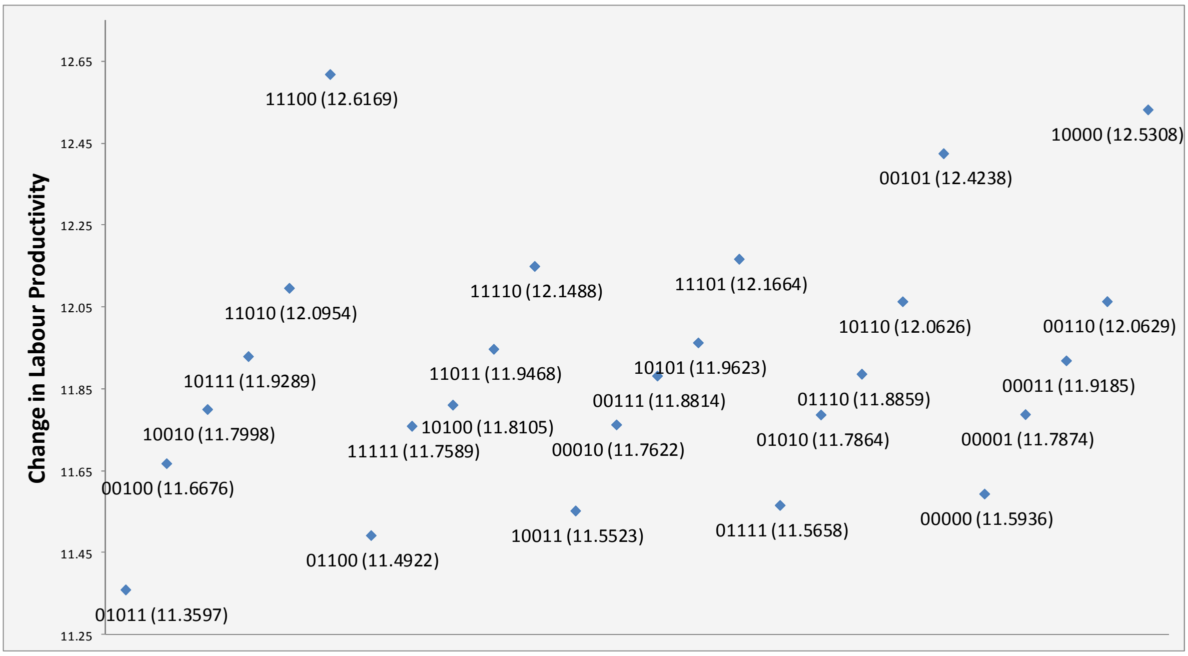
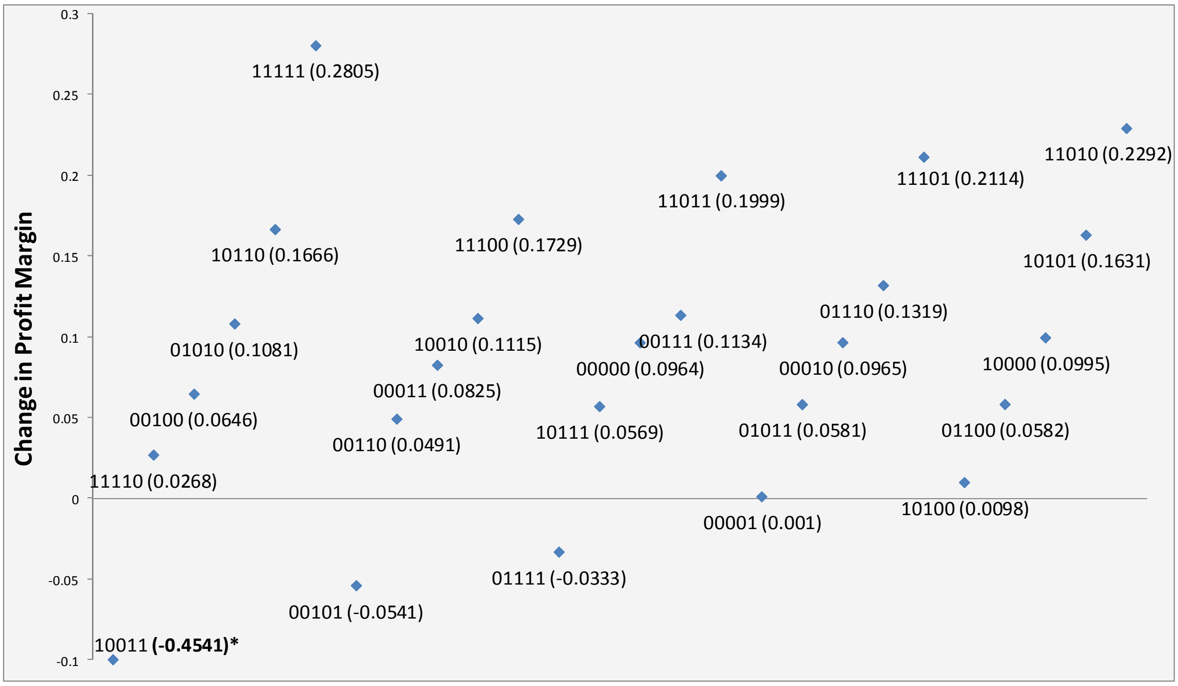


FIGURE 8. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- FINANCE & INSURANCE [21]



When analyzing the results for the information and cultural industries, one can see that with respect to labour productivity improvements, all types of training are complementary (refer to Table 25). The results with respect to improved profitability are very unique. In this sector there are three significant substitute pairings. In-class general training is a substitute with both

[20] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

[21] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

on-the-job general training, and technology training. On-the-job general training is also a substitute with occupational health and safety training with respect to increased profitability. There are also two pair-wise comparisons that reject both hypotheses: occupational health and safety training with both in-class general training, and technology training. These results demonstrates that the benefit of occupation health and safety training in the information and cultural industries is perhaps not as well defined or important as in other service sectors such as health care. More research is required to fully understand the impact of occupational health and safety training in the information and cultural service sector. There are also a number of complementary pairings with respect to improved profitability. On-the-job general training and technology training are found to be complements. As well, apprenticeship programs are complementary with both in-class general training, and occupational health and safety training. This demonstrates the importance of skills reinforcement and mentorship in this industry.

TABLE 25. LR-TEST FOR TRAINING FACTORS-INFORMATION[22]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Information and Cultural Industries	1&2	1.171	8.734+	1.157	0.044
	1&3	0.013	3.585+	5.127+	0.502
	1&4	0.029	3.047+	11977.104+	2.393**
	1&5	0.000	0.352	8241.113+	2.046**
	2&3	0.000	1.598	8551.878+	3.186+
	2&4	0.000	3.627+	8059.870+	0.962
	2&5	0.000	0.828	6836.246+	0.905
	3&4	0.000	2.844+	671.962+	2.181**
	3&5	0.000	1.072	5636.832+	1.016
	4&5	0.000	1.510	9175.621+	2.684+

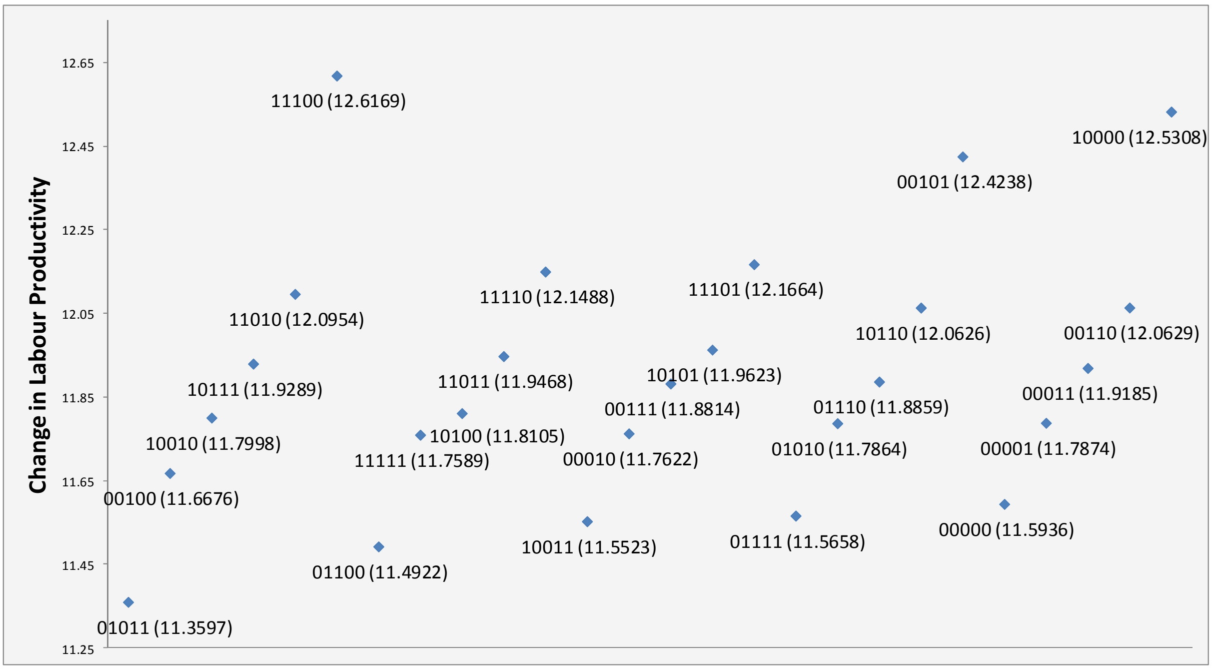
+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

The plots of the average performance measures for the information and cultural services sector are shown in Figure 9 and 10. The plot of the labour productivity values demonstrates that there is strong support for the complementarity results. In particular, the better performing states exhibit all exhibit factors 3, 4, and 5 (technology, occupational health & safety, and

[22] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

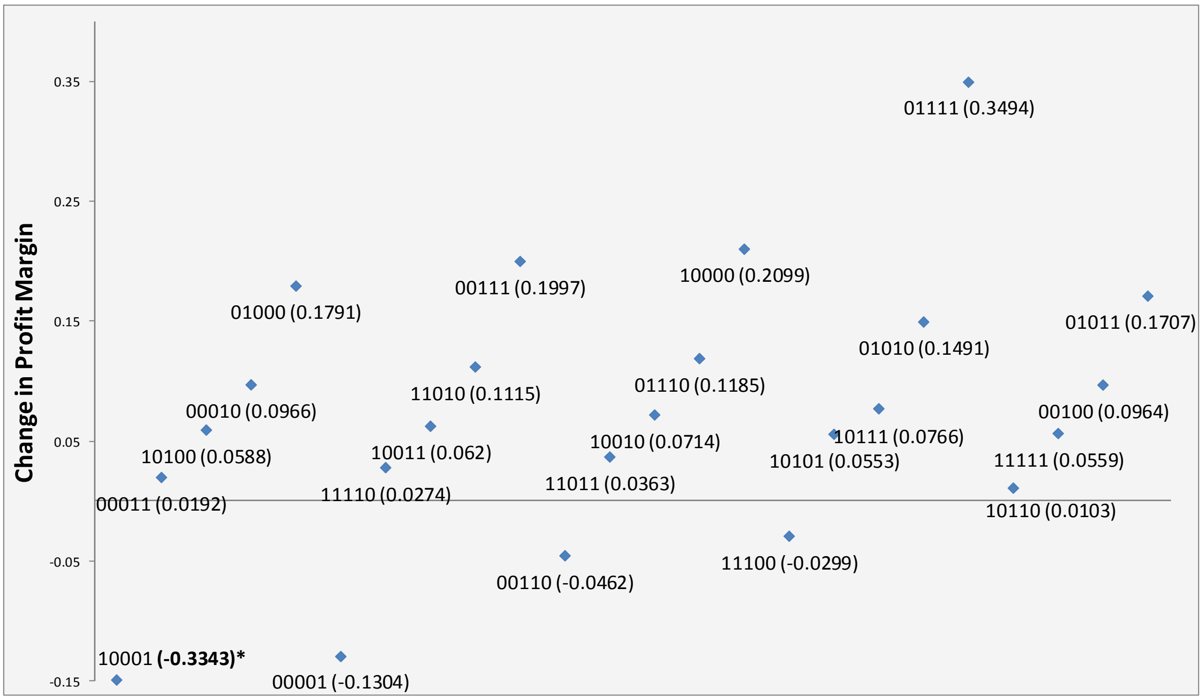
apprenticeship) and the occurrence of just these three together performs significantly better than the average firm. The plot of the results for productivity support the complementarity findings with the best performing state exhibiting all factors except factor 1 (In-class general training) which was a substitute with most other training factors.

FIGURE 9. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-INFORMATION[23]



[23] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

FIGURE 10. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- INFORMATION [24]



In the real estate sector, all significant results are complementary pairings except for one (refer to Table 26). All types of training are found to be complements with respect to improved labour productivity except in-class general training and both on-the-job general training or technology training practices where the two hypotheses were rejected. There are also a large number of significant results with respect to improved profitability demonstrating the more critical and direct impact of training in the real estate industry as compared to many of the other service industries. In the real estate industry, occupation health and safety training is found to be complementary with all other forms of training practices. On-the-job general training and technology training practices are also found to be complementary. This demonstrates the importance of on-the-job reinforcement of technology training to ensure that the technology is properly integrated into the practices used by the real estate agents and brokers. As well, apprenticeship programs are found to be complementary with all other training practices except technology training. These results demonstrate the importance that mentorship has in

[24] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

the real estate sector and the role played by brokers in supporting new real estate agents with the firm.

TABLE 26. LR-TEST FOR TRAINING FACTORS-REAL ESTATE[25]

Industry	Factor Pairs	Complementarity Test		Substitute Test	
		Labour Prod	Profit	Labour Prod	Profit
Real Estate	1&2	3.862^{+}	2.139**	3.321^{+}	0.231
	1&3	3.789^{+}	0.768	2.503**	1.601
	1&4	0.000	0.000	7078.195^{+}	3.211^{+}
	1&5	0.000	0.000	3212.790^{+}	2.051**
	2&3	0.000	0.004	5097.065^{+}	6.171^{+}
	2&4	0.000	0.000	6512.294^{+}	3.306^{+}
	2&5	0.000	0.000	4204.336^{+}	113.457^{+}
	3&4	0.000	0.000	9331.063^{+}	5.592^{+}
	3&5	0.000	0.002	799.044^{+}	1.069
	4&5	0.000	0.000	4564.165^{+}	2.302**

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

Figure 11 and 12 demonstrate the average performance measures for the real estate sector. The plot of the labour productivity values demonstrates that there is some support for the complementarity results. In particular, the better performing states exhibit multiple factors with the inclusion of factors 1 and 2 (in-class general training and on-the-job general training respectively) not occurring very often. The plot of the results for productivity support the complementarity findings. In the real estate sector there are many occurrences of negative changes in profitability with the majority of them including factor 1 (in-class general training) which was found to be a substitute for on-the-job general training. This supports the idea that mentorship and on-the-job training is where many real estate sales agents learn the skills required to become successful and ultimately real estate brokers.

[25] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

FIGURE 11. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-REAL ESTATE[26]

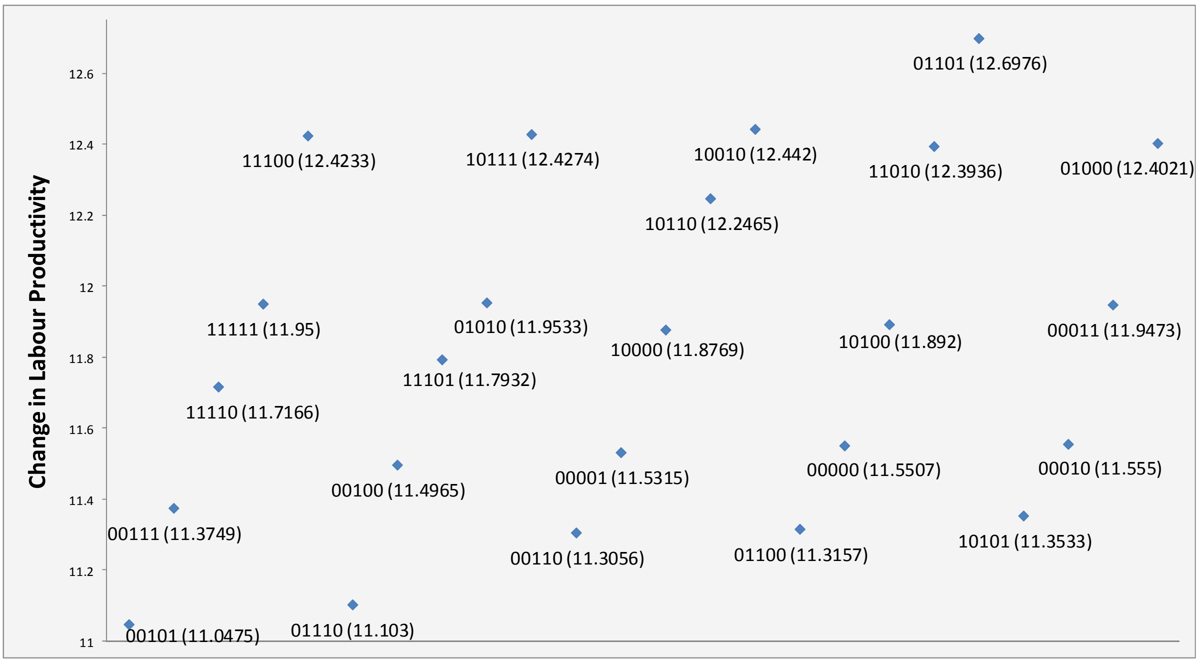
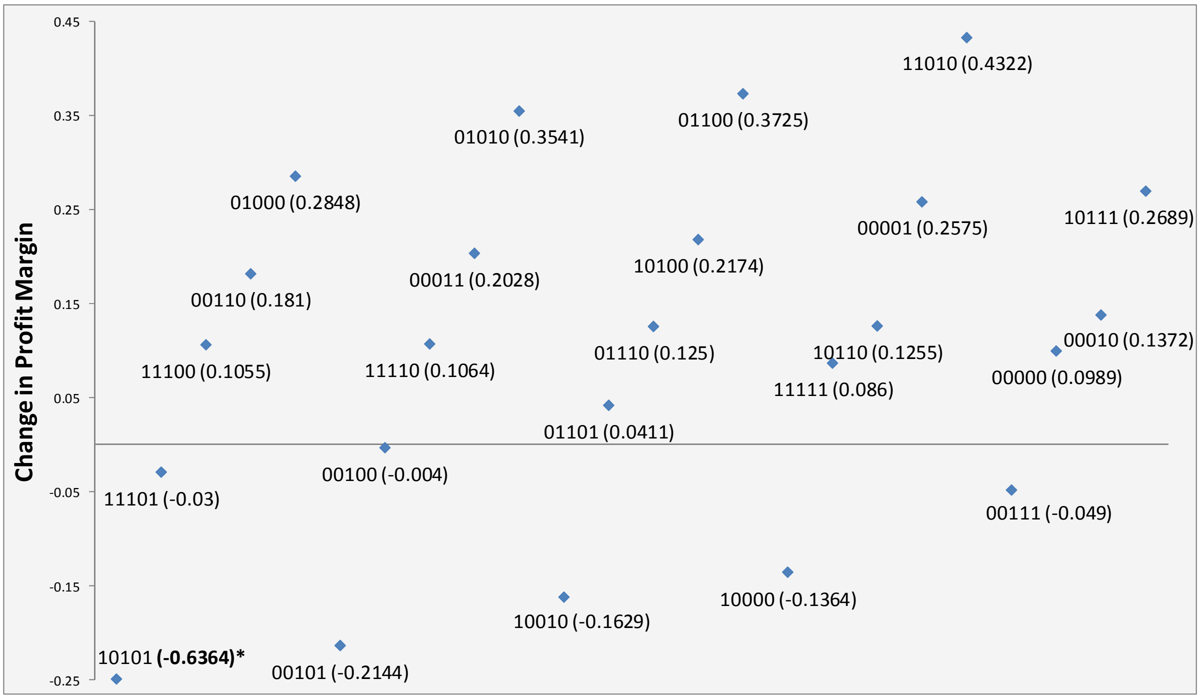


FIGURE 12. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- REAL ESTATE [27]



Retail and consumer service can see improved labour productivity and employee performance if training practices are implemented simultaneously (refer to Table 27). All types of training are found to be complements with respect to improved labour productivity

[26] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.
[27] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

except in-class general training and technology training practices where the results are inconclusive. As in the real estate industry there are a large number of significant results with respect to improved profitability demonstrating the more critical and direct impact of training on the organization's profit margins. In the retail industry, occupation health and safety training is found to be complementary with all other forms of training practices. As well, apprenticeship programs are found to be complementary with all other training practices except technology training. These results demonstrate the importance that mentorship from experienced sales and marketing staff has in the retail sector. These results are also supported by the general promotion and organization structure found in the retail industry.

TABLE 27. LR-TEST FOR TRAINING FACTORS-RETAIL AND CONSUMER SERVICE[28]

Industry	Factor	Complementarity Test		Substitute Test	
	Pairs	Labour Prod	Profit	Labour Prod	Profit
Retail and Consumer Service	1&2	0.176	0.521	146.913+	0.078
	1&3	1.269	0.076	1.021	0.550
	1&4	0.000	0.000	17290.774+	3.034+
	1&5	0.000	0.000	13263.434+	2.688+
	2&3	0.000	0.000	7866.424+	1.016
	2&4	0.000	0.000	17158.460+	2.791+
	2&5	0.000	0.000	12092.612+	75.880+
	3&4	0.000	0.000	15809.972+	1.951**
	3&5	0.000	0.000	8028.290+	1.272
	4&5	0.000	0.000	14707.638+	3.048+

+ Significant at 0.01 level **Significant at 0.05 level *Significant at 0.1 level

The plots of the average performance measures for the retail and consumer services sector are shown in Figure 13 and 14. The plots of the mean performance measure values do not demonstrate strong support for the complementarity results. There are very few trends that can be directly observed and the states with the majority of the training factors present do not seem to be the optimal set of practices. This is most likely due to the overall small range of values for labour productivity exhibited. One interesting observations is in the state with only the state of just the two general training factors where the performance is almost an

[28] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

entire unit lower than the next worst performing state.

FIGURE 13. GRAPH OF THE CHANGE IN LABOUR PRODUCTIVITY BY STATE-RETAIL & CONSUMER SERVICES[29]

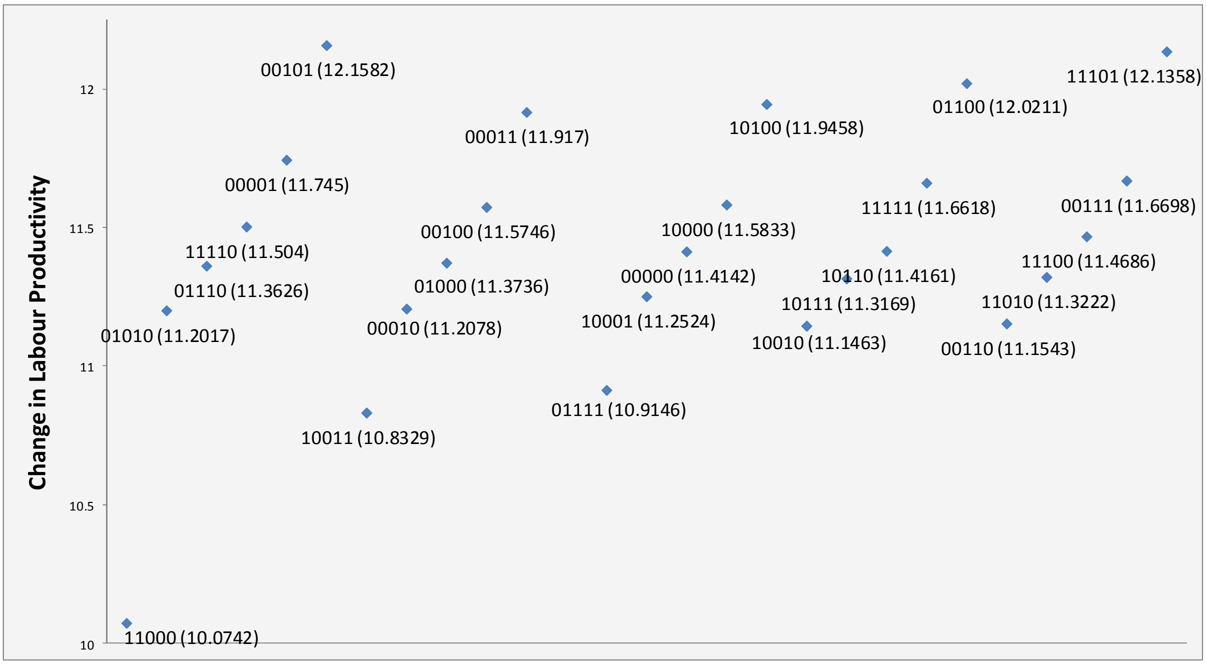
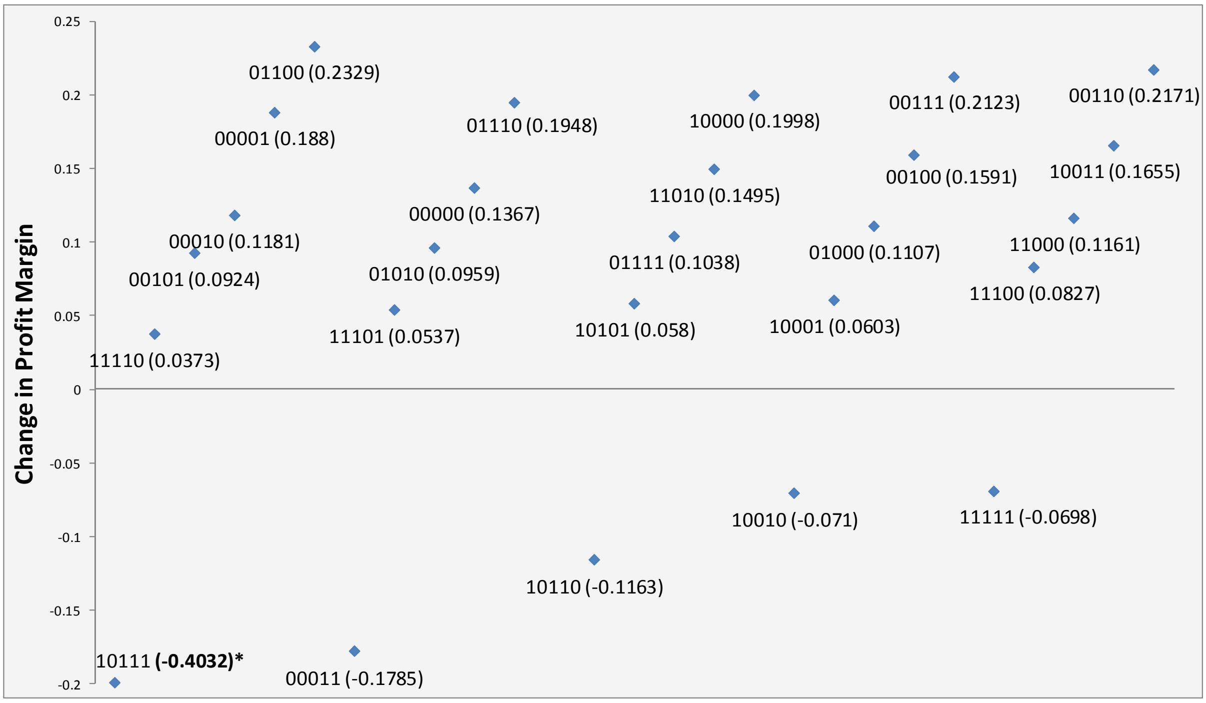


FIGURE 14. GRAPH OF THE CHANGE IN PROFITABILITY BY STATE- RETAIL & CONSUMER SERVICES [30]



[29] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

[30] Factor 1: In-class general training; Factor 2: On-the-job general training; Factor 3: Technology training; Factor 4: Occupational health and safety training; Factor 5: Apprenticeship programs. Refer to Appendix A for strategic training state code translations.

5. Conclusion

This study has used longitudinal data comprised of seven years of observations, over 14 industries and 3,528 establishments using Statistics Canada's Workplace and Employee survey. In order to determine the relationship between training and workplace productivity we have translated an organizational outcome measure (productivity) into financial outcomes (net present value (NPV) and internal rate of return (IRR)). Our productivity analysis results, that twelve of the fourteen industries had positive total training elasticities, are supported by those of the meta-analysis of Tharenou et al. (2007). However, when the elasticities are put within a financial context of return on investment (IRR), it was found that only four industries showed positive internal rates of return. The IRR results are therefore somewhat contradictory to the elasticity analysis. This may be due to the additional set of variables and the time horizons used to measure the return on the training investment. The IRR calculations are also more profitability based where the effect of training is more confounded due to other environmental variables.

In industries where the training investment does not correlate directly with higher productivity, it could simply be that training investments are so low that they have no way of affecting productivity. For instance, in the real estate industry, training investments amount to 0.05 percent of productivity per employee. Or the results may indicate that there are some other environmental factors not measured at work other than training that mask the contribution of training to productivity. It may also be practical for some industries to "under invest" in training because of historically high turnover and low employee loyalty (i.e. fast food). This may help explain the lack of results in real estate and retail trade, yet other industries such as education and health are characterized by good pay and status. Anomalies such as these remain for further in depth analysis.

We also investigated the relationship between training investment and innovation capacity, both with respect to probability of innovating as well as quality of innovation produced. Our study found that in nine out of fourteen industries the current year's training expenditure had a positive effect on the probability of creating a world-first innovation. While in six out of fourteen industries the two-year lagged training investment was positive and significant. The results shed more light onto the ability of firms to translate training into innovations—the training investments appear to be more important than for simply "innovation". Establishments reporting a world-first innovation would appear to use training in such a way that it facilitates novel/valuable innovations. The importance of a strong training program to support world-class innovation capacity is clear although the effect of training can be lagged. These results can be used by HR managers to support their requests for additional investment in training, particularly in industries where innovation is a key strategic objective.

Human resources managers and senior management can also use the findings of the study to engage in discussion about the design of their training strategy and its fit with the organization's strategic innovation objectives. The results from the various regression models demonstrate that a long term investment in training is critical to support increases in labour productivity and innovation output. These results provide HR managers with strong evidence that the return on training cannot be consider by looking only an annual results but that the effect of training investment will remain with the organization for at least a three year period. By considering the longitudinal effect of training, this may enable HR manager to better support their argument for increased training investment to support both productivity gains as well as innovation capacity.

In this study, we also investigated the impact of various types of training on labour productivity and profit in the Canadian services sector. A complementary analysis was conducted to explore the interactions between training practices by the size of firms and by industry. Depending on the size of the firm and the industry in which it operates, we found out that firms can perform better with respect to labour productivity and/or profit if some training practices are adopted simultaneously. On the other hand, some training practices can reduce labour productivity and/or profit if they are adopted at the same time within the firm. In particular, it appears that regardless of the service sector in which a firm operates, to support increased labour productivity it is beneficial for firms to implement a collection of all forms of training practices simultaneously with the possible exception of in-classroom general training with either of on-the-job general training or technology training where the results are specific to the particular industry sector. The results from this analysis do support the possibility of developing a global government policy and/or programs to improve labour productivity in the service sector through comprehensive training incentive programs for organizations.

HR managers and senior management can apply the results from the complementarity and substitute testing to analyze the composition of elements provided as training to employees. Both the size of the organization as well as the industry in which it operates has a significant effect on the set of training practices that should be implemented simultaneously by the organization making the industry level analysis of this study particularly useful. For example, if the manager were in the forestry, mining, oil, and gas industry then they would see that they should invest in both general training and apprenticeship programs simultaneously as these are complements but that investing simultaneously in general training and technology and professional training is not a good idea as these are substitutes.

As previously found (Boselie et al, 2005), although financial measures are typically used in performance analysis, these are not the most accurate measures as the effect between HRM practices and profit is hard to measure due to environmental confounding. The number of significant results with respect to profitability increases is lower than with respect to the more direct measure of labour productivity. In particular, if the objective is to support increased profit margins, then the results differ significantly based on the specific service sector in which the firm operates. The insights obtained from the hypothesis tests of the underlying constrained regression models can help managers in firms of different size class from various industries determine their complementary training sets in order to improve the performance of their firms by increasing the ROI of their training initiatives.

Using the plots of the changes in labour productivity and profitability, we can see that there is strong support for the complementarity and substitute findings determined through the constrained regression analysis. The plots of the average profitability and labour productivity with respect to the set of strategic training practices implements can be used by senior administrators to support discussion and decisions concerning the existing set of strategic training options provided at the organization. We can also use these plots to enable managers to visually see the impact that making changes in their training investments may have. The managers are able to look on the graph for where they currently sit and then compare their internal results to the industry average for that strategic combination as well as other possible combinations they might be considering.

One limitation to this study is the lack of investment details for each type of training practice implemented. As a result, we cannot determine the impact of the size or scope of the training initiative on the complementary effects or the observed changes in labour productivity or profit margins. We were also limited in the number of specific variables we could analyze due to computational constraints. If possible, a larger number of practices should be included in the analysis to provide more specific feedback to managers on the exact practices which when combined results in the highest ROI. We also leave to future research the longitudinal analysis of prolonged training initiatives to determine the cumulative effect of training and complementarities that exist between training practices at various points in time. We also leave the analysis of the impact of employee perception on the effectiveness of the training on the complementarities that are exhibited and the ROI of the training initiatives.

It should be noted that the expenditure on training is not a perfect proxy for training intensity as it does not account for the majority of on-the-job training (Freel, 2005). Future research includes developing and testing models with greater diversity of training measures such as the number and type of on-the-job training initiatives. There is also a need to consider the effectiveness of the incorporating more methods of training. Investing more in training may not improve the knowledge/innovation capacity of the establishment if the training is used as a replacement to initially hiring higher skilled workers.

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APPENDIX A – STRATEGIC TRAINING STATE CODING

Strategic Training State Code	**Strategic Factors Engaged in By the Organization**
00000	No strategic training practices
00001	Apprenticeship only
00010	Occupational Health and Safety only
00011	Occupational Health and Safety and Apprenticeship
00100	Technology training only
00101	Technology training and Apprenticeship
00110	Technology training and Occupational Health and Safety
00111	Technology training, Occupational Health and Safety, and Apprenticeship
01000	On-the-job general training only
01001	On-the-job general training and Apprenticeship
01010	On-the-job general training and Occupational Health and Safety
01011	On-the-job general training, Occupational Health and Safety, and Apprenticeship
01100	On-the-job general training, On-the-job general training, and Technology training
01101	On-the-job general training, Technology training, and Apprenticeship
01110	On-the-job general training, Technology training, and Occupational Health and Safety
01111	On-the-job general training, Technology training, Occupational Health and Safety, and Apprenticeship
10000	In-classroom general training only
10001	In-classroom general training and Apprenticeship
10010	In-classroom general training and Occupational Health and Safety
10011	In-classroom general training, Occupational Health and Safety, and Apprenticeship
10100	In-classroom general training and Technology training
10101	In-classroom general training, Technology training, and Apprenticeship
10110	In-classroom general training, Technology training, and Occupational Health and Safety
10111	In-classroom general training, Technology training, Occupational Health and Safety, and Apprenticeship
11000	In-classroom general training and On-the-job general training
11001	In-classroom general training, On-the-job general training, and Apprenticeship
11010	In-classroom general training, On-the-job general training, and Occupational Health and Safety
11011	In-classroom general training, On-the-job general training, Occupational Health and Safety, and Apprenticeship
11100	In-classroom general training, On-the-job general training, On-the-job general training, and Technology training
11101	In-classroom general training, On-the-job general training, Technology training, and Apprenticeship
11110	In-classroom general training, On-the-job general training, Technology training, and Occupational Health and Safety
11111	In-classroom general training, On-the-job general training, Technology training, Occupational Health and Safety, and Apprenticeship (All strategic training practices)

APPENDIX B – DESCRIPTIVE STATISTICS BY INDUSTRY

TABLE 28 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-BUSINESS SERVICE

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	249	12.0825 (7.3026)	0.0982 (4.5625)
00001	47	12.2991 (3.5676)	0.1487 (1.1441)
00010	140	11.8695 (5.2844)	0.0731 (3.9873)
00011	49	11.9986 (2.2444)	0.0035 (1.8118)
00100	21	11.7006 (4.6091)	0.0431 (2.9341)
00101	Insufficient data		
00110	25	11.5805 (6.8176)	0.1051 (1.2075)
00111	20	12.0662 (3.0484)	0.1426 (3.2218)
01000	10	10.8259 (3.1563)	-0.067 (0.6726)
01001	Insufficient data		
01010	19	12.2536 (4.9083)	0.1385 (1.0692)
01011	20	12.9204 (3.4391)	0.0108 (1.0143)
01100	Insufficient data		
01101	Insufficient data		
01110	27	12.9477 (5.8625)	-0.2641 (4.5207)
01111	27	11.9384 (1.6302)	0.0112 (3.1698)
10000	18	12.4352 (0.9463)	0.0151 (0.694)
10001	15	11.1787 (3.1928)	0.0401 (1.6246)
10010	28	11.8462 (8.5521)	0.2242 (2.1566)
10011	42	12.044 (2.6598)	0.1167 (0.362)
10100	19	11.4258 (4.8764)	-8.7712 (43.1661)
10101	23	11.1056 (3.4083)	0.045 (0.4665)
10110	13	12.618 (10.6182)	0.1699 (2.7863)
10111	67	12.4304 (2.2546)	-0.1021 (5.471)
11000	Insufficient data		
11001	Insufficient data		
11010	31	11.8594 (2.4448)	0.089 (0.6373)
11011	36	12.182 (2.0653)	0.1332 (0.586)
11100	Insufficient data		
11101	17	11.9878 (1.9036)	0.2189 (0.4199)
11110	96	12.2506 (5.8235)	0.077 (1.5493)
11111	200	12.736 (3.2768)	0.057 (3.3414)

TABLE 29 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-COMMUNICATION AND OTHER UTILITIES

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	359	11.7884(4.2522)	0.1603(1.9661)
00001	112	11.5791(3.2039)	0.0778(1.5953)
00010	144	11.506(5.5068)	-0.0106(4.8664)
00011	85	11.5515(5.0192)	-0.0002(1.4434)
00100	20	11.8851(3.0651)	0.1139(0.8645)
00101	19	11.717(2.515)	0.2192(1.1359)
00110	30	11.5524(3.2903)	0.1176(1.6249)
00111	40	11.8196(2.298)	0.1438(1.0738)
01000	Insufficient data		
01001	14	12.8393(0.8374)	-0.0175(0.7739)
01010	25	11.4015(4.0633)	0.0553(1.6565)
01011	27	12.3935(1.3321)	0.0303(0.3485)
01100	13	12.0199(3.6159)	0.1152(0.9789)
01101	Insufficient data		
01110	41	12.0035(3.3014)	0.1416(1.501)
01111	33	12.1293(2.4788)	0.1163(0.6593)
10000	Insufficient data		
10001	25	12.424(1.4415)	0.0435(0.7191)
10010	25	12.157(5.78)	0.1182(0.9314)
10011	39	12.2079(2.9859)	0.0889(0.5501)
10100	23	12.4146(5.4061)	0.2495(1.8198)
10101	20	12.1975(3.9213)	0.1776(0.6661)
10110	56	12.151(3.851)	0.1391(0.9207)
10111	105	12.4037(3.4985)	0.1784(1.2076)
11000	Insufficient data		
11001	12	12.8913(1.1519)	0.2152(0.2948)
11010	22	11.3988(2.9425)	0.0862(0.9413)
11011	40	12.3076(2.0792)	0.0404(0.6729)
11100	16	12.4294(2.4669)	0.1027(0.3392)
11101	17	11.8933(2.1225)	0.2013(0.1859)
11110	107	12.3083(3.2344)	0.0869(2.636)
11111	283	12.3745(2.1954)	0.0923(1.2075)

TABLE 30 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-CONSTRUCTION

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	394	11.7088(5.5304)	0.0957(10.3825)
00001	93	11.7181(3.4998)	0.1234(1.194)
00010	149	11.6911(4.0289)	0.092(3.7738)
00011	69	11.6234(3.4383)	0.1552(1.4386)
00100	33	11.9088(4.9324)	0.0518(2.2442)
00101	25	11.4913(3.5111)	-0.1005(3.4106)
00110	41	12.0113(3.2145)	0.0919(1.4267)
00111	35	11.7887(2.0815)	0.0628(1.7319)
01000	14	11.8968(2.7645)	0.0233(1.368)
01001	Insufficient data		
01010	20	12.1548(4.2755)	0.3836(2.4154)
01011	12	12.0193(2.7848)	0.1604(0.6303)
01100	14	12.2261(6.658)	0.1425(3.031)
01101	Insufficient data		
01110	38	11.7877(2.9588)	0.1015(1.7775)
01111	33	11.7529(2.4612)	0.0474(4.8317)
10000	14	11.684(3.125)	-0.1187(1.2703)
10001	16	12.494(2.9375)	0.1791(1.5398)
10010	53	12.1361(2.542)	0.1519(1.2802)
10011	33	11.6578(2.9007)	0.0925(1.072)
10100	21	12.4101(2.1477)	0.1812(4.2083)
10101	16	11.7077(4.7774)	0.1655(0.5753)
10110	68	12.4372(5.0143)	0.2519(2.0067)
10111	99	11.9354(3.0755)	0.2428(1.6408)
11000	Insufficient data		
11001	Insufficient data		
11010	18	11.6768(5.2133)	0.0323(0.9079)
11011	26	12.4054(1.9)	0.1688(0.705)
11100	20	12.0263(8.2218)	0.2227(1.3352)
11101	17	12.5601(2.1688)	0.1815(0.484)
11110	100	12.5293(4.3808)	0.064(5.8779)
11111	188	12.3357(2.8753)	0.0941(2.9989)

TABLE 31 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-FINANCE AND INSURANCE

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	1005	11.5936(6.3302)	0.0964(12.167)
00001	235	11.7874(6.5367)	0.001(3.221)
00010	400	11.7622(6.0809)	0.0965(2.3569)
00011	261	11.9185(3.7161)	0.0825(1.5965)
00100	66	11.6676(5.463)	0.0646(1.8885)
00101	37	12.4238(8.3423)	-0.0541(4.0542)
00110	67	12.0629(2.9982)	0.0491(1.7205)
00111	88	11.8814(3.601)	0.1134(0.9545)
01000	Insufficient data		
01001	Insufficient data		
01010	21	11.7864(7.7277)	0.1081(0.8549)
01011	24	11.3597(3.1616)	0.0581(2.6749)
01100	10	11.4922(7.076)	0.0582(0.45)
01101	Insufficient data		
01110	29	11.8859(2.9342)	0.1319(0.5065)
01111	38	11.5658(6.5923)	-0.0333(4.4526)
10000	12	12.5308(1.6014)	0.0995(0.3136)
10001	Insufficient data		
10010	150	11.7998(4.4454)	0.1115(1.2894)
10011	107	11.5523(6.1873)	-0.4541(5.4396)
10100	33	11.8105(5.5748)	0.0098(0.832)
10101	19	11.9623(4.9149)	0.1631(2.1942)
10110	180	12.0626(3.7318)	0.1666(1.0109)
10111	179	11.9289(4.5241)	0.0569(2.1466)
11000	Insufficient data		
11001	Insufficient data		
11010	44	12.0954(2.4808)	0.2292(1.1564)
11011	53	11.9468(2.0697)	0.1999(0.8329)
11100	12	12.6169(3.7815)	0.1729(1.078)
11101	16	12.1664(2.2684)	0.2114(0.6455)
11110	124	12.1488(2.4262)	0.0268(2.8117)
11111	213	11.7589(3.4053)	0.2805(1.7554)

TABLE 32 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-INFORMATION AND CULTURAL INDUSTRIES

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	Insufficient data		
00001	36	11.5082(4.3244)	-0.1304(3.1739)
00010	179	11.6494(4.6169)	0.0966(1.7849)
00011	40	11.6425(4.2196)	0.0192(2.0905)
00100	39	11.5847(3.6891)	0.0964(1.9217)
00101	Insufficient data		
00110	50	11.7609(4.3456)	-0.0462(4.6505)
00111	20	12.9335(4.7639)	0.1997(0.8732)
01000	15	11.6821(2.123)	0.1791(0.5571)
01001	Insufficient data		
01010	28	11.6758(2.4575)	0.1491(0.764)
01011	13	11.4157(1.6832)	0.1707(0.4031)
01100	Insufficient data		
01101	Insufficient data		
01110	62	11.8478(2.855)	0.1185(0.9087)
01111	17	12.4425(2.3499)	0.3494(0.8618)
10000	25	11.9316(2.2098)	0.2099(1.7486)
10001	21	12.5983(1.7833)	-0.3343(3.8351)
10010	73	11.8456(3.1432)	0.0714(1.6656)
10011	22	12.1036(4.2136)	0.062(1.899)
10100	22	11.686(2.9967)	0.0588(0.9531)
10101	16	12.126(1.6384)	0.0553(0.5522)
10110	78	12.0891(3.953)	0.0103(4.8148)
10111	78	12.245(4.3099)	0.0766(4.9293)
11000	Insufficient data		
11001	Insufficient data		
11010	21	11.6904(3.6734)	0.1115(1.1479)
11011	13	11.8098(3.0277)	0.0363(2.3318)
11100	22	11.7569(1.6103)	-0.0299(1.7958)
11101	Insufficient data		
11110	230	11.8478(3.4083)	0.0274(4.0947)
11111	190	12.1103(3.7421)	0.0559(6.2305)

TABLE 33 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-LABOUR INTENSIVE TERTIARY MANUFACTURING

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	800	11.1345(17.0812)	-0.0078(24.5698)
00001	116	10.9584(16.1999)	0.0943(3.8841)
00010	398	11.1901(17.7976)	0.127(6.5006)
00011	53	11.3212(10.9817)	0.1362(1.5003)
00100	68	11.7071(11.7391)	0.4343(5.1391)
00101	31	10.6846(10.1608)	0.1187(2.5888)
00110	76	11.7319(15.9579)	0.1044(5.2149)
00111	25	11.5169(8.2857)	0.1715(1.7264)
01000	48	10.7694(9.7477)	0.0825(1.73)
01001	19	10.5921(5.9745)	0.1549(0.9515)
01010	136	10.9713(11.1494)	0.1447(6.0091)
01011	14	10.6642(4.7428)	0.2912(4.4345)
01100	59	11.6622(10.1311)	0.1018(6.8681)
01101	17	11.4402(5.0992)	0.532(4.7782)
01110	219	11.2228(16.1143)	0.2043(6.2076)
01111	64	11.136(10.8986)	0.1893(2.9103)
10000	44	10.9592(13.8075)	0.1929(2.2799)
10001	26	11.9306(6.7885)	0.3893(2.1341)
10010	69	11.2824(11.8116)	0.2482(3.6919)
10011	28	10.892(6.2186)	0.108(1.3135)
10100	36	11.554(14.7094)	-0.0527(3.5434)
10101	51	11.6994(9.682)	0.2673(5.4814)
10110	107	11.7326(8.1316)	0.3532(4.9695)
10111	83	11.3526(6.9152)	0.225(3.0515)
11000	Insufficient data		
11001	Insufficient data		
11010	100	10.9112(8.3763)	0.1877(3.117)
11011	51	10.8943(9.2125)	0.168(3.4766)
11100	25	11.8494(9.6368)	0.3559(2.9039)
11101	25	12.2134(15.6011)	0.0105(1.2974)
11110	313	11.5265(9.5063)	0.1512(8.4131)
11111	266	11.799(10.469)	0.2667(3.2677)

TABLE 34 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-PRIMARY PRODUCT MANUFACTURING

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	337	11.7501(7.9302)	0.0523(8.2895)
00001	40	11.7003(3.8715)	0.1929(1.7916)
00010	45	11.9436(5.6338)	0.2068(2.0582)
00011	Insufficient data		
00100	118	11.7468(6.2312)	0.1416(2.2755)
00101	26	12.5111(2.0205)	0.3756(1.6981)
00110	47	11.8182(6.5042)	0.3117(2.6137)
00111	Insufficient data		
01000	25	11.5324(3.3491)	-0.1289(3.8504)
01001	Insufficient data		
01010	14	11.8755(5.035)	0.2254(2.7427)
01011	Insufficient data		
01100	87	11.7574(7.1259)	0.1299(4.0632)
01101	Insufficient data		
01110	80	11.9634(5.7825)	0.282(2.5089)
01111	26	11.7251(3.3464)	0.0411(3.8884)
10000	74	11.827(4.704)	0.1391(2.2394)
10001	32	11.4232(6.8508)	-0.6931(5.9382)
10010	25	12.1072(3.7173)	0.3136(1.9615)
10011	Insufficient data		
10100	201	11.6137(4.9787)	0.0751(4.5375)
10101	69	12.0135(4.0144)	0.2834(1.6411)
10110	120	11.7533(4.6798)	0.181(2.357)
10111	29	11.6865(7.4964)	0.0637(4.0506)
11000	27	12.1492(2.053)	0.2654(0.9053)
11001	10	12.2641(2.4271)	0.1946(0.8064)
11010	14	12.0098(3.6443)	0.4354(2.1133)
11011	Insufficient data		
11100	234	11.7711(4.8416)	0.0121(41.478)
11101	91	11.9759(1.9253)	0.1545(2.2299)
11110	475	11.8174(4.8821)	0.2883(2.4797)
11111	260	11.8504(3.3851)	0.2987(2.399)

TABLE 35 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY- REAL ESTATE, RENTAL AND LEASING OPERATIONS

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	422	11.5507(8.0174)	0.0989(3.3768)
00001	36	11.5315(2.4209)	0.2575(1.6123)
00010	92	11.555(8.3611)	0.1372(1.7291)
00011	11	11.9473(3.4885)	0.2028(1.277)
00100	70	11.4965(7.0719)	-0.004(2.7808)
00101	10	11.0475(2.2034)	-0.2144(2.0393)
00110	65	11.3056(5.655)	0.181(1.5159)
00111	11	11.3749(1.9539)	-0.049(1.3835)
01000	13	12.4021(2.0766)	0.2848(0.8905)
01001	Insufficient data		
01010	19	11.9533(5.638)	0.3541(1.5637)
01011	Insufficient data		
01100	22	11.3157(9.1042)	0.3725(3.274)
01101	10	12.6976(4.2653)	0.0411(0.5193)
01110	83	11.103(4.9934)	0.125(1.7204)
01111	Insufficient data		
10000	19	11.8769(7.0432)	-0.1364(3.4901)
10001	Insufficient data		
10010	16	12.442(4.258)	-0.1629(5.55)
10011	Insufficient data		
10100	57	11.892(7.4427)	0.2174(1.5657)
10101	18	11.3533(1.9719)	-0.6364(2.9839)
10110	55	12.2465(6.9373)	0.1255(2.6576)
10111	34	12.4274(2.0887)	0.2689(1.0389)
11000	Insufficient data		
11001	Insufficient data		
11010	15	12.3936(6.3817)	0.4322(1.5713)
11011	Insufficient data		
11100	40	12.4233(4.8501)	0.1055(1.2929)
11101	13	11.7932(1.6323)	-0.03(1.1779)
11110	132	11.7166(7.2775)	0.1064(3.2795)
11111	95	11.95(3.7681)	0.086(0.9845)

TABLE 36 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-RETAIL TRADE AND CONSUMER SERVICES

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	635	11.4142(11.4675)	0.1367(10.9768)
00001	56	11.745(11.9841)	0.188(3.8063)
00010	211	11.2078(7.4391)	0.1181(3.6753)
00011	16	11.917(4.9345)	-0.1785(3.3948)
00100	158	11.5746(11.167)	0.1591(5.574)
00101	21	12.1582(11.6755)	0.0924(2.829)
00110	101	11.1543(11.2938)	0.2171(2.8198)
00111	11	11.6698(3.558)	0.2123(0.8576)
01000	35	11.3736(3.2701)	0.1107(8.422)
01001	Insufficient data		
01010	29	11.2017(4.8298)	0.0959(1.5333)
01011	Insufficient data		
01100	55	12.0211(7.2633)	0.2329(2.6908)
01101	Insufficient data		
01110	115	11.3626(10.8715)	0.1948(12.5855)
01111	16	10.9146(6.0652)	0.1038(2.553)
10000	52	11.5833(4.1963)	0.1998(1.8489)
10001	12	11.2524(3.6147)	0.0603(1.2258)
10010	58	11.1463(8.2574)	-0.071(42.7861)
10011	18	10.8329(8.1233)	0.1655(1.1236)
10100	126	11.9458(9.3921)	0.2799(3.5494)
10101	29	12.3524(10.7424)	0.058(4.41)
10110	181	11.4161(9.3608)	-0.1163(13.7551)
10111	46	11.3169(6.7935)	-0.4032(15.7448)
11000	16	10.0742(4.713)	0.1161(0.5954)
11001	Insufficient data		
11010	40	11.3222(7.4266)	0.1495(4.4559)
11011	Insufficient data		
11100	124	11.4686(5.4339)	0.0827(5.9855)
11101	36	12.1358(3.0712)	0.0537(1.3798)
11110	297	11.504(6.059)	0.0373(5.3712)
11111	113	11.6618(5.8978)	-0.0698(5.5224)

TABLE 37 DESCRIPTIVE STATISTICS OF DEPENDENT VARIABLES BY INDUSTRY-TRANSPORTATION, WAREHOUSING, WHOLESALE

State	Frequency	Labour Productivity Mean (Std. Dev.)	Profit Mean (Std. Dev.)
00000	336	11.3372(4.3705)	0.0627(3.9484)
00001	62	11.8407(2.1208)	0.1677(0.7245)
00010	53	11.0101(5.0384)	0.1439(4.2651)
00011	10	11.5683(1.2539)	0.1794(0.3391)
00100	81	11.6164(4.9154)	0.1705(1.85)
00101	19	11.7164(2.0384)	0.1406(0.8732)
00110	44	11.167(5.242)	-0.0318(4.2952)
00111	15	11.5268(1.0996)	0.2555(0.9639)
01000	22	11.2456(2.8477)	-0.0642(1.1)
01001	Insufficient data		
01010	20	10.6439(3.5995)	-0.0773(1.8489)
01011	Insufficient data		
01100	52	11.5349(4.0437)	0.131(1.4113)
01101	Insufficient data		
01110	62	11.3437(3.9617)	0.0786(3.5304)
01111	17	10.8683(1.957)	0.0689(2.1107)
10000	35	11.295(2.4136)	0.1452(1.9596)
10001	12	11.8483(0.9589)	0.0775(1.5473)
10010	16	12.3592(9.6265)	0.2203(1.541)
10011	Insufficient data		
10100	70	11.6314(4.1892)	-0.029(2.5851)
10101	18	11.4949(3.5443)	0.094(3.2547)
10110	53	11.6394(4.9767)	0.0815(2.7309)
10111	18	11.7514(1.0502)	0.3599(0.8708)
11000	Insufficient data		
11001	Insufficient data		
11010	16	10.7048(4.1582)	-0.8972(15.4878)
11011	Insufficient data		
11100	71	11.4266(3.6139)	0.0253(2.2665)
11101	39	11.6055(1.4056)	0.1042(0.9471)
11110	119	11.7119(3.613)	0.0573(6.767)
11111	103	11.7824(2.8804)	0.0899(1.3137)