DEA Based Analysis of Software Project Efficiency

by

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Abstract

Modern computers have become increasingly indispensable in all sorts of industries. However, the increasing software cost and delivery delay encourage Information System Department to attempt to install objective measurement programs for their software projects. The traditional methods used for this purpose have a number of problems and limitations and therefore, there is a continuing need to explore new methods to measure the efficiency of the software project production process. The multi-dimensionality of software development makes Data Envelopment Analysis an attractive solution. The objective of this work is to validate the hypothesis that DEA is a superior technique for measuring software project efficiency in an actual production environment relative to commonly used techniques. Two DEA models are developed for this purpose. The results compared favorably to the results of several popular ratio analyses. The key factors that affect performance are investigated using DEA results. In addition, the projects are segmented to three categories and carry out more analysis.

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CHAPTER 1 Introduction

1.1 Background

The modern computer has become an indispensable tool in all sorts of industries. Software is playing an increasingly critical role in successful, modern organizations. It has the potential to enable an enterprise to gain and maintain a competitive advantage over its peers. Managers, thinking strategically, continually increase their expectations of the contribution software makes to their businesses. However, such expectations are often not met due to the fact that software development costs are rapidly increasing and delivery delays are encountered in all sorts of software projects.

As a result, Information System Departments are facing an increasing need to simultaneously focus on decreasing their costs while increasing their productivity. At the beginning of this decade, Maglitta [MAGL91] reported: "while 82 percent of the respondents said current economic conditions are affecting their business, only 26 percent have reduced their spending on hardware, software or communications. Staff reductions

and delayed capital investments were the favored cost-cutting measures". The strategy of staff reductions and delayed capital investments will adversely affect current and future software productivity. Forward looking managers still expect their information technology to be as productive as before and to be as helpful in achieving an advantage over their competitors.

According to Boehm [Boeh87], over $800 Billion US will be spent on software production world-wide in the year 2000. Therefore, any significant increase in software development productivity will be worth billions of dollars and deserve serious attention. Given management expectations and the large sums of money spent on software development, it is imperative to find a method to identify factors that affect software productivity in either a positive or a negative way. With this information in hand, project managers should be able to improve the situation by reinforcing the factors that have a positive impact, while eliminating those factors that will adversely affect productivity.

After both individuals and organizations become aware of such a need, they attempt to install objective measurement and analysis of their projects. They want to know how effective they are to compare to their peers and competitors and how to improve their operations to be more efficient.

1.2. Y2K Problem

As time approaches to year 2000, software problems attract more management attention. Fixing Y2k is a challenge without precedent. This problem involves distinguishing the century in dates, which represents year by a two-digit number in computer program. There has never been, until recently, a need to explicitly state the century. Therefore, in an effort to conserve valuable memory and storage space in early computer designs all dates were designated with 6 digits... DD/MM/YY. The year 1998 would therefore only be stored as '98', the same way we often write the date in shorthand. The software would then take the two-digit year value and add 1900 so that '98' would read as 1998. This meant that all calculations concerning the year were made on just two digits, this works only so long as the result of calculation falls within the 1900's.

The two-digit date is a defect inherent in almost every software system in the world. Fixing and testing the code will be extremely expensive. However, it provides a good opportunity to measure software project performance.

The Y2K problem is fundamentally different from other software development efforts. The entire issue has consumed a very substantial portion of a firm's programming resources for the past two years. Management had to adjust to the special nature of the Y2K problem by recognizing the following:

- The deadline for completing this project is set and can not be changed;
- The problem is well defined and fundamentally easy to fix;
- The activity is essentially a maintenance process;
- Time and cost estimates can be made relatively accurately;
- In effect, the results can not be fully tested until all efforts are complete;
- Regardless of the company's own efforts, outsider will play a major role in the firm's own success;
- There is an essentially complete utilization of all programming resources, so adding more staff is not a real option;
- The success of this effort is necessary to stay in business - there are no alternatives.
- There are very few, if any, new lines of code produced.

Of course, these differences will likely show in the research as the results may not correlate with those of other researches. This also offers future opportunity to examine many of the issues about different programming languages, automated tools and techniques used in IT industry.

1.3. Problem Definition

The objective of this work is to address the need to measure performance by analyzing the actual productivity of software teams working in Year 2000 program applications. The collaborating bank is a large Canadian bank which provided the data for

this work. Furthermore, the hypothesis that Data Envelopment Analysis (DEA) can be used in a real production environment to measure software team productivity needs to be validated and to analyze the difference between efficiency calculated from "estimated" data with efficiency calculated from the "actual" data.

The methodology adopted in this research, DEA, has several advantages associated with its use. It is non-parametric and provides a multidimensional measure of project performance. DEA has the ability to handle multiple inputs and multiple outputs without preassigned weights on their relative importance and reduce these multiple measures into a single efficiency score. Furthermore, DEA ensures that the applications being examined will only be compared to the best-observed performers from a set of similar units. Hence, it can objectively establish each project's efficiency relative to all others. Finally, DEA offers a set of realistic targets that managers can utilize to improve performance.

In order to achieve the objective DEA based production models are developed to generate efficiency scores for each application. These models aim at precisely capturing the factors that influence software project performance. The results are compared to those obtained from ratio analysis. Efficiency scores for these applications are calculated by using "actual" data for the most part and augment this with estimates when required. Some application areas of DEA are outlined and the overall power of DEA is also examined. Note that, the software projects measured are focused on converting existing application code, and have the unique characteristic of being almost a maintenance activity. Hence, the

way I used to present DEA results in this research will be a little different from the traditional ways.

1.4. List of Contributions

The contributions of this research are:

- The development of appropriate software efficiency measurement models. The models developed capture the multidimensional nature of the software development process.

- The results of the analysis show the use of DEA as a good tool to measure software project performance since the results are favorable compared with the results of the performance ratio approach, which is widely used in the software industry, and in most cases outperform it.

- The comparison between "estimated" data and "actual" data gives some indication of the accuracy of the estimates.

- The method of presentation suggests that the DEA results can become genuine building blocks of a firm's management strategy for controlling its software costs and it provides insight into the operations of their organization.

- The analysis of the DEA results offers guidance as to where and when management action is needed to improve performance.

1.5. Thesis Structure

This thesis is structured as follows:

- Chapter 2 gives a review of the literature related to the performance analysis of software projects. The shortcomings of the existing methods are outlined, as well as the benefits of the DEA approach shown.

- Chapter 3 gives a comprehensive description of DEA, outlining the related terminology and mathematical treatment. The attributes that make DEA appropriate for the analysis are also highlighted.

- Chapter 4 discusses the different DEA models developed and used in the analysis to measure software project performance.

- Chapter 5 summarizes the data acquisition process and transformations required for the DEA analyses. The DEA models used in this work are also introduced.

- Chapter 6 presents the results and the discussion of the findings.

- Chapter 7 concludes the work and offers recommendations for future work.

CHAPTER 2 Literature Review

Software production has become a focus of major economic activities all over the world. However, this activity is hard to measure in a conventional sense because participants in the industry can not agree on what is to be measured, how and what standards may be set for any of these efforts. As time goes on, not only individuals but also the organizations they work for become aware of a distressing ignorance of how their effectiveness compares to that of their peers and competitors. This section reviews the relevant literature on software efficiency measurement and outlines the traditional approaches to it. At the same time, the limitations of these approaches are addressed and the reasons why the DEA approach is most suitable are given.

2.1. Traditional Software Measurement Techniques

2.1.1. Comparative Efficiency Analysis

When the efficient standards are not available, organizations, especially service organizations, turn to comparative efficiency analysis (CEA) to measure their performance. CEA compares the current performance with historical data, other organizations and opinions to determine if the unit is producing efficiently. The inherent problem of this method lies in the benchmarks used. If the benchmark used for a comparison is flawed, the problems identified by the analysis will not be an organizational problem, but a benchmark related problem. While a comparison between the current data and the historical data does provide some insights on past performance, it does not indicate whether the unit is efficient **[SHER88]**.

2.1.2. Ratio Analysis

Efficiency measurements naturally evoke the concept of ratios of outputs to inputs. If efficiency standards were available, the ratio of the standard to actual results would represent an efficiency ratio. Where standards are not available, ratios are often used to gauge operating performance. Usually many different ratios are calculated to focus on different aspects of the operations. In addition, such ratios are generally used to compare

various dimensions of performance among comparable units as well as within a single unit over several time periods. The popularity of these ratios partially lies in their simplicity.

Banker [**BANK86b**] categorized these direct measures of efficiency into three groups. The first consists of partial productivity measures. They are based on simple ratios of output quantity divided by a single input quantity. To compensate for the inability of one ratio to capture the output mix differences and to segregate the types of inefficiencies, the second group recognizes the multiple input nature of most production processes, and therefore, employs a vector of partial productivity measures. This vector provides insights into the components that may require attention to improve productivity. The third approach derives a single aggregated productivity measure as the weighted sum of the partial productivities for different inputs, where the weights are based on the cost shares of individual inputs.

At first glance, ratio analysis seems easy to carry out and use. Although it can be helpful to obtain qualitative efficiency measures and classifications, this method is subject to several limitations: **[SHER88]**

- Interpreting the information, in the context of the entire activity, provided by each ratio is a very difficult and a largely subjective task.

♦ Even when the weighting scheme is well defined, problems still exist. For example, the choice of weights may be very subjective, or even arbitrary.

♦ Direct comparison of each ratio does not account for tradeoffs between different inputs and outputs.

● Finally, qualitative classifications and measures of productive efficiency provide only a weak link between such measurements and the appropriate managerial action indicated.

In spite of these limitations, ratio analysis is still very helpful in many instances and its use in combination with other techniques can result in very powerful actionable insights. Now, many service industries rely heavily on such ratios.

2.1.3. Parametric Methods

In the software productivity literature of parametric methods, there are ten primary models **[BOEH81]**:

SDC Model -- SDC model is based on the extensive analysis of 104 attributes of 169 software projects studied by System Development Corporation (SDC) in the mid-1960's.

The best possible linear estimation model was produced by statistical techniques. It provided a valuable base of information and insight for cost estimation and future models.

Wolverton Model -- The best use of Wolverton Model includes breaking the software into components and estimating their cost individually. In addition, the model provides a good breakdown of project effort by phase and activity.

SLIM Model -- The SLIM Model is a commercially available software product based on Putnam's analysis for the software life-cycle in terms of the Rayleigh distribution of project personnel level versus time.

Doty Model -- The Doty Model is the result of an extensive data analysis activity, including many of the data points from the SDC sample.

The RCA PRICE S Model – PRICE S Model is a commercially available macro cost-estimation model developed primarily for aerospace applications. It has improved steadily with experience; earlier versions with a widely varying subjective complexity factor have been replaced by versions in which a number of computer, personnel, and project attributes are used.

The IBM-FSD Model -- Only parts of the IBM FSD model have been described in the literature. It is based on the extensive, well-defined data base of IBM-FSD projects. The

main difficulty with this model is in separating out how much of the *i*th productivity change is due to the effects of other correlated factors, or in double counting by using four factors to account for the use of modern programming practices. However, the information on cost driver attributes, and related results on estimation of schedule, computer costs, and documentation have been highly valuable.

The 1977 Boeing Model – The 1977 Boeing model produces a nominal man-month estimate as a function of size and divides up the nominal man-month estimate by phase. Furthermore, it applies the effort multipliers to the nominal effort estimates for each phase to produce an adjusted effort estimate for each phase.

The 1979 GRC Model -- The 1979 GRC model has a number of good features, including a thorough definition of the quantities being estimated and a set of relationship for estimating such quantities as training and installation costs and labor-grade distributions. Some drawbacks, however, include the use of number of output formats as the basic size parameter.

The Bailey-Basili Meta-Model – The Bailey-Basili Meta-Model involves a rigorous statistical process. This model developed composite ratings for total methodology, cumulative, and cumulative experience.

COCOMO Model -- Boehm developed the COCOMO Model, based on his analysis of 65 software projects **[BOEH81].** This non-proprietary model predicts the effort and duration of a project based on inputs relating to the size of the resulting systems and 15 different cost drivers.

Kemerer **[KEME87]** cross-referenced these models and narrowed this list to COCOMO, SLIM and PRICE. He also located another two models which are non-SLOC based (source lines of code): Function Points and ESTIMACS.

Most of the above models focus on cost estimation and determination of factors affecting cost and productivity. Since the purpose of these models is not to measure efficiency, the details will not be provided in this thesis. The reader is referred to **[REES93]** for further information.

2.2. Data Envelopment Analysis (DEA)

DEA, a relatively new quantitative technique that is a cornerstone of the service productivity management program, is used to establish a best practice group of units and to determine which units are inefficient compared to the best practice groups (the efficient units) and the magnitude of inefficiencies present. Now the DEA theory, benefits and its applications will be reviewed.

2.2.1. DEA Theory

DEA was first introduced by Charnes, Cooper and Rhodes [**CHAR78**] in the formulation of the constant returns to scale (CRS) ratio form in 1978. The CCR (CRS) model, named after the three authors, is an extension of Farrel's [**FARR57**] idea of linking the estimation of technical efficiency and production frontiers to multiple input-output combinations. In this model, both technical and scale inefficiencies were encompassed by using the optimal values of the ratio form. This ratio is obtained directly from the data without using preassigned weights and/or explicit delineation of assumed functional forms of relationships between inputs and outputs. It allows for the calculation of the relative technical efficiency of similar *Decision-Making Units* (DMUs) in the analysis on a CRS basis. Based on the classical definition of efficiency, they use the weighted sum of outputs of a DMU to its weighted sum of inputs to indicate the efficiency.

Since 1978, the study on DEA has been growing dramatically and rapidly. The second major milestone in DEA development was the introduction of the VRS model by Banker, Charnes and Cooper in 1984 [**BANK84**]. Compared to the CRS model, the VRS model relaxes the convexity constraint, which allows for the measurement of DMU efficiency on a variable return scale (VRS) basis. Furthermore, the VRS model allows the separation of the efficiency scores into technical and scale efficiencies. The scale efficiency measures whether a DMU is operating at the most efficient scale size, while technical

efficiency gives a measure of how well the DMU is allocating its resources to maximize its outputs.

Two further notable developments of DEA theory are the introduction of the Multiplicative model and the Additive model. The former provides a piecewise Cobb-Douglas interpretation of the production process while the latter relates the efficiency results to the economic concept of Pareto optimality **[ALI93]**, **[CHAR94a]**, **[CHAR94b]** and **[LOVE93]**. Furthermore, there are numerous models and approaches to the selection of an appropriate model depending on the nature of the production-technology. In general, these models differ in their orientation (input-orientation, output-orientation), disposability, diversification and returns to scale, etc.

DEA has the ability to handle exogeneously fixed or nondiscretionary inputs and outputs. Banker and Morey **[BANK86a]** illustrate the impact of nondiscretionary inputs. They also did research on the use of categorical variables in the DEA context **[BANK86b]**. In recent years, some researchers explored ways to incorporate judgement into DEA. The most remarkable effort involves limiting the flexibility of the LP in assigning values to input-output weights. Weights are the trade-offs between different variables. Golany and Roll **[GOLA94]** brought forward the idea of extending industrial engineering concepts by associating them with a methodology that can be applied in multiple-output-multiple-input contexts.

2.2.2. Advantages of DEA

DEA is a very powerful OR technique particularly usable by service firm management. The essential strength of DEA lies in its fairness. It directly incorporates multiple inputs and outputs, which means that the results will be explicitly sensitive to the complexity and mix of outputs. In addition, DEA clearly and objectively indicates which units should be able to improve efficiency and shows the amount of input resource savings or output augmentation measures that these inefficient units must achieve to meet the level of the efficiency of the best practice units. In summary, DEA is an excellent technique that can objectively locate real productivity improvement possibilities without the need for any pre-defined standards and that it identifies best practice and inefficient units by comparing their actual operating results [SHER88].

As a new way to organize and analyze data, DEA results in new managerial and theoretical insights. Charnes et al [CHAR94] describes this new way like this:

"♦ Focus on individual observations in contrast to population averages;

♦ Produce a single aggregate measure for each DMU in terms of its utilization of input factors (independent variables) to produce desired outputs (dependent variables);

♦ Can simultaneously utilize multiple outputs and multiple inputs with each being stated in different units of measurement;

- Can adjust for exogenous variables;
- Can incorporate categorical (dummy) variables;
- Are value free and do not require specification or knowledge of a priori weights or prices for the inputs or outputs;
- Place no restriction on the functional form of the production relationship;
- Can accommodate judgement when desired;
- Produce specific estimates for desired changes in inputs and /or outputs for projecting DMUs below the efficient frontier onto the efficient frontier;
- Are Pareto optimal (Pareto optimality refers to the points in an economic system at which there is no possible for a transaction that can benefit one entity without harming another);
- Focus on the revealed best-practice frontier rather than on central tendency properties of the frontier; and
- Satisfy strict equity criteria in the relative evaluation of each DMU."

2.2.3. Applications Areas

Since the introduction of Data Envelopment Analysis, it has been applied to respects in over 50 industries, such as health care, education (schools, universities), banks,

manufacturing, benchmarking, management evaluation, fast food restaurants, and retail stores, just to list a few.

2.2.4. Applications to Software Production

Current economic conditions, exacerbated by year 2000 problem, are forcing information system departments to simultaneously focus on decreasing costs while increasing software productivity. For many organizations, however, measuring software productivity has been a difficult task. Banker and Kemerer **[BANK89]** investigated economies of scale present in software development. Elam **[ELAM90]** outlines how DEA can be used to enhance existing software measurement practices by applying the data to identify best practices. There has been some research involving software productivity measurements using DEA, including **[BOEH81]**, **[KEME87]**, **[FENT91]** and others. In these papers, they set up different DEA models focused on cost estimation. Mahmood **[MAHM91]** summarized these different DEA models to measure software performance and has shown that DEA technology could be successfully used to identify efficient and inefficient software projects. Furthermore, within the inefficient group, DEA can also identify factors that affect software productivity in a positive or negative manner, allowing managers to take corrective actions.

2.2.4.1. Software Measurement Using DEA in Banks

Performance ratios are widely used to measure the success of software projects in banks. However, each of these ratios just gives a one dimensional, incomplete picture of the projects' health. This shortcoming of ratio analysis has led to alternative approaches. The multidimensional nature of DEA makes it an attractive option. Now DEA has become a well-established operational research tool that supplements traditional approaches and provides further comprehensive insights. Paradi et al. **[PARA97]** presents two empirical studies conducted in two large Canadian Banks to measure the efficiency of the new software production process.

2.3. Summary

In this chapter, the different techniques that have been used in literature were discussed with their advantages and disadvantages. Moreover, why DEA is the technique suitable for this research was justified.

CHAPTER 3 Data Envelopment Analysis

This chapter discusses the Data Envelopment Analysis (DEA) methodology, as an approach to measure software project creation performance. First, the related terminology used in DEA is introduced, then the mathematical models used are highlighted. Finally, this chapter provides the DEA attributes that this thesis takes advantage of.

3.1. DEA Terminology

Production process can be defined as a process that can turn a set of resources into desirable outcomes by firms or production units. During this process, efficiency is used to measure how well a production unit is performing in utilizing its resources to generate the derived outcomes.

3.1.1. Productive Efficiency and Scale Efficiency

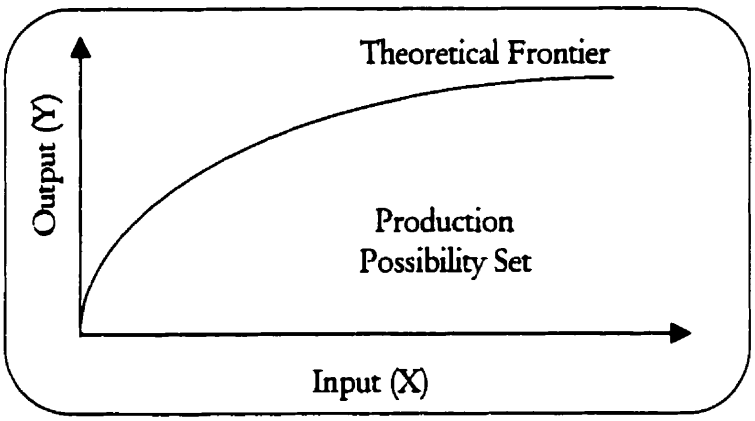
Overall productive efficiency measures how well the production unit is optimizing its output generation process using the available resources. Efficiency can be decomposed into two components: technical efficiency and allocative efficiency. Technical efficiency refers to the ability of a production unit to produce as much output as input usage allows, or to the ability to use as little input as is required by output production, or some combination of the two. Hence, it deals solely with the "operational performance" of the unit and is independent of the behavioral goals of the producer. A unit is technically efficient if an increase in any output requires an increase in at least one input or the reduction of at least one other output, and if a reduction in any input requires the increase of any other input or the decrease of at least one output. Allocative efficiency refers to the ability of the unit to combine inputs and outputs in optimal proportions that satisfy the behavioral objectives of the producer. These objectives include cost minimization, revenue or profit maximization or other objectives the producer pursues. As allocative efficiency gives a measure of whether the Decision-Making Units (DMUs) are using the right proportion of input and output mix to achieve the behavioral goals of the producers, it can be called a measure of effectiveness from the perspective of satisfying the defined objectives of the production units.

Scale efficiency addresses the optimal production volume level. Production of more or fewer goods or services than the optimal level results in added costs solely due to volume and size.

3.1.2. Empirical Production Frontier

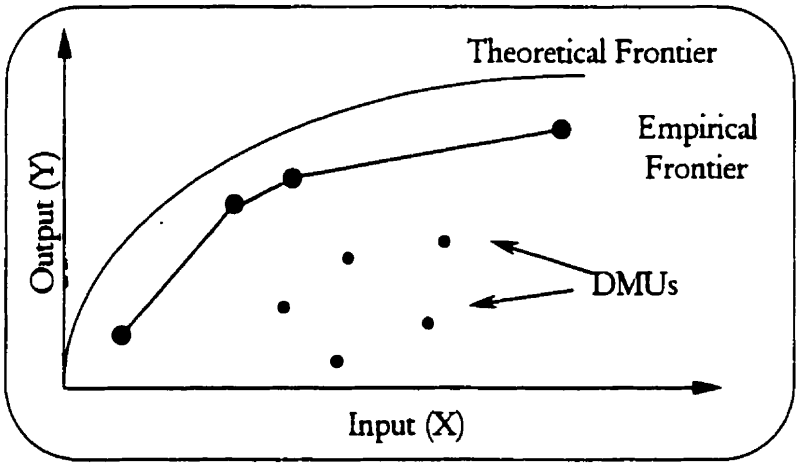
The relationship between the resources consumed by the production process and the resulting outputs is formally described as the production function. It constitutes a frontier for the production possibility set. It can be illustrated by the following one input one output two-dimensional example (figure 3.1). The curve shows the theoretical production possibility set, as it indicates the maximum amount of the output that can be generated from a certain input level and the minimum input required to obtain a desired output. However, this is typically not known and in most cases, especially in service organizations, can not be established accurately.

Figure3.1 Production Frontier



Efficiency computations can be made relative to this frontier if this frontier is known. However, in practice, only a set of observations corresponding to achieved output levels for given input levels is available. The observed data can only identify the empirical production frontier, or envelopment surface, usually below the theoretical frontier (figure 3.2).

Figure 3.2 Theoretical and Empirical Frontier



There are two types of efficiencies related to the production frontier: total efficiency and relative efficiency. Total efficiency measures the actual performance relative to the best possible performance or standard. It is the measure of the distance from the theoretical frontier. Relative efficiency is the actual performance relative to the empirically observed peer performance derived from the other real production data of similar

production units. Hence, relative efficiency is the measure of the distance from the empirical frontier.

3.1.3. Techniques for Efficiency Measurement

Basically, there are two approaches to productive efficiency measurement: the econometric approach and mathematical programming approach, which is referred to as DEA. The two approaches differ in many ways and each has its own advantages and disadvantages. Generally speaking, the econometric approach is stochastic and attempts to distinguish the effects of noise from the effects of production inefficiency. In addition, it is parametric and thus, compounds the effects of misspecification of functional form with inefficiency. The mathematical programming approach is non-stochastic, although stochastic DEA does exist, and non-parametric. It usually lumps noise and inefficiency together and calls the combination inefficiency. Furthermore, it is less prone to specification error. **[LOVE93]**

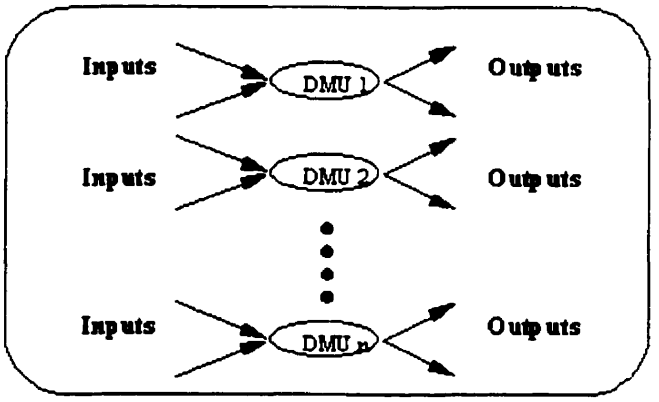
3.2. Data Envelopment Analysis

Considerable research effort has been expended in the development of evaluating the efficiency of a unit in relation to the other units in its group. The breakthrough came when DEA was first introduced by Charnes, Cooper and Rhodes in 1978 **[CHAR78]**. They generalize the single-output/input technical-efficiency measure of Farrel et al. **[FARR57]** to

the multiple-output/multiple-input case. In short, DEA can be explained as a way to measure efficiency as the ratio of weighted sum of outputs to weighted sum of inputs subject to constraints that the efficiency of all the units is less than or equal to unity.

In order to employ DEA for analysis purposes, three components are needed: the inputs, outputs and a set of DMUs they belong to. (Figure 3.3).

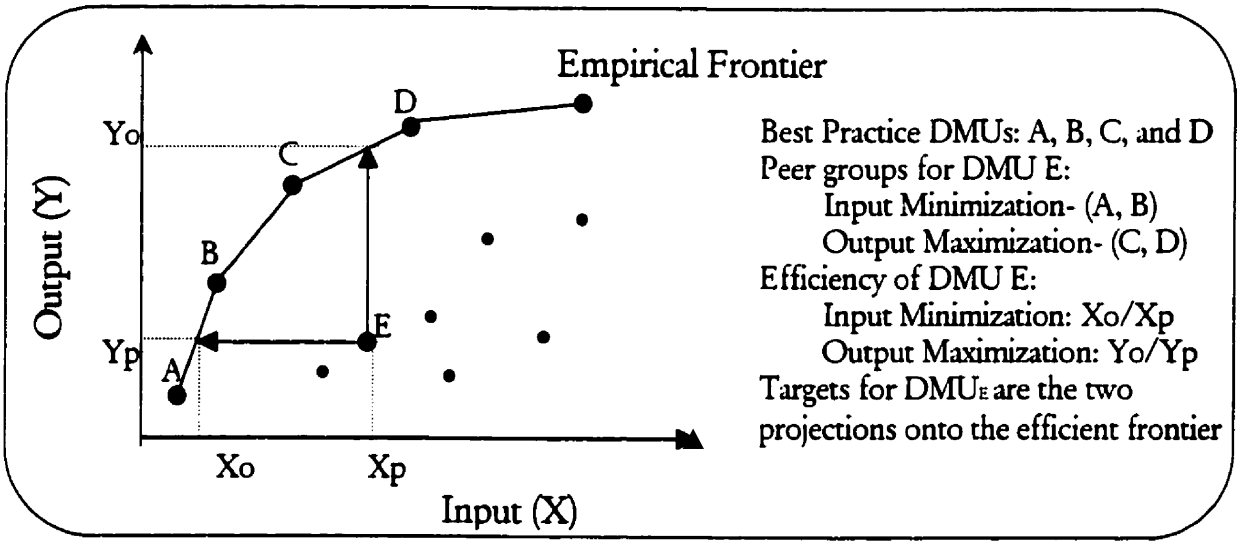
Figure 3.3 DEA Components



Each of the various DEA models seeks to determine which of the n decision-making units determine an envelopment surface that represents the best practice, referred to as the empirical production function or the efficient frontier. Units that lie on the surface are deemed efficient in DEA while those units that do not, are termed inefficient. DEA provides a comprehensive analysis of relative efficiencies for multiple input-multiple output situations by evaluating each DMU and measuring its performance relative to an

envelopment surface composed of other DMUs. Those DMUs form the efficiency reference set, known as the peer group, for the inefficient units. As the inefficient units are projected onto the envelopment surface, the efficient units closest to the projection and whose linear combination comprises this virtual unit forms the peer group for that particular DMU. The targets defined by the efficient projections give an indication of how this DMU can improve to be efficient. The results of DEA are shown by the following two-dimensional example (figure 3.4).

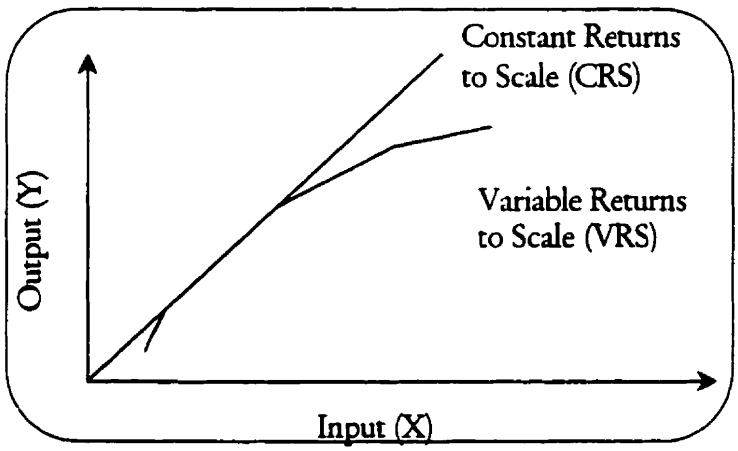
Figure 3.4 Results from DEA



There are two basic types of DEA models based on the envelopment surface used, referred to as constant returns-to-scale (CRS) and variable returns-to-scale (VRS) surfaces.

Figure 3.5 shows these two types of envelopment surfaces. As the names indicate, an implicit assumption concerning returns-to-scale is associated with each type of surface. The CRS model, also known as CCR model, assumes that regardless of the scale of operation, proportional increases in inputs result in proportional increases in outputs. The VRS model, or BCC model, and the additive models relax the constant returns to scale assumption, indicating that the scale of operations affect the input-output relationship. Both of these envelopment technologies result in piecewise linear envelopment surfaces. However, other piecewise envelopment surfaces are possible. For example, one can utilize multiplicative combinations of the inputs and outputs. The resulting envelopments are piecewise log linear or piecewise Cobb-Douglas with multiplicative measures of relative efficiency **[CHAR82]**, **[CHAR83]**.

Figure 3.5 CRS and VRS Frontiers



The preceding discussion of proportional reduction/augmentation is in the framework of the VRS and CRS envelopments. In oriented models (on the basis of the

projection path to the envelopment surface for the inefficient DMUs), the envelopment surface remains the same, either VRS or CRS. However, one set of variables (inputs or outputs) preempts the other in that proportional movement toward the frontier is first achieved in that space. For a radial input oriented model, one is seeking maximal movement towards the frontier through proportional reduction of inputs such that the unit is still capable of producing at least as much output as before. In this case, the projection to the efficient frontier is shown by the projection between DMU_A and DMU_B (figure3.4). For a radial output oriented model, one is seeking maximal movement to the frontier via proportional augmentation of outputs such that the same amount of inputs will be used as before while increasing outputs. In this case, the projection to the efficient frontier is shown by the projection between DMU_C and DMU_D (figure 3.4).

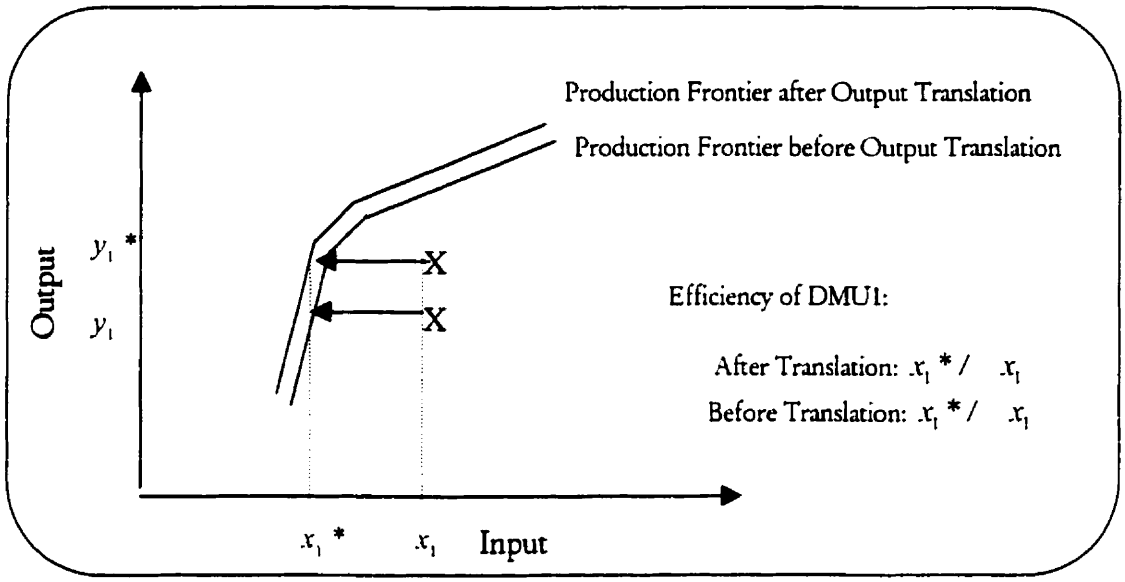
Instead of considering the amount of proportional increase or decrease, one could equivalently characterize input and output orientation in terms of the resultant proportion of the input or output vector after the increase or decrease has been affected. This is the additive model. In this chapter, only the input and output oriented VRS and CRS models will be dealt with in any detail. For the characteristics of the additive model, the reader is referred to **[CHAR94]**.

3.3. Scale and Translation Invariance

Invariance is an important issue when either the input or the output data have negative values. There are two types of invariance: scale invariance and translation invariance. Scale invariance means that if one or more inputs or outputs of the DMUs are scaled by a certain amount, the efficiency scores of the DMUs will not be affected. Translation invariance means that the efficiency scores will be invariant to the translation of inputs and outputs by a scalar. The VRS model is both scale and translation invariant due to its variable return to scale property, while the CRS model is only scale invariant.

The input oriented VRS model is translation invariant in the outputs. This means that the efficiency of a particular DMU will not be affected if one or more of the outputs of all DMUs are translated by a scalar quantity. With the same reasoning, the output oriented VRS model is translation invariant in the input. Refer to figure 3.6 for a graphical interpretation of the translation invariance.

Figure 3.6 Input Oriented VRS Model Translation Invariance



The VRS models, including both the input and output oriented models, are also scale invariant. For example, the efficiency of DMU1 on the above figure is x1*/x1. A scaling of this input by A will result in an efficiency of Ax1*/Ax1, which has no effect on it. In addition, both input and output-oriented CRS models also have such a property.

3.4. Mathematical Treatment

In the discussion to follow, we assume that there are *n* decision-making units (DMUs) to be evaluated. Each DMU has similar inputs and outputs and consumes varying

amounts of *m* different inputs to produce *s* different outputs. Specifically, DMU_j (j =1,2,... ,n) consumes amounts $X_j = \{x_{ij}\}$ of inputs (i=1,2,... ,m)and produces amounts $Y_j = \{y_{rj}\}$ of outputs (r=1,... ,s). We assume $x_{ij} > 0$ and $y_{rj} > 0$. The $s * n$ matrix of output measures is denoted by Y, and the $m * n$ matrix of input measures is denoted by X.

Essentially, the various models for DEA each seek to establish which subsets of n DMUs determine parts of an envelopment surface. As will be seen, the input and output oriented VRS models and CRS models will be presented in the following session.

3.4.1. Input Oriented VRS (BCC) Model

The input oriented VRS model focuses on maximal movement toward the frontier through proportional reduction of inputs.

The linear programs for the VRS model with an input orientation are given below.

$$\min_{\theta,\lambda,s^+,s^-} \quad z_0 = \theta - \varepsilon \cdot \bar{1}s^+ - \varepsilon \cdot \bar{1}s^- \qquad \text{[Equation 3.1]}$$

$$s.t. \quad Y\lambda - s^+ = Y_0$$

$$\theta X_0 - X\lambda - s^- = 0$$

$$\bar{1}\lambda \geq 1$$

$$\lambda, s^+, s^- \geq 0$$

The above [3.1] is called the envelopment form, or primal form. The multiplier form or dual form is given as:

$$\max_{\mu,\nu} \quad w_0 = \mu^T Y_0 + u_0 \qquad \text{[Equation 3.2]}$$

$$s.t. \qquad \nu^T X_0 = 1$$

$$\mu^T Y - \nu^T X + u^0 \vec{1} \le 0$$

$$-\mu^T \le -\varepsilon \cdot \vec{1}$$

$$-\nu^T \le -\varepsilon \cdot \vec{1}$$

$$u_0 \text{ free}$$

Performing a DEA analysis actually requires the solution of *n* linear programming problems of the above form, one for each decision-making unit. The (scalar) variable θ is the proportional reduction applied to all inputs of DMU$_0$ (the DMU being evaluated) to improve efficiency. This reduction is applied simultaneously to all inputs and results in a radial movement toward the envelopment surface. The presence of the non-Archimedean ε in the primal objective function effectively allows the minimization over θ to preempt the optimization involving the slacks. Thus, the optimization can be computed in a two-stage process with maximal reduction of inputs being achieved first, via the optimal θ*; then, in the second stage, movement onto the efficient frontier is achieved via the slack variables (s^+ and s^-). The positive elements of the vector λ indicate the contribution of the efficient DMUs to the peer group that forms the reference set for the DMU under evaluation. Their magnitude indicates the degree to which the characteristics of the efficient DMUs are used to construct the virtual DMU on the frontier to which the inefficient one is projected.

The dual problem yields an alternative geometric interpretation. In the dual form, ν and μ are the vectors of input and output weights. Efficiency is measured as a function of these weights. Each DMU is then allowed to choose weights that maximize its efficiency, provided that the set of weights yield efficiency scores that do not exceed unity, for all DMUs. The variable u is the measure of scale efficiency, where $u>0$ indicates decreasing returns to scale, $u< 0$ indicates increasing returns to scale and $u=0$ indicates constant returns to scale.

The optimal value, z_0^* (= w_0^*), yields an efficiency rating that measures the distance that a particular DMU being rated lies from the frontier. A DMU is technically efficient if and only if $w_0^* = z_0^* = 1$. In other words, if a DMU is efficient, the following two conditions must be satisfied:

1. The optimal value $\theta^* = 1$;
2. All slack variables are zero.

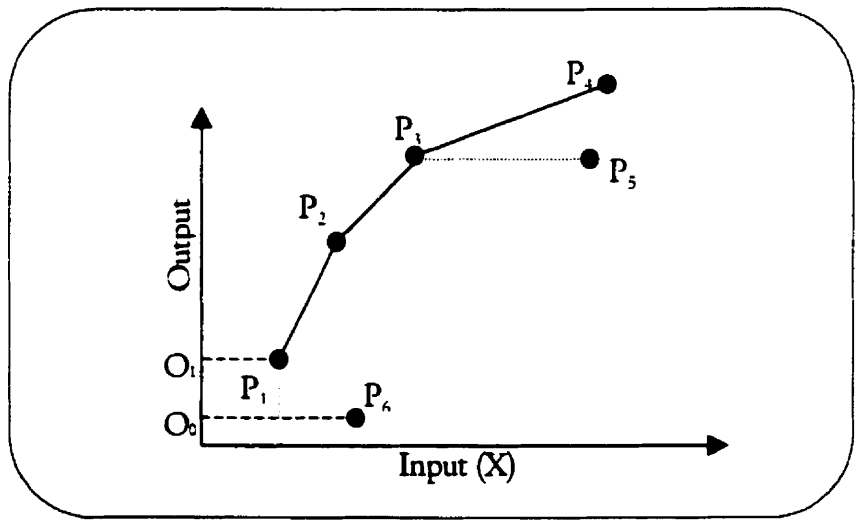
The objective function values obtained partition the set of DMUs into two sets:

- DMUs for which $z_0^*=w_0^*=1$ are efficient and determine the envelopment surface

- DMUs for which $z_0^* < 1$ are inefficient and are enveloped by the surface.

A two dimensional example is given in figure 3.7. Using an input-oriented VRS model, DMU-1, 2, 3, and 4 are efficient and determine the envelopment surface. For DMU-5 to become efficient, proportional input reduction is needed. Note that in this example, DMU-3 is the only peer for DMU-5 because both produce the same output but DMU-3 uses less input. In addition, $\lambda_3 = 1$ to show that it is the only peer. But for DMU-6, it requires not only a proportional reduction in input but also an increase in output by an equivalent amount to the output slack (O_1-O_0), which resulted from the nonzero slack variable.

Figure 3.7 Input-Oriented VRS Example



3.4.2. Output-Oriented VRS Model

The essential difference between the previous input-oriented VRS model and the output-oriented VRS model is that in output orientation the focus is to maximize the proportional increase in the output vector while remaining within the envelopment space. The output-oriented VRS model is stated below.

Output -Oriented VRS model Primal

$$\max_{\varphi,\lambda,s^+,s^-} z_0 = \varphi + \varepsilon \cdot \vec{1}s^+ + \varepsilon \cdot \vec{1}s^- \qquad \text{[Equation 3.3]}$$

$$s.t. \quad \varphi Y_0 - Y\lambda + s^+ = 0$$
$$X\lambda + s^- = X_0$$
$$\vec{1}\lambda = 1$$
$$\lambda, s^+, s^- \geq 0$$

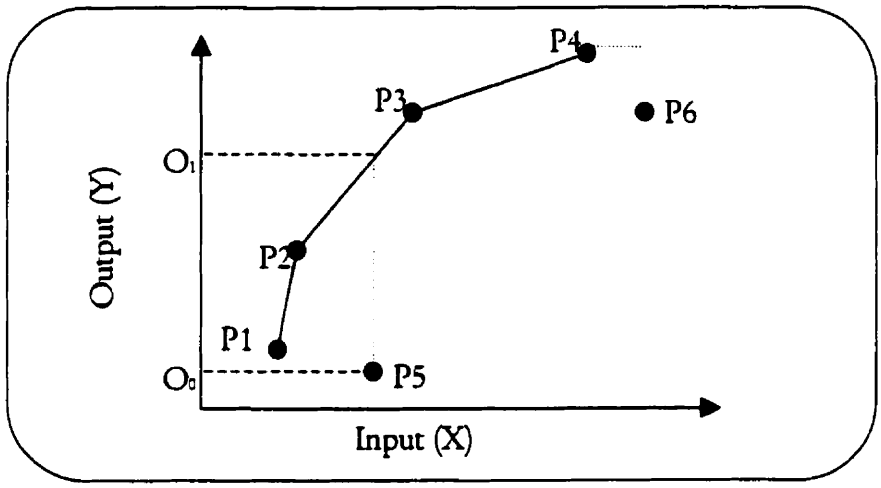
Output-Oriented VRS model Dual

$$\min_{\mu,\nu,\nu_0} q_0 = \nu^T X^0 + \nu_0 \qquad \text{[Equation 3.4]}$$

$$s.t. \quad \mu^T Y_0 = 1$$
$$-\mu^T Y + \nu^T X + \nu_0 \vec{1} \geq 0$$
$$\mu^T \geq \varepsilon \cdot \vec{1}$$
$$\nu^T \geq \varepsilon \cdot \vec{1}$$
$$\nu_0 \quad free$$

The linear program maximizes on φ to achieve proportional output augmentation. The interpretation is similar to that applied in the previous section. If φ > 1 then the DMU is inefficient and requires a proportional increase of φ in all its outputs followed by a further shift towards the frontier by the slacks to become efficient. Now I turn to interpreting the way inefficient DMUs are projected to the frontier under the output-oriented VRS model by a two dimensional example (figure 3.8).

Figure 3.8 Output-Oriented VRS Example



DMU-1,2,3 and 4 are efficient units again and form the envelopment surface. For DMU-5, the proportional output augmentation by φ (O_1/O_0) is sufficient to achieve efficiency. For DMU-6, additional movement of the envelopment surface is necessary and is accomplished via positive input and/or output slack values. In other words, for DMU6 the

efficient projection to frontier requires both an output augmentation portion and the input slack reduction.

3.4.3. The CRS (CCR) Model

The CRS model of Charnes, Cooper, and Rhodes also admits both input and output orientation, and the formulation is similar to that for the VRS model. However, the envelopment surface for the CRS model is different, which is demonstrated by figure 3.5.

Compared to the input oriented VRS model, neither the convexity constraint ($\bar{1}\lambda = 1$) nor the variable u_0 appears in the formulation of the input oriented CRS model. The absence of the convexity constraint enlarges the feasible region. The result is the reduction in the number of efficient DMUs. The non-appearance of u_0 takes away the scale efficiency measurement capability of the model and assumes that all DMUs are operating at constant returns to scale. Under the CRS input oriented model, the values of θ are generally smaller and the values of φ are generally larger than under VRS model.

Similarly the output oriented CRS model can be obtained by removing the convexity constraint $\bar{1}\lambda = 1$ from the primal form and the variable v_0 from the dual form of the VRS output oriented model. Further information can be found in **[CHAR94]**.

In addition to the models discussed above, known as the basic DEA models, there are still other models, such as the Multiplicative model, the Additive model and so on. For further details, refer to **[CHAR94]**.

3.4.4. Extensions to DEA Models

A number of extensions to basic DEA models have been introduced in the literature. These extensions are valuable additions to the methodology of DEA. We briefly examine three of the more important extensions, which are viewed as modifications of the reference set, the variable set and the possible range for multipliers, respectively.

3.4.4.1. Categorical Variables

Frequently, an input or output variable may have a natural representation as discrete levels or may reflect the presence or absence of a particular capability. Banker and Morey **[BANK86b]** discuss the problems associated with attempting to estimate the resources that a bank branch should require to achieve a given level of deposits, given a population base of 100,000 with specific demographic characteristics. DEA will compare the DMU under examination with a combination of efficient DMUs, some of which might have a population base considerably larger than the DMU being examined. Thus it would be less controversial if the comparison group of DMUs, consisted only of branches with a population of 100,000 or less. Similar considerations would hold if some branches of a bank

have a drive-in capability while others do not. In such situation, one may wish to ensure that a branch is compared with branches that are in the same category or possibly with those operating in an even more difficult or unfavorable situation. The use of categorical variables allows the incorporation of such discrete or binary factors and can improve the construction of an efficient reference set.

Suppose that an input variable that may take on one of the values 1,2,... ,M. These M values effectively partition the set of DMUs into categories. Specifically, the set of decision-making units $D = \{1,2,\ldots,n\} = \{D_1 \cup D_2 \cup \ldots \cup D_M\}$ where $D_a = \{i \mid i \in D$ and input value is a$\}$ and $D_a \cap D_b = \varphi$, $a \cong b$. The following model specification allows the evaluation of a decision-making unit L with respect to the envelopment surface determined for the units comprising its and all preceding categories.

$$\min_{\lambda_j, s_r^+, s_i^-} -(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^-) \qquad \text{[Equation 3.5]}$$

$$\sum_{j \in \cup_{K=1}^{K} D_K} y_{rj}\lambda_{rj} - s_r^- = y_{r0} \quad r = 1,\ldots,s$$

$$-\sum_{j \in \cup_{K=1}^{K} D_K} x_{ij}\lambda_j - s_i^- = -x_{i0} \quad i = 1,\ldots,m$$

$$\sum_{j \in \cup_{K=1}^{K} D_K} \lambda_j = 1$$

$$\lambda_j \geq 0, \qquad j \in \cup_{K=1}^{K} D_K$$
$$s_r^+ \geq 0, \qquad r = 1,\ldots,s$$
$$s_i^- \geq 0, \qquad i = 1,\ldots,m$$

The above specification provides an explanation of how the implied hierarchy of evaluation in the category can be addressed via DEA. A decision-making unit L $\in$ D_K, K$\in$ {1,... ,M} may be evaluated with respect to the units in $\cup_{K=1}^{K} D_K$. Although the presentation is for the Additive model, it should be obvious the categorical variables can be easily incorporated in this manner into any DEA model.

3.4.4.2. Nondiscretionary Variables

Nondiscretionary variables are variables over which a DMU has no control. The key to the proper mathematical treatment of a nondiscretionary variable lies in the

observation that information about the extent to which a nondiscretionary input variable may be reduced is not meaningful for the DMU manager.

In the case of input orientation, it is not relevant to maximize the proportional decrease in the entire input vector. Such maximization should be determined only with respect to the subvector that is composed of discretionary inputs. For an output orientation, the necessary modifications to incorporate nondiscretionary variables are similar.

3.4.4.3. Constrained Multipliers

In the particular applications, it may be desirable to perform an analysis with additional restrictions on the variables μ and ν. Such restrictions can increase the discriminating power and flexibility of DEA and thus yield sharper efficiency estimates by incorporating ancillary managerial information into the analysis. Incorporating inequality constraints of the following kind in the multiplier form problem can enforce additional restrictions:

$$\mu a_k^o + \nu a_k^i \leq 0, \qquad k = 1,\ldots,K$$

where a_k^o is the s-vector of coefficients for the output multipliers, μ, and a_k^i is the m-vector of coefficients for the input multipliers, ν.

Such constraints may be included in any of the DEA models. The detailed explanations are given in **[ALI94]**.

3.5. Summary

This chapter has discussed the solution approach in details. Brief theoretical and mathematical treatments of DEA were provided. To enhance its usefulness, several extensions to DEA models have also been presented.

CHAPTER 4 Software Production Measurement

DEA Models in the Literature

This section reviews the relevant applications of DEA to software production reported in the literature.

Banker and Kemerer **[BANK89]** apply DEA models to estimate the Most Productive Scale Size (MPSS) for different data sets. They use single-input (Effort) single-output (Source Lines of the Code) production functions which allow for both increasing and decreasing returns to scale. It is proposed that the knowledge of MPSS may enable managers to estimate the MPSS for the organization and to understand the costs of deviating from this point. Later, Banker, Dater and Kemerer **[BANK91b]** use single-input (Effort) two-output (Function Points (FP) and Source Lines of Code) to study the effects of project

characteristics on different phases of the software maintenance process. Some environmental variables are also included in this model.

In Elam's **[ELAM90]** model, a quality attribute of the software as an output was considered. In addition, Elam outlines how DEA can be used to augment existing software measurement practices by applying the data to identify "best practice". The following inputs and outputs are included in his model:

Inputs

- Labour (Salary/Employee)
- Expenses (Expenses other than Salary/Employee)

Outputs

- Productivity (Function Points/Work Month)
- Quality (Employee Hours Spent Correcting Defects/FP)

This model is more extensive, but most of its measures were normalized: labour cost per employee; FPs per work-month; and quality was measured by the total rework hours per FP. This may result in some undesirable properties. The most significant is the inability to analyze scale efficiencies.

In **[REES93]** and **[PARA97]** a model with one input and three outputs was presented. The single input, project cost, measures the effort and reflects the project cost including labour, overhead, computer charges and other costs. The three outputs are size (Function Points), quality (Defects) and duration (Days).

The production models mentioned above are summarized in table 4.1.

Table 4.1 Review of Software Production Models Using DEA

	Inputs		Outputs			
	Labour (hrs or $)	Other Expenses	Function Points	SLOC Lines of Code	Quality	Project Duration
Banker and Kemerer,1989	×			×		
Elam, 1991	×	×			×	
Banker, Datar and Kemerer,1991	×		×	×		
Reese,1993 Paradi, Reese and Rosen, 1997	×	×	×		×	×
Reese, 1996	×	×	New Code Modified Code		×	×

Notice that all the models use effort, measured by labor hours or costs, as the main input. The main output for the models is the size of the code delivered. Basically, there are two kinds of measures for this attribute. One is the number of source lines of code (SLOC) approach, the other is the FPs approach. A number of researchers, led by Albrecht

[ALBR79], believed that the Function Points method should be used in measuring software productivity. Albrecht and Gaffney **[ALBR83]**, Behrens**[BEHR83]**, Low and Jeffey **[LOWC90]**, and Kemerer **[KEME93]** provided evidence in favor of using this method. However, the FPs method has been criticized for being labor intensive since it requires rigorous data gathering and does not easily lend itself to automation, unlike source lines of code. In addition, this method has questionable reliability since computation is based on the subjective judgement of the person doing the counting rather than objective data. In contrast, other researchers believed that SLOC is the most appropriate measure of software productivity. Boehm provided the most complete and thoroughly documented model, using SLOC for measuring software productivity. This approach has also been criticized concerning the rules for counting SLOC since a number of researchers have included comments in their counts, while others have not. Also SLOC has been criticized for not addressing the issue of language difficulty when comparing the productivity of software projects written in different languages, as well as the terse (APL) or verbose (COBOL) characteristics of different languages.

As mentioned above, Banker **[BANK89]**, Banker, Datar and Kemerer **[BANK91]** used both the FPs and SLOC approaches simultaneously for estimating software productivity of the same project. SLOC was used for gauging the size of the project and the FPs method was used to measure the complexity of the project.

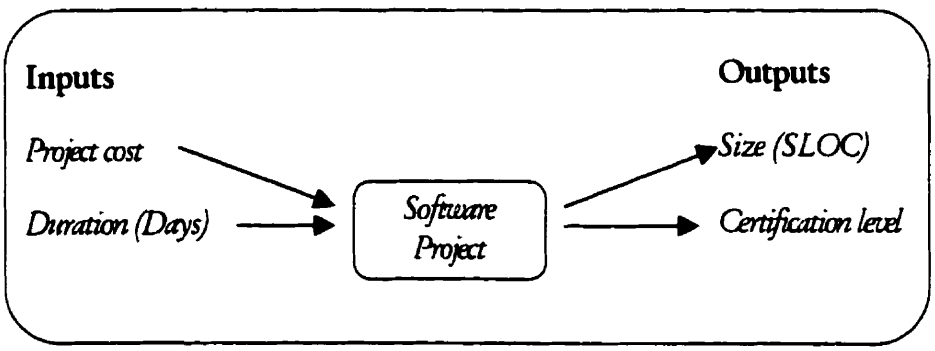
This research uses SLOC as a surrogate software productivity measure for a number of reasons.

- Software project data included in this work are collected by the Bank's Year 2000 Program. They use this measure for their own needs.

- Boehm stated that "delivered source instructions... is a more practical productivity metric than the currently available alternatives"

- SLOC is the most widely used measure of productivity in the software industry.

Project cost is the most commonly used measure of the software project development effort. This research uses this measure as an input variable. In the basic DEA model, there are two inputs and two outputs.



This model introduces the duration as one of the inputs, which results from Putnam and Meyers's **[PUTN92]** findings that there are interactions between time and other project measures, such as size and cost.

Obviously, a number of other factors, in addition to those already mentioned, may also affect the productivity of a software project. For example, Elam **[ELAM91]** suggested the inclusion of the quality attribute. Paradi and Reese **[REES96]** recommended that the environment size should be taken into consideration. Unfortunately, due to the unavailability of the data, these factors will not be considered. If data were available, these variables would easily be integrated into the above model. In addition, programming language, degree of "inter-operation" and other factors will also exert influence on project efficiency. In a later chapter, the comparison of a few efficient vs. inefficient projects will give some indication of these factors.

CHAPTER 5 Data Acquisition and the DEA Models

The correct conclusion comes from not only the right methodology but also good quality data. Data acquisition is a crucial part of this work, especially made difficult by the fact that some of the applications under study have not been completed yet. In this chapter, the process of application selection, data collection and manipulation will be discussed.

5.1. Application Selection

The data used in this work were collected by the Bank's year 2000 activities accounting program. In the database, there are 292 applications in all. Each application has three classification levels. This work chooses the first two levels of the application as a Decision-Making Unit (DMU), since almost all applications' third level have not been completed yet. The raw data on these applications are separated into two groups: one group is the "estimated" data for the applications, the other is "actual" data. Therefore, this work

will measure not only the "actual" efficiency but also efficiency using "estimated" data and make a comparation between the "actual" efficiency and "estimated" efficiency in order to provide some indication on how effective the software project estimation process is.

Furthermore, this work also uses the whole application as the DMU. However, this is restricted to those applications that have complete information on all three levels. Due to the limited data, this work measures the estimated efficiency for the whole application. Nevertheless, some conclusions on which level of the application causes most of the inefficiency of the whole application after the whole efficiency is computed to those at different levels.

5.2. Data Collection and Transformation

All of the raw data are obtained from the Bank's Year 2000 Program. Table 5.1 gives the data elements and their sources.

Table 5.1 Data Elements and Source

Data	Source
Full Time Equivalent (FTE)	Resource Plan
Source Lines of Code (SLOC)	Main table
Project Start Date And End Date	Application Plan
Certification Level	Main table

Data are extracted and imported into a Microsoft Excel Spreadsheet. The raw data are not fully compatible with the information required for my models. In order to gather required data to be consistent and complete some extrapolation and transformations are required.

In the database, although the programmer effort, measured in full time equivalence (FTE), is assigned by year, it is possible that more than one level of the application is in progress in the same year. Substantial effort was made to find the amount of FTE utilized for each level of the applications, yet some error must still exist.

Moreover, for some applications the FTE assigned to the application is zero, but the source lines of codes (SLOC) is positive. To ensure that the data are clean, such applications had to be dropped from the study at this time.

To measure the project cost, a consistent data-item is required for all applications. In this study, FTE in Canadian Dollars is used. For this purpose, data from the Bank's Year 2000 Program application database are used. Normal planning for development used a rate of $540/day (development programmer) and 17.25 workdays per month for costing. An equivalent FTE dollar value would be one FTE/year * $540/day * 17.25 days/month * 12 months = $111,780/year. This value is used to compute the FTE in dollars. The duration for each project is also needed for the model. In the database, I just have the information about the start date and end date. The standard of 17.25 days/month to calculate project duration is used.

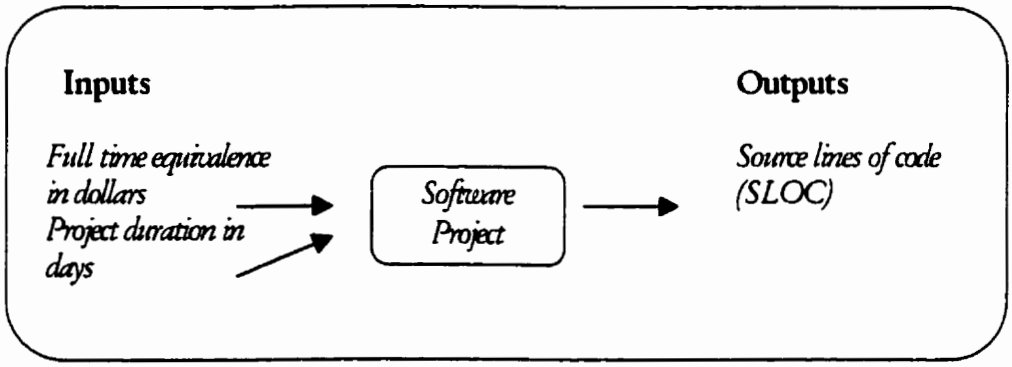
With the above-mentioned extrapolations and transformations, the database is complete for this study. Now there are 52 applications for estimated efficiency study, 37 applications for actual efficiency study and 88 applications for the whole project estimated efficiency study.

5.3. The DEA Models

The following is the list of the inputs and outputs of the DEA model (Model I) used to measure the efficiency as of first two levels of the applications. This model will be used twice in this work. On the one hand, this model will measure estimated efficiency by budget plan data; on the other hand, it will measure actual efficiency by actual performance data. The diagram for the DEA model is also provided.

- Full time equivalence in dollars
- Project duration
- Source lines of code

Figure 5.1. DEA Model I



Another list of the inputs and outputs and the diagram of the model (Model II) to measure the efficiency of the whole application are also given.

- Full time equivalence in dollars
- Project duration
- Source lines of code
- Certification level(0,1,2,3)

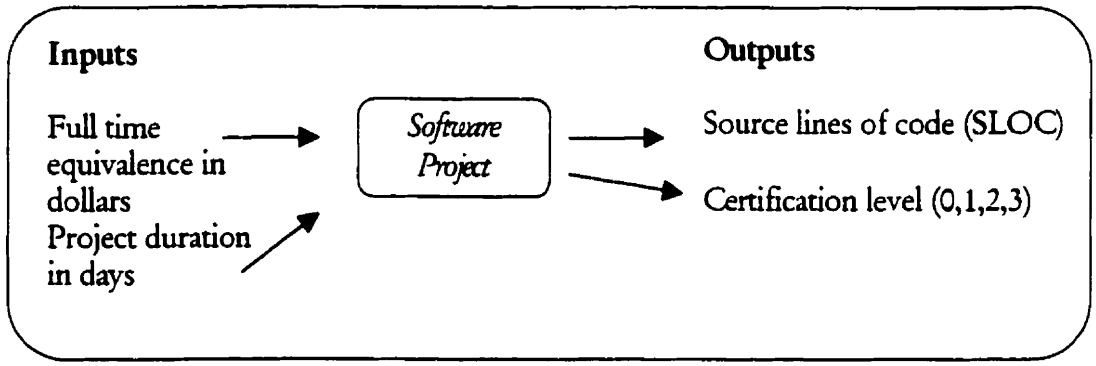
'0' indicates that no certification level has been achieved

'1' indicates that the application have been tested using current dates to ensure that they have no negative impact on current processing and, if appropriate, implementation into production

'2' indicates that the application has been tested successfully in a simulated year 2000 environment

'3' indicates that the application has been tested in a Year 2000 "'time machine" environment

Figure 5.2. DEA Model II



Input orientation is selected for the DEA models in this work for two reasons. On the one hand, the output level, especially SLOC, is to a great extent determined by the application. Many times no new SLOC is created. On the other hand, an assumption is made that the management is more interested in minimizing the consumption of input to a certain output level, which in this case usually means "getting the job done" rather than some goal measured in SLOC or FPs. Both types of envelopment surfaces, VRS and CRS, are used and their results are compared.

5.4. Summary

This chapter has documented how I obtained all the useful information required for this study. The detailed description of the models developed for this study is also presented. The inputs and output are explained.

CHAPTER 6 Results and Discussions

This chapter presents the results of this analysis using the two DEA models outlined in Chapter 5 and compares the results from the performance ratio approach described in Chapter 2 with the results obtained from the DEA analysis. Furthermore, this chapter discusses the correlations between different variables in the DEA models. I also separated the projects into size groups and examined the results.

6.1. Analysis Using Performance Ratios

Partial production ratios are widely used measures for assessing the performance of software projects. In this study, the software projects are confined to the process of fixing and testing application software code when fixing Y2K problem. In the usual case, the software includes development, testing, implementation, operation, maintenance and enhancement. Here, two particular ratios were used to compare to the DEA results and help validate the conclusions:

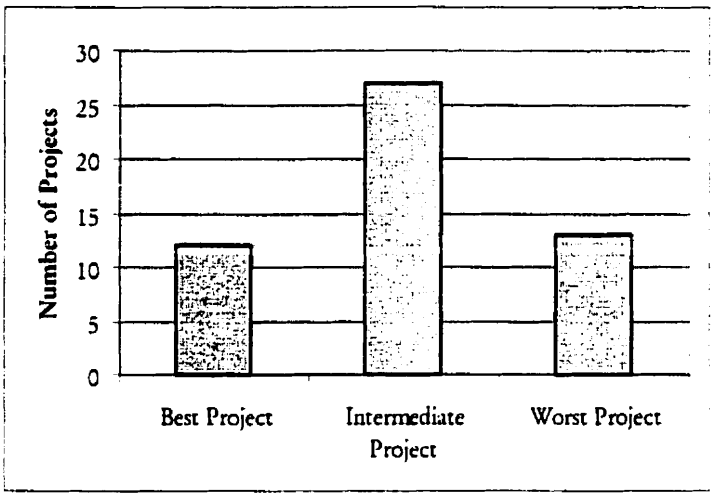
- R1= Project Cost/SLOC

- R2= Project Duration/SLOC

We then combine the two ratios in order to classify the projects. The ratios were calculated for the first two levels (certification level one and two) of each available project, using "estimated" data (plan data) and "actual" data (actual performance data) separately. I also performed ratio analyses for the whole project using available "estimated" data. The basic data and the two ratios are given in Appendix A with one qualitative classification.

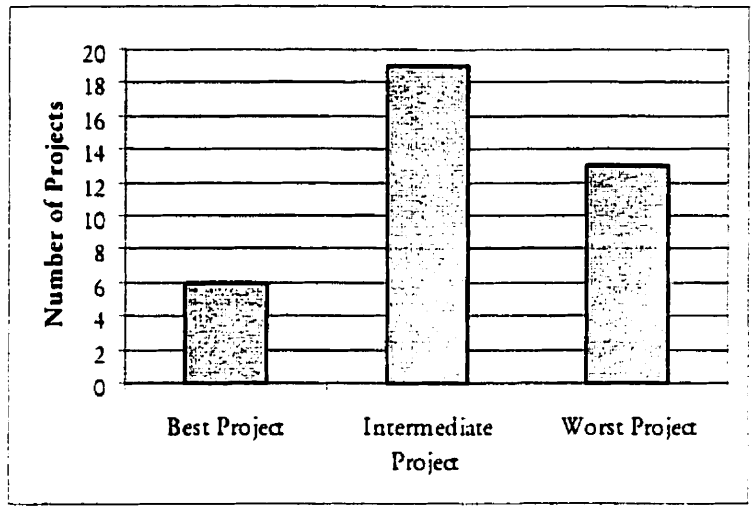
For the first two levels (certification level one and two), there are altogether fifty-two projects available to calculate ratios using "estimated" data. Twelve projects were found to be relatively efficient ("best") because both the Project Cost/SLOC and the Project Duration/SLOC ratios are low. Another thirteen projects were judged to be the most inefficient ("worst") due to relatively high values of the two ratios. The remaining projects were considered intermediate. For example, project *C/A Bulk Filing* was considered intermediate primarily due to its high Project Cost/SLOC ratio. Similarly, Project *Cheque Imaging* was considered intermediate due to a high Project Duration/SLOC ratio. Figure 6.1 shows the results of the ratio analysis.

Figure 6.1 Results Using Ratio Analysis (Estimated Data)



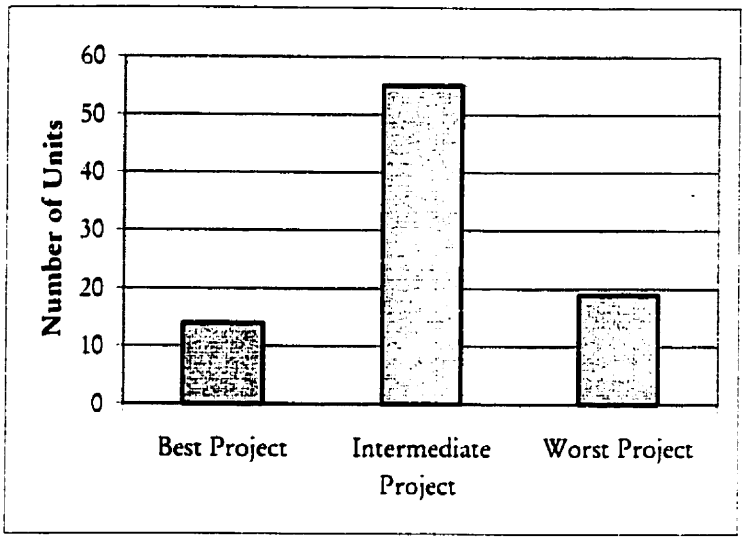
Then I turn to the actual ratios of the first two levels of the projects. Due to the unavailability of the actual performance data, there are only thirty-seven projects to work with in this analysis. Seven projects are considered relatively efficient, eleven projects are found most inefficient and the rest are intermediate. Figure 6.2 gives the results of the ratio analysis.

Figure 6.2 Results Using Ratio Analysis (Actual Data)



Finally, the projects are analyzed as a whole (based on plan data). Among eighty-eight projects fourteen projects are judged to be relatively efficient, nineteen projects are most inefficient and the remaining are intermediate. Figure 6.3 shows the ratio analysis results on the basis of the whole project.

Figure 6.3 Results Using Ratio Analysis (for the Whole Project)



It is important to point out that different people give different classifications based on the same ratios. Thus, the combined ratios just give a "fuzzy" efficiency measure. This further demonstrates the subjective nature of the ratio analysis and the difficulties associated with such partial performance measures.

In summary, this section gives ratio analysis results. For the first two levels based on budget plan data, twelve projects out of fifty-two projects were judged relatively efficient, thirteen were most inefficient and the rest twenty-seven were intermediate. For the first two levels based on actual performance data, seven out of thirty-seven projects were considered relatively efficient, eleven were most inefficient and the other nineteen were intermediate. For the whole project, fourteen projects out of eighty-eight projects

were relatively efficient, nineteen were most inefficient and the other fifty-five were intermediate.

6.2. Results and Discussions from DEA Models

6.2.1. Correlation Analysis

In order to confirm and analyze the impact of the variables on efficiency the correlations between each pair of variables in the models are calculated. Very high correlations between a pair of variables imply that the two variables represent the same production mechanism. In such a case, one of these variables could be excluded from the model. On the other hand, if a variable has very low correlation with the other variables, it may imply that this variable does not fit the model.

We did not find any variable with a very low or a very high correlation with other variables in three models. The following tables give the correlation coefficients of each pair of variables.

Table 6.1. Correlation Coefficients of Estimated Data for the First Two Levels

	Correlation Coefficients
Project Cost vs. SLOC	0.588
Project Cost vs. Project Duration	0.452
SLOC vs. Project Duration	0.360

Table 6.2. Correlation Coefficients of Actual Data for the First Two Levels

	Correlation Coefficients
Project Cost vs. SLOC	0.786
Project Cost vs. Project Duration	0.677
SLOC vs. Project Duration	0.421

Table 6.3. Correlation Coefficients of Estimated Data for the whole Project

	Correlation coefficients
Project Cost vs. Certification Level	0.326
Project Cost vs. SLOC	0.740
Project Cost vs. Project Duration	0.553
Certification Level vs. SLOC	0.257
Certification Level vs. Project Duration	0.458
SLOC vs. Project Duration	0.355

6.2.2. Technical Efficiency

Since input oriented DEA models are used, technical efficiency scores can be interpreted as the proportion of inputs that could produce the DMU's output vector if the DMU was operating on the frontier. Moreover, the amount and type of resource saving that can be achieved by making each inefficient unit as efficient as the most efficient ones are identified and directions for management to achieve these savings are highlighted.

6.2.2.1. First Two Levels Estimated Model Results Using Model I

The overview of the variables used in this model is given in table 6.4.

Table 6.4. Summary Statistics of Outputs and Inputs for First Two Levels Estimated Model - Using DEA Model I

Inputs and Outputs	*Total*	*Average*	*Max*	*Min*
Input				
FTE(in dollars)	6,878,941	132,287	748,926	5,589
Project Duration(days)	13,790	265	894	32
Output				
SLOC	11,245,571	216,261	2,277,377	1,000

The technical efficiency results based on the estimated data (plan data) for the first two levels (certification level one and two) of the applications are shown in Appendix B.

The average technical efficiency scores under constant returns to scale and variable returns to scale are 0.233 and 0.470 respectively. Efficiency scores are greater under variable returns to scale than under constant returns to scale because the frontier constructed under variable returns to scale envelopes the data more tightly.

The following table summarizes the DEA results under CRS and VRS assumptions.

Table 6.5. DEA results - Using DEA Model I

	VRS	CRS
Technical efficiency		
Average Score	0.470	0.233
Maximum Score	1	1
Minimum Score	0.108	0.013
Number of Efficient DMUs	6	2
Returns to scale		
Number of efficient DMUs exhibiting IRS	3	---
Number of efficient DMUs exhibiting DRS	1	---
Number of efficient DMUs exhibiting CRS	2	---

We split these projects into four groups (based on VRS score)**[MICH91]**:

- The robustly efficient units will appear in many reference sets and are likely to remain efficient unless there were major shifts in their fortunes. In the analysis, 5 projects, including *Project Branch Clearing, Cage II Control, HUMAN RESOURCES, GMAC* and *Project CIBC Wood Gundy Securities Operations*, are robustly efficient units.

- The weakly efficient units will typically appear in only one or two reference sets and would be likely to drop below 1.0 if there was even a small drop in the value of an output variable (or a small increase in the value of an input variable). In this analysis, *Project*

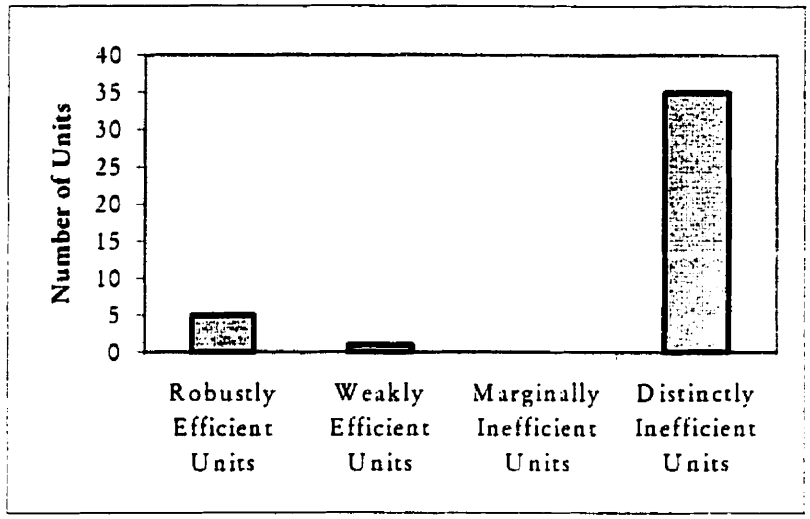
Bankcard is the only weakly efficient unit. Note that weakly efficient units will not be outliers (or self evaluating units) because the outliers do not appear in any reference set.

- The marginally inefficient units. These will have an efficiency rating in excess of 0.9(but less than 1) and could raise their score towards 1.0 with a relatively small amount of improvement in their operating results. There is no such unit in this analysis.

- The units with an efficiency score of less than 0.9 would have difficulty in making themselves efficient in the short term. However, if the efficiency score of a unit is less than 0.6, then this unit would likely remain inefficient unless there was a major change in their operating circumstances. Therefore, theses units with scores of less than 0.6 are classified as distinctly inefficient units. In this analysis, 35 projects belong to this category.

Figure 6.4 shows the number of units in each category using this model.

Figure 6.4. Number of Units in Each Category (Estimated Model)



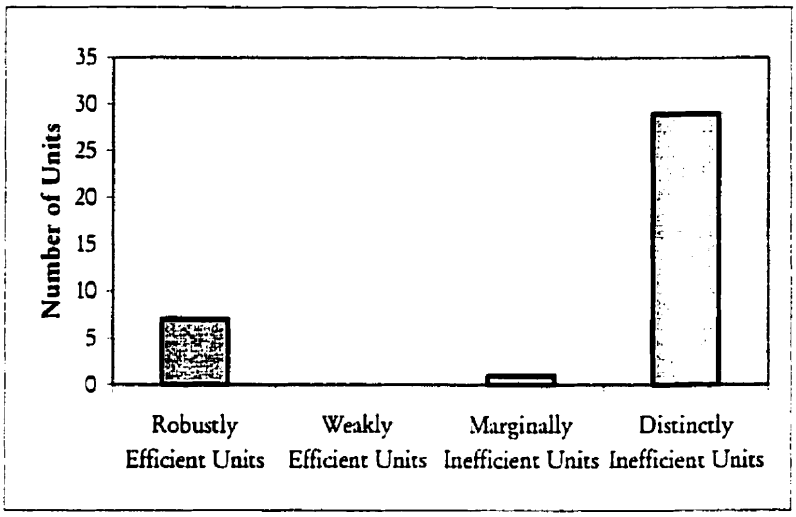
Careful analysis of the above result suggests that the thirty-five distinctly inefficient units are too many for a real-life situation. Yet the six efficient units appear to be OK. To investigate this issue, it is most likely that the efficient units may have something unusual about one or more of their inputs or outputs. Thus, setting targets may be unrealistic for other projects to reach because the distances between the inefficient units and the frontier are unusually large. To examine this, the six efficient projects and one outlier on the frontier were removed from the analysis - this is called "peeling off the frontier"- and the DEA model was run again to see what effect this has in the thirty-five distinctively inefficient DMUs. In this analysis, there are altogether forty-five projects. Table 6.6. summarizes the new results.

Table 6.6. DEA results Using Model I

	VRS	CRS
Technical efficiency		
Average Score	0.536	0.264
Maximum Score	1	1
Minimum Score	0.140	0.02
Number of Efficient DMUs	7	4
Returns to scale		
Number of efficient DMUs exhibiting IRS	3	---
Number of efficient DMUs exhibiting DRS	0	---
Number of efficient DMUs exhibiting CRS	4	---

After I peeled off the frontier, the efficiency scores of the remaining projects increased some. The average efficiency score increases from 0.470 to 0.536 (VRS model). Moreover, there are twenty-nine distinctively inefficient units based on seven efficient units. This suggests that the original frontier might objectively reflect the performance of the organization since the results after peeling off the frontier are close to the original results. Based on the new DEA results, the projects are separated into groups. The results are shown in Figure 6.5.

Figure 6.5. Number of Units in Each Category



In summary, this section presents the technical efficiency of the available fifty-two projects for the first two levels estimated model. Five were found robustly efficient, one was weakly efficient and thirty-five distinctly inefficient. After peeling off the frontier, forty-five projects were left. Among them, seven were considered robustly efficient, one was marginally inefficient and twenty-nine were distinctively inefficient.

6.2.2.2. First Two Levels Actual Model Results Using Model I

The input oriented model is used to measure the actual efficiency of the software projects. Summary statistics of the inputs and outputs used in this model are included in Table 6.7.

Table 6.7. Summary Statistics of Outputs and Inputs for First Two Levels Actual Model - Using DEA Model I

Outputs and Inputs	*Total*	*Average*	*Max*	*Min*
Input				
FTE(in dollars)	3,346,693	90,451	423,646	1,118
Project Duration (days)	8,193	221	894	37
Output				
SLOC	5,486,603	148,287	1,550,000	460

The technical efficiency results based on the actual data (actual performance) for the first two levels are shown in Appendix B. The average technical efficiencies under constant returns to scale and variable returns to scale are 0.261 and 0.535 respectively after one project is dropped due to its extremely low efficiency score. This project was found to need major rewrite and fundamental changes from its original version, hence is not really comparable to the rest of the data.

The results indicate that the potential improvement of the actual performance of these software projects is very high. The bank could use far less input obtaining the same level of outputs if they were to adopt "best practice" technology. The best practice unit represents the collective views of service providers about the most efficient way to provide

this service. Here the best practice units are those DMUs on the frontier. For the same reason as I referred to in Section 6.2.2.1, the frontier was peeled off and the DEA model was run again. Table 6.8 compares the results of before and after peeling off the frontier under both CRS and VRS assumptions.

Table 6.8. DEA results Using DEA Model I

	VRS		CRS	
Technical Efficiency	Before peeling off the frontier	After peeling off the frontier	Before peeling off the frontier	After peeling off the frontier
Average Score	0.535	0.668	0.261	0.262
Maximum Score	1	1	1	1
Minimum Score	0.115	0.234	0.014	0.020
Number of Efficient DMUs	6	3	2	2
Returns to Scale				
Number of efficient DMUs exhibiting IRS	3	1	---	---
Number of efficient DMUs exhibiting DRS	1	0	---	---
Number of efficient DMUs exhibiting CRS	2	2	---	---

The "actual" efficiencies reveal the real performance of the organization. To provide insights to management for improvements, the most immediate and most straightforward method is to prepare a list of units in descending order of relative efficiency. Those with a relative efficiency score of 1.0 are differentiated by computing the number of times they appear in the reference sets. Therefore, I split the list into five groups (using the DEA results after peeling off the frontier):

- The super efficient units. These units have efficiency scores of 1.0 before I peeled off the frontier. Therefore, after the frontier was peeled off, these units appeared above the new frontier, which is the reason why they are named super efficient units. In this analysis, *Project Branch Clearing, IMS COLT, Invest Products System, Software Amortization System, Wood Gundy Rapid Confirms* and *project Financial Model System* are super efficient units.

- The robustly efficient units. According to the definition in Section 6.2.2.1, *Project EFT, GMAC* and *project Float* belong to this category. Units in this group represent "best practice" units. They are managing their resources very well in the environment in which they operate.

- The weakly efficient units just appear in a few reference sets. Thus, they would be easy to become inefficient even though there were small changes in their fortunes. There is no such unit in this analysis.

- The marginally inefficient units. *Project Geographical Distribution* and *project Utility Bills* belong to this group. Although the efficiency score of these projects are less than 1.0, their efficiency ratings are in excess of 0.9, which are 0.989 and 0.914 respectively. Hence, they could soon raise their score towards 1.0. From management perspective, the marginally inefficient units are more meaningful than the outliers are.

- The distinctly inefficient units. As mentioned in Section 6.2.2.1, these projects with efficiency score of less than 0.6 would not reach the frontier until there was a major change in circumstance. My analysis suggests that twelve projects are the distinctly inefficient units. The projects in this group are obviously not succeeding and the reason for this should be investigated by management. However, it should be remembered that these results are only at level 2 of the projects and therefore, these units may become more efficient when measured at level 3. This can happen if very few resources will be used at level 3, perhaps because more were used at level 1 and 2. There could be trade-off here. Furthermore, I have no way of establishing how well estimates were made, by whom or by what methods. Hence, I can not make value judgement or prediction as to how units will show efficiency changes after the level 3 data are available.

I also carried out the same analysis for the DEA results before peeling off the frontier. All the results are shown in Figure 6.6.

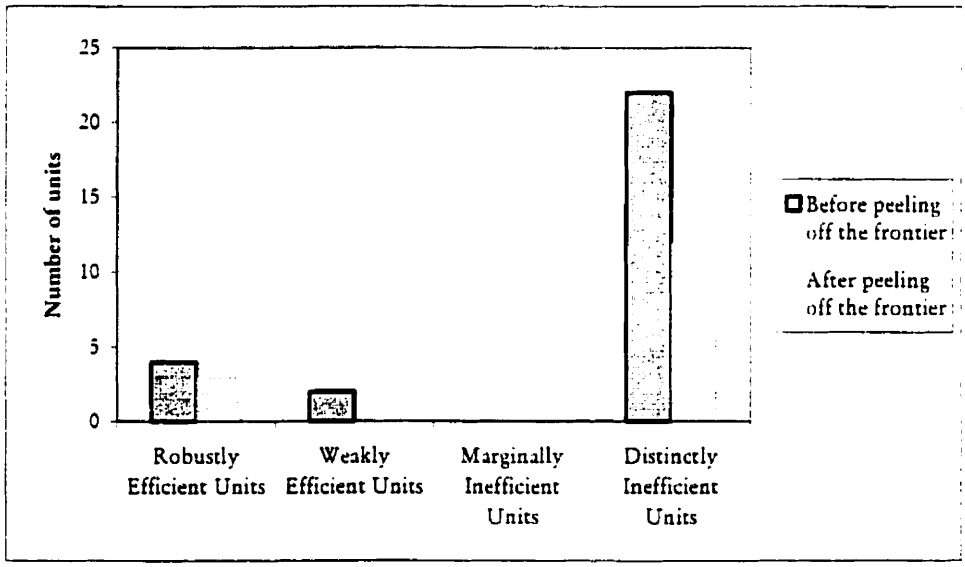
Before peeling off the frontier, *project IMS COLT*, *Software Amortization System*, *Wood Gundy Rapid Confirms* and *project Financial Model System* are robustly efficient units.

Project Branch Clearing and *project Invest Products System* belong to the weakly efficient group.

No marginally inefficient unit exists in this analysis.

Twenty-two units belong to distinctively efficient units.

Figure 6.6. Number of Units in Each Category (Actual Model)



From this figure, I can conclude that the results after peeling off the frontier may provide more insight to management because the efficiency scores increased sharply. Therefore, it is feasible for them to be the peers for the other inefficient units.

This section has discussed the technical efficiency for the first two levels actual model. Two out of thirty seven projects were robustly efficient, two were weakly efficient and twenty-two were distinctively inefficient. After peeling off the frontier, three were robustly efficient, two were marginally inefficient and twelve were distinctively inefficient.

6.2.2.3. *Whole Project Estimated Model Results Using DEA Model II*

Summary statistics for the inputs and outputs in this model are reported in table 6.9.

Table 6.9 Summary Statistics of Outputs and Inputs for the Whole Project Estimated Model – Using DEA Model II

Outputs and Inputs	*Total*	*Average*	*Max*	*Min*
Input				
FTE(in dollars)	29,345,603	333,473	1,922,616	8,942
Project Duration(days)	34,357	390	1,345	35
Output				
SLOC	26,206,896	297,806	2,301,000	99
Certification Level	N/A	N/A	3	2

The technical efficiency results based on the estimated data (plan data) for the whole project are shown in Appendix B. The average technical efficiency scores under constant returns to scale and variable returns to scale are 0.445 and 0.515 respectively. Furthermore, there are fourteen efficient units under variable returns to scale and ten under constant returns to scale. These show that the results are pretty reasonable. To further examine the above results, I peeled off the frontier and carried out another analysis using the same model.

The summary of the DEA results before peeling off the frontier and after peeling off the frontier using DEA model II under CRS and VRS are shown by Table 6.10.

Table 6.10. DEA Results Using DEA Model II

	VRS		CRS	
Technical Efficiency	Before peeling off the frontier	After peeling off the frontier	Before peeling off the frontier	After peeling off the frontier
Average Score	0.515	0.556	0.445	0.483
Maximum Score	1	1	1	1
Minimum Score	0.130	0.164	0.099	0.116
Number of Efficient DMUs	14	15	10	8
Returns to Scale				
Number of efficient DMUs exhibiting IRS	3	2	-------	------
Number of efficient DMUs exhibiting DRS	4	6	-------	------
Number of efficient DMUs exhibiting CRS	7	7	-------	-------

These results suggest that the DMU performances before peeling off the frontier are realistic because the results after peeling off the frontier are quite similar to them. This further means that the efficient units on the original frontier are practical targets for the other inefficient units.

We use the results before peeling off the frontier to carry out the following analysis.

Project General Clearing, Cage II Control, COINS - Op Cntrl, HUMAN RESOURCES, Info Capture System (Replaced by 283), CRIBS Savings (Replaced by 284), Tracing, SFT-Calculators, ICBS (International Comprehensive Banking System), Financial Model System and *project Collections-Property Administration* are robustly efficient units.

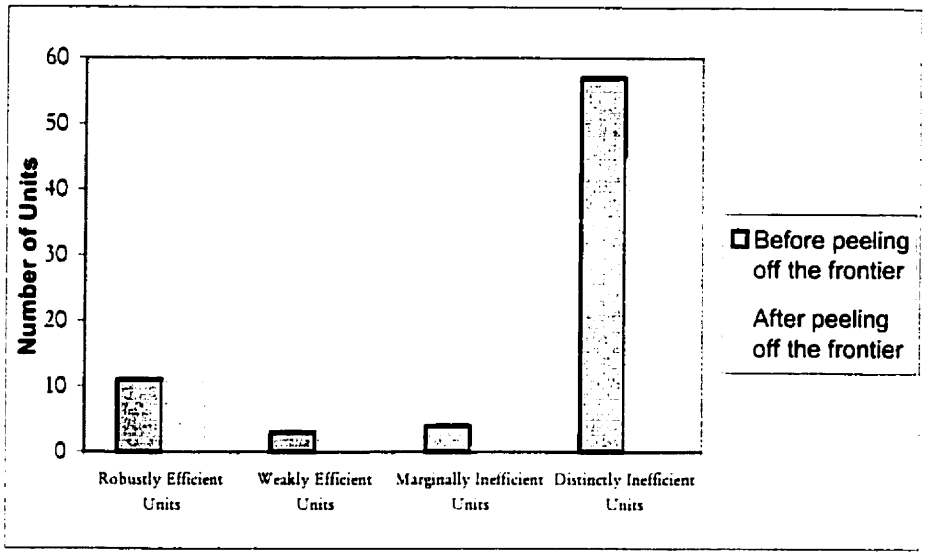
Project IBTSS, ECIF, and *project Bankcard* are the weakly efficient units.

Project Geographical Distribution, Centralized Rates, RICS FEE and *project T4RIF Printing* are the marginally inefficient unit.

Fifty-seven projects belong to the distinctly inefficient units in this analysis.

To make a comparison, the same analysis was done for the results after peeling off the frontier. Figure 6.7 shows the summary of all the results.

Figure 6.7. Number of Units in Each Category (for the Whole Project)



This section gives the DEA results of the whole project estimated model. Among eighty-eight projects, eleven were robustly efficient, three were weakly efficient, four were marginally inefficient, and fifty-seven were distinctively inefficient. After peeling off the frontier, eleven were robustly efficient, four were weakly efficient, one was marginally inefficient, and forty-five were distinctively inefficient.

6.2.3. Stage Analysis

Due to the unavailability of the actual performance data, the stage analysis is confined to estimated data. Table 6.11 gives the comparison of fist two level performance

and the whole performance. This analysis is based on the results before peeling off the frontier.

Table 6.11. Stage Analysis

Project Name	First Two Levels		The Whole Project	
	Efficiency Score	Classification	Efficiency Score	Classification
GL Data Collect	0.883	-------	0.768	------
Inter Branch Banking	0.308	Distinctively Inefficient Unit	0.434	Distinctively Inefficient Unit
Auto 412	0.204	Distinctively Inefficient Unit	0.218	Distinctively Inefficient Unit
DACS/GL	0.335	Distinctively Inefficient Unit	0.377	Distinctively Inefficient Unit
VISA Front End	0.142	Distinctively Inefficient Unit	0.309	Distinctively Inefficient Unit
Cheque Imaging	0.313	Distinctively Inefficient Unit	0.483	Distinctively Inefficient Unit
Customer Profitability	0.347	Distinctively Inefficient Unit	0.420	Distinctively Inefficient Unit
Portfolio Info Facility	0.292	Distinctively Inefficient Unit	0.335	Distinctively Inefficient Unit
Business and Farm Loans Life Insurance System	0.229	Distinctively Inefficient Unit	0.232	Distinctively Inefficient Unit
Geographical Distribution	1	Outlier	0.978	Marginally Inefficient Unit

General Clearing	0.616	-------	1	Robustly Efficient Unit
RRSP	0.133	Distinctively Inefficient Unit	0.169	Distinctively Inefficient Unit
Historical Results	0.776	------	0.5291	Distinctively Inefficient Unit
ECIF	0.895	------	1	Weakly Efficient Unit
Cage II Control	1	Robustly Efficient Unit	1	Robustly Efficient Unit
Branch Details	0.210	Distinctively Inefficient Unit	0.224	Distinctively Inefficient Unit
HUMAN RESOURCES	1	Distinctively Inefficient Unit	1	Robustly Efficient Unit
Deposit Account (STB)	0.225	Distinctively Inefficient Unit	0.259	Distinctively Inefficient Unit
Unclaimed Balances	0.638	-------	0.673	------
Invest Products System	0.824	------	0.670	------
CDIC Prem Reduct	0.279	Distinctively Inefficient Unit	0.532	Distinctively Inefficient Unit
Inventory Asset Management	0.181	Distinctively Inefficient Unit	0.223	Distinctively Inefficient Unit
Corporate Credit Processing (CCP)	0.171	Distinctively Inefficient Unit	0.246	Distinctively Inefficient Unit
Mutual Funds Order Entry & Transfer System (MOTE)	0.110	Distinctively Inefficient Unit	0.210	Distinctively Inefficient Unit
Statement Reprint System	0.5	Distinctively Inefficient Unit	0.477	Distinctively Inefficient Unit

Kiting Detection System	0.477	Distinctively Inefficient Unit	0.368	Distinctively Inefficient Unit
Integrated Profitability Management System (EFIP)	0.701	------	0.701	------
National Trust Back Office	0.268	Distinctively Inefficient Unit	0.280	Distinctively Inefficient Unit
WINFAST (Replacing Lending Advisor)	0.108	Distinctively Inefficient Unit	0.130	Distinctively Inefficient Unit
GST Input Collection & Calc/Decalc	0.328	Distinctively Inefficient Unit	0.206	Distinctively Inefficient Unit
CIBC Online (SCC-MVS)	0.229	Distinctively Inefficient Unit	0.228	Distinctively Inefficient Unit
Deposit Acceleration (Replacing Part of 26)	0.307	Distinctively Inefficient Unit	0.545	Distinctively Inefficient Unit
415 Statistics (Replacing Part of 26)	0.324	Distinctively Inefficient Unit	0.561	Distinctively Inefficient Unit
Statement on COM (Replacing Part of 26)	0.312	Distinctively Inefficient Unit	0.570	Distinctively Inefficient Unit
Credit Data Warehouse (Previously Part of PIF)	0.181	Distinctively Inefficient Unit	0.226	Distinctively Inefficient Unit

This table shows that certification level 3 exerts important influence on the project. Normally, this level will increase the project efficiency scores.

Clearly, Y2K projects are not typical of the usual software development process as far as bugs created and found. Since Y2K work could be considered as maintenance

activity, albeit, a special type, it should not create bugs in the same way as new software projects. Hence, the expected control chart by bugs reported and fixed over time does not apply. This also means that level 3 certification will go further than expected and that should result in higher efficiency levels.

This section shows the comparison of first two level performance and the whole performance for the available thirty-five projects.

6.2.4. Returns to Scale

According to the definition given in Chapter 3, scale efficiency can be calculated as the ratio of the CRS and VRS scores ($\theta_{CRS}/\theta_{VRS}$). If the frontiers of CRS and VRS models are very close, one can conclude that the industry generally operates at a constant returns to scale. I again consider combining or in this case comparing the two situations. All the available projects (before peeling off the frontier) are used to carry out this analysis because the scale efficiency is related to all the projects. The average scale efficiencies of the three DEA models are summarized in Table 6.12.

Table 6.12. Scale Efficiency

DEA models	Average Scale Efficiency Score
First Two Levels Estimated Model	0.496
First Two levels Actual Model	0.488
Whole Project Estimated Model	0.869

This result suggests that variable returns to scale are exhibited in the projects examined because the average scale efficiencies are not close or equal to one, which would be required for constant returns to scale. This inefficiency results from the projects' size. Additional indication that the bank exhibits variable returns to scale is that the number of efficient units on the CRS frontier and VRS frontier are quite different.

6.2.5. Peers and Target analysis

Target projections provide insights into potential performance improvements and associated savings for each inefficient DMU. The peers for each inefficient DMU indicate the efficient units to which the comparison is made. Using some linear combinations of the peers' inputs and outputs, a target projection is determined. Considering input oriented DEA models are used, the difference between actual and target values indicate the potential savings through input reduction.

In this analysis, the VRS model before peeling off the frontier is used. As mentioned earlier, there are units that are not used as peers for any of the inefficient units. Those units are always considered to be outliers or self evaluating units. Table 6.13 provides a summary on the peers of the three models.

Table 6.13. Peer Analysis Result

	Model (level 1&2, estimated)	Model (level 1&2,actual)	Model (whole project)
Efficient DMUs	7	6	14
Reference Set Peers	6	6	14

Significant peers are identified as those belonging to a reference set having a λ value greater than 0.1. This constraint is arbitrarily imposed in order to focus on the dominant units in the reference sets.

In the first two levels estimated model (This model uses the plan data and combined certification level one and two), the average times a significant peer appears for each inefficient DMU is 1.7. This number implies that the average input of the projected inefficient unit is a linear combination of less than two reference units. Moreover, all the efficient units (including $\lambda \leq 0.1$) appear as peers one hundred and thirty times altogether, and two of them (*Project Branch Clearing* and *project CIBC Wood Gundy Securities Operations*)

appear as significant peer fifty-four times. This suggests that these two projects may be outliers which have performance characteristic that other projects can not adopt. Therefore, these two units were removed and I ran DEA model again. This resulted in seven efficient units, five of which have an efficiency score of 1.0 in the previous analysis. This result further shows that project Branch Clearing and *project CIBC Wood Gundy Securities Operations* are realistic peers and the previous discussion is valid because the results before and after peeling off these two units are very close.

For the first two levels actual model (This model uses the actual performance data and combined certification level one and two), on average, each efficient unit appears 14.3 times in the reference sets although two of the six efficient units (*Project Branch clearing* and *Project Invest Products System*) just appear in one or two reference sets, including its own. This suggests that *Project Branch clearing* and *Project Invest Products System* are weakly efficient units while other four units are robustly efficient units. This conclusion agrees with the previous results in Section 6.2.2.2. Each inefficient unit has 1.5 significant peers.

Of the fourteen units that form the efficient frontier in the whole project model (This model uses the plan data and measures the project on the whole), no one is considered as self evaluating unit since all the units whose efficiency scores are equal to 1 appear in reference sets. Therefore, the reference set of the seventy-four inefficient units are composed of fourteen efficient units. On average, each efficient unit appears in the

reference sets 17.8 times. The average number of peers for each inefficient unit, for which $\lambda > 0.1$, is 1.77. (Some of peers for the inefficient units have $\lambda \leq 0.1$)

6.2.6. Comparisons between Estimated Data and Actual Data

In this work, there are 27 software projects that have both estimated and actual information. The raw data and input-oriented VRS results of these projects are shown in Appendix C.

Four projects have the exactly same estimated and actual data although their estimated and actual efficiencies are different. This comes from the fact that changes to the other projects' data affect these as well.

Nine projects used more FTE (in dollars) than anticipated including *Project Branch Clearing*, *Project New Mellon Bank Interface System (Replacing 75 & 270)* and *Project Geographical Distribution*, which consumed 200%, 168% and 100% more FTE (in dollars), respectively. These nine projects consumed 73.8% more FTE on average, that is, $292,863. Eleven projects used less FTE than expected. They consumed 33.7% less FTE than predicted, that is $728,804. For these projects, the estimation is quite similar to the actual performance except Project *Deposit Acceleration (Replacing Part of 26)*, *Project 415 Statistics (Replacing Part of 26)*, *Project Statement on COM (Replacing Part of 26)* and *project IMS COLT*.

As to project duration, the difference between estimated data and actual data are not very large except for *Project Tracing* and *Project Cage II Control*. In the case of SLOC, the actual data are essentially always the same as the estimated data because the projects measured in this work are focused on converting existing applications for Y2K problem.

Table 6.14 gives the correlation coefficients of each pair of estimated and actual variables.

Table 6.14. Correlation Coefficients of Estimated and Actual Variables

	Correlation Coefficient
Project Cost (Estimated vs. Actual)	0.784
Project Duration (Estimated vs. Actual)	0.938
SLOC (Estimated vs. Actual)	1.000

From the table, I can see that the estimation is pretty close to the reality.

6.2.7. Management Usage of DEA Results

DEA highlighted the reasons for the favorable and poor aspects of the unit's performance — factors that contributed to or detracted from its efficiency rating. The results in Appendix B indicate the amount of resource savings that these inefficient units

must achieve to meet the highest level of efficiency exhibited in the firm. To make the messages that emerge from a DEA analysis more acceptable to managers, a detailed analysis for those units that belong to the 'distinctly inefficient' group offer the best opportunity, one which should prove to be an extremely useful exercise.

Nevertheless, one of the most powerful pieces of information that is obtained by the DEA analysis is the set of target values for those units assessed as inefficient. The reference set provides strong indications of what type and amount of inputs and outputs are needed to make the inefficient units efficient. Since input oriented DEA models are used in the analysis, there will be target input values that the inefficient units could use to achieve an efficiency score of 1.0.

The above are the traditional ways to make use of DEA results. Since the projects measured in this work are unique (the Y2K problem), the target input values can not provide much insight to management. However, what the stage analysis and programming language analysis can offer leads to future improvements. The stage analysis shows that certification level 3 can change project efficiency sharply. Therefore, in reality, management should pay attention to the assigned FTE to the latest stage of software development. Since the programming language of most projects is COBOL, the projects on the frontier can be practical targets for the other projects. The collaborating bank should carry out an analysis on the project teams involved based on DEA results, because the leadership, skill level and

the position of the team are important factors to project efficiency and valuable lessons may be learned from this work.

Hence, DEA is a technique that provides management with the background information upon which to base decisions. Once DEA is adopted as a standard method of analysis, further work can be undertaken to derive additional insights into the operations of the DMUs. Base performance can be established and hence periodic analysis carried out to show progress and help all DMUs to improve with respect to their part performance.

6.3. Comparisons with Ratio Analysis

The following are the comparisons of the DEA results and ratio analysis results.

At first glance, performance ratios seem easy to calculate and hence, to use. However, interpreting the partial information provided by each ratio is difficult and highly subjective. Moreover, the ratio analysis just gives qualitative classifications of the projects. Consequently, this measure provides only a weak link between measurement and action.

Many of the deficiencies of ratio analysis can be overcome by DEA particularly because it uses all inputs and outputs simultaneously. DEA also provides a more consistent and systematic method of incorporating judgement into performance analysis while reducing these multiple measures to a single efficiency score.

Comparing the results from the DEA models with the results from ratio analysis, I can see that there exists some difference between them. The reason for the difference is that DEA considers the tradeoffs between different attributes and gives each output a weight to show its relative importance with respect to the other attributes. In ratio analysis, only two measures were considered, namely: the relationship between the project cost and source lines of code; and the relationship between project duration and source lines of code. In fact, there still exist other tradeoffs including the tradeoff between project cost and duration. Furthermore, no weighting scheme is defined in ratio analysis, also, it is inherently a constant returns to scale methodology.

Note that, most of the efficient applications in the peer groups have a relatively low value in performance ratios, which means that they are also relatively efficient as shown by multiple-ratio measures. Moreover, many projects that were classified as the most inefficient from ratio analysis also have relatively low DEA efficiency scores. This is not a surprising result since the DEA model used is relatively simple (two inputs and one or two outputs) and DEA is a "ratio" itself with all factors considered at the same time. If the outputs (in two inputs and one output DEA model) are highly correlated, the DEA results will be very close to ratio analysis results. As shown in Section 6.2.1, the correlation coefficients between two outputs are 0.360 and 0.421, respectively. Under such circumstance, DEA is a better method to provide an objective performance measurement because DEA incorporates multiple inputs and outputs. The difference between ratio analysis and DEA results can be best explained by the multi-dimensionality of the data and

the simultaneous consideration of management judgement regarding multiple producer's objectives. Table 6.15. gives the comparisons between DEA results and ratio analysis results based on the actual performance. (We just measure the first two levels of the project because of the unavailability of the data.)

Table 6.15. The Comparisons between DEA Results and Ratio Analysis Results

Application Name	VRS score	R1=Cost/ SLOC	R2=Durartion /100SLOC	Programming Language	Classification Based on Ratios
Rapidtrans	0.232	1.297	0.208	Assembler, COBOL, Easytrieve	intermediate
Branch Clearing	1	0.202	0.166	COBOL, Easytrieve	best
US Dollar Float	0.210	1.290	0.646	COBOL, SAS	intermediate
DACS/GL	0.403	1.869	0.721	COBOL, Easytrieve	intermediate
Centralized Instr	0.239	1.110	0.168	Assembler, COBOL, Easytrieve, GDF	intermediate
EFT	0.699	0.325	0.040	Assembler, COBOL, REXX	best
Geographical Distribution	0.775	0.658	0.538	COBOL	intermediate
General Clearing	0.588	3.726	3.642	COBOL	worst
RRSP	0.152	2.142	0.292	COBOL	intermediate
Account Info Facility	0.264	1.892	0.289	COBOL	intermediate
IMS COLT	1	0.217	0.027	Assembler, COBOL	best
Cage II Control	0.26	1.258	0.896	Assembler, COBOL	intermediate
Branch Details	0.277	8.304	1.0227	COBOL	worst
Portfolio Manager	0.336	2.795	1.227	COBOL, SAS	worst
Deposit Account (STB)	0.304	1.361	0.194	COBOL,GDF	intermediate
Invest Products System	1	0.263	0.029	Clipper, COBOL, REXX, Visual Basic, Easytrieve	best
CDIC Prem Reduct	0.347	3.493	1.031	COBOL	worst

Software Amortization System	1	5.589	1.84	Access	worst
NISA	0.642	0.415	0.411	C, C++, Clipper	intermediate
Utility Bills	0.776	14.58	20.25	Easytrieve	worst
Mutual Funds Order Entry & Transfer System (MOTE)	0.115	3.966	1.005	COBOL	worst
Tracing	0.429	1.260	1.191	REXX, COBOL, Easytrieve	intermediate
C/A Bulk Filing	0.417	2.223	0.231	COBOL, Easytrieve	intermediate
GMAC	0.873	4.289	6.531	COBOL	worst
RICS FEE	0.687	5.589	9.2	IBM PC COBOL/2, FoxPro	worst
Kiting Detection System	0.401	2.104	0.970	COBOL	intermediate
National Trust Back Office	0.279	0.907	0.706	Assembler, COBOL, Dialogue System, Microfocus WkBent	intermediate
Float	0.872	0.295	0.357	COBOL, REXX	intermediate
New Mellon Bank Interface System (Replacing 75 & 270)	6.93E-2	12.296	8.936	Easytrieve	worst
Wood Gundy Rapid Confirms	1	0.203	1.756	COBOL	intermediate
Consolidated Bill Payment	0.67	0.388	0.302	COBOL	best
CIBC Online (SCC-MVS)	0.253	1.208	0.548	Not available	intermediate
Deposit Acceleration (Replacing Part of 26)	0.397	1.597	0.608	Assembler, COBOL	intermediate
415 Statistics (Replacing Part of 26)	0.382	4.791	1.421	COBOL	worst
Statement on COM (Replacing Part of 26)	0.384	4.192	1.243	COBOL	worst

Financial Model System	1	1.118	0.472	Microsoft Visual Bas, Crystal Report Gene	best
GIS TXN Conf Printing	0.598	4.387	3.549	Not available	worst

Generally speaking, ratio analysis is concerned with measuring one particular aspect of the operation with respect to another while DEA is an analytical tool that attempts to assess performance 'on the whole'. It is useful to use a mixture of techniques to further extend the range of useful management information.

6.4. Refined DEA Results

Upon the examination of the peer groups, I believe that comparing different sized projects might not be fair. Furthermore, it was important for management to arrive at targets that were consistent with their experience, and setting efficient targets from a combination of projects in different categories was not meaningful since the project characteristics are quite different. Therefore, I separated the projects into different goups and ran the DEA model (I or II) again.

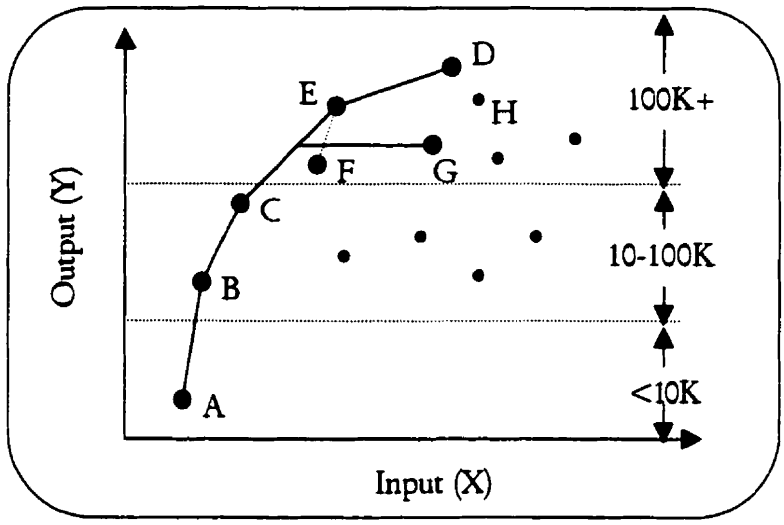
The results of this refined analysis are presented in the following.

6.4.1. Refined First Two Levels Estimated Model

The projects were separated into three categories according to size; projects of over 100,000 SLOC were in a large size category, those of between 10,000 and 100,000 SLOC were in a medium size category, and those of under 10,000 were included in a small category. The VRS model (model I) was rerun for each category. The results are presented in Appendix D. They suggest the following:

- Among the large projects, there are six efficient DMUs. Two of them were efficient units in the previous discussion. The other four also had relatively high efficiency scores in the previous discussion. Almost all the projects have a higher efficiency score except *Project Invest Products System which* nearly keeps the same efficiency score. This result is not unforeseen. After the projects were separated, the basic shape of the new frontier for the large sized projects will be close to the original frontier except that the edge will be "inward". The inward bend results in shorter distances between the frontier and some of the inefficient units. Therefore, the efficiency scores will be no less than the original efficiency score, but may be a bit higher. Figure 6.8 illustrates such situation.

Figure 6.8 The Frontier Comparisons Before and After the Introduction of Segmentation Variables



In the above figure, ABCED is the frontier before the projects were separated. After I separated the projects, the new frontier for the large sized projects is FED because the original DMU C does not belong to the large sized projects. Since the distance between inefficient unit G and the new frontier becomes less, its efficiency score will increase a bit. However, for DMU_H, the distance stays the same, hence, its efficiency score will not change.

- Among the medium sized projects, in general, the efficiency scores did not change dramatically, which resulted from the fact that three of the five efficient units have an efficiency score of 1.0 and the other two also have relatively high scores in the full data set model. Consequently, the new frontier is very close to the original frontier, hence, the efficiency scores will not change too much.

- Among the small sized projects, two projects kept the same score and the other six became more efficient for the same reasons mentioned for the large sized projects.

6.4.2. Refined First Two Levels Actual Model

Following the same technique, I divided the projects and reran the DEA model (model I) three times. The results are shown in Appendix D.

- Among the large and medium sized projects, the efficiency scores of all the projects are no less than the results from the normal DEA model because of the same reason that mentioned in Section 6.4.1. Three projects were found efficient among the large projects and three among medium projects.

- For the small sized projects, the results are quite similar to those from the full data set DEA model, which results form the fact that the new frontier is very close to the original one.

6.4.3. Refined Whole Project Estimated Model

With the same classification, I still divided the projects into the three categories: large, medium and small. The results are presented in Appendix D.

- Among the large projects, there is not much difference between the efficiency scores from the DEA model before and after size division.

- Among the large and small projects, the efficiency scores are much higher than the scores from the full data set DEA model for the same reason that mentioned in Section 6.4.1. Moreover, some new efficient units appear. After further investigating these units, I found that these newly efficient units are all on the edge of the frontier. This can be best explained by the fact that after the projects were divided, the units on the original edge of the frontier are not in this category. Thus, some new efficient units appear on the frontier (see figure 6.8).

6.5. Summary

In this chapter, the preliminary results and related analyses were presented. Several techniques were used to provide insight to management as well. I also separated the projects into groups to provide a more fair and equitable comparison.

CHAPTER 7 Conclusions and Recommendations

This chapter summarizes the conclusions of this work and offers recommendations for future work.

7.1. Conclusions

With the increased focus on reducing software cost and increasing productivity, objective measurement and analysis of software projects are an essential research area. Performance ratio analysis has been the widely used technique for addressing this need, but there are a number of shortcomings associated with this method. In this thesis, DEA is presented as a solution for software project measurement due to its ability to handle multiple inputs and outputs and the lack of the need for relative weight or value. The objective of this thesis is to show that DEA is a superior technique that can be used in a real environment to

measure software team performance and to examine suggested management actions that can be derived from DEA results.

Two software efficiency measurement DEA models with different types of envelopment surfaces (VRS and CRS) were developed for this purpose. I also summarized the process of data collection and the related transformations. The choice of input and output variables is based on the ratio analysis, which is the benchmark for this research results. The results of the DEA models are compared with those from the ratio analysis.

Performance ratio analysis is concerned with one particular aspect of the operation while DEA is an analytical tool that attempts to assess overall performance. In other words, DEA is clearly superior to ratio analysis in its sensitivity to multiple outputs and inputs. In addition, DEA results also indicated the amount of resource savings that the inefficient units may achieve to meet the level of efficiency of the best practice units.

We examined the technical efficiency scores that resulted from the DEA models, and classified the projects into four groups from a management perspective. Features and management actions for each group were also provided.

Using the "frontier peeling" technique, the problem of ensuring that outliers are not used as efficient peer units was addressed. In the DEA model which measures the whole projects based on the estimated data, the results before peeling off the frontier just partially

reflected the performance of software projects. The results after peeling off the frontier provided more practical performance improvement targets for the inefficient units.

A peer group analysis differentiates the DMUs whose efficiency scores are equal to 1.0 to peers or outliers, moreover, it gives some indication of whether or not the results are realistic. Depending on the average number of times each efficient unit appears as a peer, I compared the results by excluding, one at a time, the DMUs which appear as peers too often, to give a sense of how sensitive the results are to one important unit.

It is important for management to arrive at targets that are consistent with their experience. Therefore, the projects were divided into three groups. The refined DEA models measure the projects in the same category according to size and provide targets with the same characteristics. Results from this analysis can be summarized briefly. In some categories, efficiency scores are very close to the original scores; in other categories, the new efficiency scores increase somewhat. The reasons for efficiency score increases were also presented.

7.2. Considerations

One objective of the work is to provide DEA results to supplement traditionally used performance indicators. They, together, provide management with the background information upon which to base decisions. DEA may supplant some partial performance

assessment including ratio analysis, but it will remain complementary to others. The question as to which part of the total picture each technique can provide has to be addressed so that management is not presented with conflicting advice.

7.3. Future Work

This research provides a framework for a comprehensive performance analysis of software projects in a Canadian bank. There still exists significant potential for further research. It may include:

- A quality measure was not included in this research because of the lack of data. There is a need to further develop a DEA model, which will include quality and more environmental factors. The development of such a model is the underlying component to the success of this method for measuring software project production performance;
- Research similar to this analysis could be performed for each level of the projects to decide which level of the project contributes more or less to its efficiency rating;
- The impact of inclusion or exclusion of certain variables on the efficiency could be analyzed in order to more precisely capture the nature of the software process;
- Management considers it important to obtain efficiency measures that account for internal policies of the IS department. Therefore, managerial information will be required in order to constrain the DEA multipliers and tighten efficiency estimates in future research.

- The analysis on the influence exerted by programming language. I will consider the language difficulty issue when comparing the productivity of projects written in different languages. This may be solved by figuring out the ratio between different languages which makes them equivalent and then multiplying these ratios to SLOC and running DEA models again.

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Glossary

Actual Data	They are taken or extrapolated from actuals recorded in the time recording system of the bank.
Actual Model	Model using actual data
Additive Model	DEA model that involves a simultaneous reduction in inputs and increase in outputs.
Allocative Efficiency	The ability to combine inputs and outputs in optimal proportions in the presence of market (or other) values.
BCC or VRS Model	DEA model that allows variable returns to scale.
Certification Level	This is the application's level of Year 2000 certification to date (0,1,2,3) where • '0' indicates that no certification level has been achieved • '1' indicates that level 1 has been achieved (changes have been tested using current dates to ensure that they have no negative impact on current processing and implemented into production) • '2' indicates that level 2 certification has been achieved (the application has been tested successfully in a simulated Year 2000 environment)

	• '3' indicates that level 3 certification has been achieved (the application has been tested in a year 2000 compliant "time machine" environment)
CCR or CRS Model	DEA model that allows constant returns to scale.
DEA	Non parametric, linear programming approach to the construction of the production frontier and the measurement of efficiency relative to the constructed frontiers which requires no prior specification of the functional form of the frontier.
Development	Evolution or bringing out from a latent or elementary condition.
DMU	Decision Making Unit.
DRS	Decreasing returns to scale. Proportionate increase in inputs results in a proportionately smaller increase in outputs.
Efficiency	A general form often associated with performing activities as well as possible.
Estimated Data	Planned project information.
Estimated Model	Model using estimated data
FP	Function point: A measure of software size.
IRS	Increasing returns to scale. Proportionate increases in inputs results in a proportionately larger increase in outputs.
Overall Efficiency	Both technically and allocatively efficient. Calculated as the product of technical and allocative efficiency.
Peer Group	The set of efficient DMUs against which inefficient units are compared.

Performance Ratio	Usually a ratio of output over input. Implicitly CRS.
Project	A systematic planned undertaking.
Scale Efficiency	The ability to operate on the most productive scale size
SLOC	Source lines of code: a measure of software size
Software	The programs and procedures required to enable a computer to perform a specific task, as opposed to the physical components of the system.
Technical Efficiency	The ability to produce as much outputs as input usage allows.
Trade-off	The impact on one or on more inputs or outputs by changing one or more other inputs or outputs.

Appendix A *Performance Ratios*

The basic data used in ratio analysis and ratios are given here with one qualitative classification.

APPENDIX A *Performance Ratios*

Part A

I. Ratios for the First Two Levels (Estimated Data)

ID	Application Name	Input		Output	Ratio		Classification
		FTE (in dollars) during Level 1&2	Duration	Source Lines	R1=Cost/SLOC	R2=Duration /100SLOC	
1	GL Data Collect	11178	154.675	70000	0.159685714	626.2301	best
3	Rapidtrans	194497.2	311.65	150000	1.296648	77.12193	Intermediate
12	Inter Branch Banking	167670	106.375	9804	17.10220318	5.8472	worst
13	Branch Clearing	5589	189.175	83000	0.067337349	1485.06	best
16	Auto 412	65950.2	207	22000	2.997736364	33.3585	Intermediate
19	US Dollar Float	92777.4	374.325	65000	1.427344615	70.06017	Intermediate
21	DACS/GL	32416.2	167.9	16743	1.936104641	51.6501	Intermediate
24	VISA Front End	201204	447.925	128000	1.57190625	63.61703	Intermediate
25	Sundry Clearing	48065.4	276	36665	1.310934133	76.28148	Intermediate
29	Cheque Imaging	17884.8	345	14000	1.277485714	78.27876	Intermediate
32	Customer Profitability	188908.2	242.075	260000	0.72657	137.633	Intermediate
33	CAMP Stop/Holds/etc.	78246	185.15	244400	0.320155483	312.3482	best
34	Portfolio Info Facility	24591.6	320.275	19525	1.259492958	79.39703	Intermediate
35	Business and Farm Loans Life Insurance System	169905.6	241.5	122500	1.38698449	72.09886	Intermediate
39	Geographical Distribution	5589	143.175	17000	0.328764706	304.1689	Intermediate
41	General Clearing	11178	121.9	3000	3.726	26.83843	worst
44	RRSP	325279.8	517.5	180000	1.80711	55.33697	Intermediate
48	Historical Results	48065.4	189.75	242733	0.198017575	505.0057	best
58	IMS COLT	748926	335.8	1244000	0.602030547	166.1045	best
62	Cage II Control	32416.2	34.5	34640	0.93580254	106.8602	Intermediate
63	Branch Details	67068	165.025	14000	4.790571429	20.87434	worst
67	Portfolio Manager	33534	147.2	12000	2.7945	35.78458	worst
73	HUMAN RESOURCES	223560	361.1	1520000	0.147078947	679.907	best
76	Deposit Account (STB)	191143.8	220.8	103500	1.8468	54.14771	Intermediate
79	Unclaimed Balances	11178	147.2	19500	0.573230769	174.4498	Intermediate
82	Invest Products System	354342.6	448.5	1550000	0.228608129	437.4298	best
83	CDIC Prem Reduct	52536.6	120.75	10880	4.828731618	20.70937	worst
89	Inventory Asset Management	185554.8	310.5	120000	1.54629	64.67092	Intermediate

APPENDIX A *Performance Ratios*

ID	Application Name	Input		Output	Ratio		Classification
		FTE (in dollars) during Level 1&2	Duration	Source Lines	R1=Cost/SLOC	R2=Duration /100SLOC	
105	TPSS	40240.8	443.9	200000	0.201204	497.008	best
115	NISA	16767	148.925	35000	0.479057143	208.7434	Intermediate
145	Corporate Credit Processing (CCP)	44712	448.5	9954	4.491862568	22.26248	worst
173	Mutual Funds Order Entry & Transfer System (MOTE)	148667.4	414	42000	3.5397	28.25098	Intermediate
196	Tracing	22356	43.7	14197	1.57469888	63.5042	Intermediate
209	Bankcard	361049.4	569.25	2277377	0.158537388	630.766	best
217	C/A Bulk Filing	134136	127.075	50281	2.667727372	37.48509	Intermediate
242	GMAC	5589	85.1	1303	4.28933231	23.31365	worst
243	VISA -- AS/400 ImagePlus	718745.4	465.175	300000	2.395818	41.7394	Intermediate
245	Statement Reprint System	11178	414	2600	4.299230769	23.25997	worst
248	Kiting Detection System	20120.4	131.675	13280	1.515090361	66.00266	Intermediate
255	Integrated Profitability Management System (EFIP)	262683	179.4	450000	0.58374	171.3091	best
272	National Trust Back Office	55890	241.5	48049	1.163187579	85.97066	Intermediate
278	New Mellon Bank Interface System (Replacing 75 & 270)	45829.8	893.55	10000	4.58298	21.81986	worst
291	WINFAST (Replacing Lending Advisor)	527601.6	655.5	200000	2.638008	37.90739	Intermediate
302	GST Input Collection & Calc/Decalc	27945	346.725	49095	0.569202566	175.6844	Intermediate
303	Consolidated Bill Payment	17884.8	87.4	46120	0.387788378	257.8726	best
304	CIBC Online (SCC-MVS)	68185.8	309.35	56425	1.208432432	82.75183	Intermediate
321	Deposit Acceleration (Replacing Part of 26)	95013	109.25	21000	4.524428571	22.10224	Intermediate
322	415 Statistics (Replacing Part of 26)	95013	100.625	7000	13.57328571	7.367413	worst
323	Statement on COM (Replacing Part of 26)	95013	104.65	8000	11.876625	8.4199	worst

APPENDIX A *Performance Ratios*

ID	Application Name	Input		Output	Ratio		Classification
		FTE (in dollars) during Level 1&2	Duration	Source Lines	R1=Cost/SLOC	R2=Duration /100SLOC	
339	EFIP Infra. - Technical Architecture	400172.4	374.9	1080000	0.37053	269.8837	best
341	CIBC Wood Gundy Securities Operations	11178	32.2	1000	11.178	8.946144	worst
344	Credit Data Warehouse (Previously Part of PIF)	63714.6	230.575	10000	6.37146	15.69499	worst

II. Ratios for the First Two Levels (Actual Data)

Application Name	Input		Output	Ratio		Classification
	Actual FTE (in dollars) in Level 1&2	Duration in Level 1 & 2	Source Lines	R1=Cost/SLOC	R2=Project Duratoin/100SLOC	
Rapidtrans	194497.2	311.65	150000	1.296648	0.207766667	intermediate
Branch Clearing	16767	137.425	83000	0.202012048	0.165572289	best
US Dollar Float	83835	419.75	65000	1.289769231	0.645769231	intermediate
DACS/GL	31298.4	120.75	16743	1.869342412	0.721196918	intermediate
Centralized Instr	251505	379.5	226550	1.110152284	0.16751269	best
EFT	423646.2	524.975	1301692	0.325458096	0.040330201	best
Geographical Distribution	11178	91.425	17000	0.657529412	0.537794118	intermediate
General Clearing	11178	109.25	3000	3.726	3.641666667	worst
RRSP	385641	525.55	180000	2.14245	0.291972222	intermediate
Account Info Facility	131900.4	201.25	69700	1.892401722	0.288737446	intermediate
IMS COLT	270507.6	335.8	1244000	0.217449839	0.026993569	best
Cage II Control	43594.2	310.5	34640	1.258493072	0.896362587	intermediate
Branch Details	116251.2	143.175	14000	8.303657143	1.022678571	worst
Portfolio Manager	33534	147.2	12000	2.7945	1.226666667	intermediate
Deposit Account (STB)	140842.8	201.25	103500	1.3608	0.194444444	intermediate
Invest Products System	406879.2	456.55	1550000	0.26250271	0.029454839	best
CDIC Prem Reduct	38005.2	112.125	10880	3.493125	1.030560662	intermediate
Software Amortization System	11178	36.8	2000	5.589	1.84	worst
NISA	14531.4	143.75	35000	0.415182857	0.410714286	intermediate
Utility Bills	6706.8	93.15	460	14.58	20.25	worst
Mutual Funds Order Entry & Transfer System (MOTE)	166552.2	422.05	42000	3.965528571	1.004880952	intermediate
Tracing	17884.8	169.05	14197	1.259759104	1.190744523	intermediate
C/A Bulk Filing	111780	116.15	50281	2.223106143	0.23100177	intermediate
GMAC	5589	85.1	1303	4.28933231	6.531082118	worst
RICS FEE	6706.8	110.4	1200	5.589	9.2	worst
Kiting Detection System	27945	128.8	13280	2.104292169	0.969879518	intermediate

APPENDIX A *Performance Ratios*

Application Name	Input		Output	Ratio		Classification
	Actual FTE (in dollars) in Level 1&2	Duration in Level 1 & 2	Source Lines	R1=Cost/SLOC	R2=Project Duratoin/100SLOC	
New Mellon Bank Interface System (Replacing 75 & 270)	122958	893.55	10000	12.2958	8.9355	worst
Wood Gundy Rapid Confirms	1117.8	96.6	5500	0.20323636+	1.756363636	intermediate
Consolidated Bill Payment	17884.8	139.15	46120	0.387788378	0.301712923	best
CIBC Online (SCC-MVS)	68185.8	309.35	56425	1.208432432	0.548249889	intermediate
Deposit Acceleration (Replacing Part of 26)	33534	127.65	21000	1.596857143	0.607857143	intermediate
415 Statistics (Replacing Part of 26)	33534	99.475	7000	4.790571429	1.421071429	worst
Statement on COM (Replacing Part of 26)	33534	99.475	8000	4.19175	1.2434375	worst
Financial Model System	11178	47.15	10000	1.1178	0.4715	intermediate
GIS TXN Conf Printing	12295.8	99.475	2803	4.386657153	3.548876204	worst

III. Ratios for the Whole Project

Application Name	Input		Output		Ratio		Classification
	FTE in dollars	Project Duration	Target Level	Source Lines	R1=Project Cost/SLOC	R2=Project Duratoin/100 SLOC	
GL Data Collect	16767	154.675	2	70000	0.239529	0.220964	intermediate
Canada Savings Bonds	65950.2	419.75	3	13660	4.82798	3.07284	worst
Project Control System	84952.8	255.3	2	110000	0.772298	0.232091	intermediate
Inter Branch Banking	143078.4	307.05	3	9804	14.59388	3.131885	worst
Bulk Filing	156492	389.275	3	152840	1.023894	0.254694	intermediate
Auto 412	115133.4	207	2	22000	5.233336	0.940909	worst
CLASS	1683407	719.9	3	1759400	0.956807	0.040917	best
DACS/GL	33534	167.9	2	16743	2.002867	1.002807	intermediate
Centralized Instr	314101.8	659.525	3	226550	1.386457	0.291117	intermediate
VISA Front End	178848	499.675	3	128000	1.39725	0.390371	intermediate
PCA/Savings	690800.4	458.275	3	297390	2.322877	0.154099	intermediate
Cheque Imaging	22356	345	2	14000	1.596857	2.464286	intermediate
IBTSS	908771.4	659.525	3	2301000	0.394946	0.028663	best
Customer Profitability	190026	242.075	2	260000	0.730869	0.093106	intermediate
Portfolio Info Facility	33534	320.275	2	19525	1.71749	1.640333	intermediate
Business and Farm Loans Life Insurance System	413586	241.5	2	122500	3.376212	0.197143	intermediate
Foreign Exchange	413586	610.075	3	456000	0.906987	0.133788	intermediate
Geographical Distribution	11178	143.175	2	17000	0.657529	0.842206	intermediate
General Clearing	11178	181.125	3	3000	3.726	6.0375	worst
RRSP	479536.2	806.725	3	180000	2.66409	0.448181	intermediate
Historical Results	109544.4	189.75	2	242733	0.451296	0.078172	best
IDT Systems	570078	619.85	3	137000	4.161153	0.452445	intermediate
ECIF	950130	249.55	3	1000000	0.95013	0.024955	best
Account Info Facility	315219.6	426.075	3	69700	4.522519	0.611298	intermediate
IMS COLT	479536.2	556.6	3	1244000	0.385479	0.044743	best

APPENDIX A *Performance Ratios*

Application Name	Input		Output		Ratio		Classification
	FTE in dollars	Project Duration	Target Level	Source Lines	R1=Project Cost/SLOC	R2=Project Duratoin/100 SLOC	
Loan Accounting System	614790	834.325	3	146765	4.188942	0.568477	intermediate
Cage II Control	67068	34.5	2	34640	1.936143	0.099596	intermediate
Branch Details	247033.8	165.025	2	14000	17.64527	1.17875	worst
COINS - Op Cntrl	111780	102.925	3	152800	0.731545	0.067359	best
HUMAN RESOURCES	760104	361.1	2	1520000	0.500068	0.023757	best
POS Merchant	558900	858.475	3	150000	3.726	0.572317	intermediate
Deposit Account (STB)	377816.4	426.075	3	103500	3.6504	0.411667	intermediate
ATM Systems-NON-TANDEM	558900	974.05	3	215000	2.599535	0.453047	intermediate
Unclaimed Balances	16767	147.2	2	19500	0.859846	0.754872	intermediate
Invest Products System	743337	737.725	3	1550000	0.479572	0.047595	best
CDIC Prem Reduct	79363.8	120.75	2	10880	7.294467	1.109835	worst
Special Debts	90541.8	393.875	3	400000	0.226355	0.098469	best
Inventory Asset Management	182201.4	310.5	2	120000	1.518345	0.25875	intermediate
Base 24-ATM	970250.4	1104	3	650000	1.492693	0.169846	intermediate
Base24 POS Online	1313415	1344.925	3	550000	2.388027	0.244532	intermediate
Acquisition Management System	225795.6	310.5	2	130000	1.736889	0.238846	intermediate
Cheque Processing (Upgrading)	122958	224.25	3	76644	1.604274	0.292587	intermediate
CRIBS DDA (Replaced by 284)	447120	172.5	3	221706	2.016725	0.077806	intermediate
Info Capture System (Replaced by 283)	111780	86.25	3	20000	5.589	0.43125	intermediate
CRIBS Savings (Replaced by 284)	245916	69	3	154535	1.591329	0.04465	intermediate
West Indies Retail System (Replaced by 283)	402408	207	3	395000	1.018754	0.052405	intermediate

APPENDIX A *Performance Ratios*

Application Name	Input		Output		Ratio		Classification
	FTE in dollars	Project Duration	Target Level	Source Lines	R1=Project Cost/SLOC	R2=Project Duratoin/100 SLOC	
West Indies General Ledger (Replaced by 287)	223560	86.25	3	127049	1.759636	0.067887	intermediate
Corporate Credit Processing (CCP)	44712	448.5	2	9954	4.491863	4.505726	worst
Centralized Rates	48065.4	181.7	3	171853	0.279689	0.10573	best
Returned Item System	55890	480.7	3	72900	0.766667	0.659396	intermediate
Mutual Funds Order Entry & Transfer System (MOTE)	243680.4	703.225	3	42000	5.801914	1.674345	worst
PMDB (Portfolio Management Data Base)	1159159	688.275	3	159000	7.290306	0.432877	intermediate
CSP (Cardholder Service Platform)	111780	810.175	3	225000	0.4968	0.360078	intermediate
Clearing	357696	519.8	3	463050	0.772478	0.112256	intermediate
RICS	22356	446.2	3	10000	2.2356	4.462	intermediate
Tracing	22356	43.7	2	14197	1.574699	0.307812	intermediate
Bankcard	1633106	621	3	2277377	0.717099	0.027268	best
C/A Bulk Filing	134136	186.3	3	50281	2.667727	0.370518	intermediate
Collection (TCS Year 2000 Upgrade)	1542564	792.35	3	1000000	1.542564	0.079235	intermediate
Merchant System	1509030	489.325	3	412000	3.662694	0.118768	intermediate
Statement Reprint System	22356	414	2	2600	8.598462	15.92308	worst
RICS FEE	11178	69	2	1200	9.315	5.75	worst
Kiting Detection System	53654.4	131.675	2	13280	4.040241	0.991529	intermediate
SFT-Calculators	33534	246.1	3	700000	0.047906	0.035157	best
Integrated Profitability Management System (EFIP)	675151.2	179.4	2	450000	1.500336	0.039867	intermediate
National Trust Back Office	55890	241.5	2	48049	1.163188	0.502612	intermediate

APPENDIX A *Performance Ratios*

Application Name	Input		Output		Ratio		Classification
	FTE in dollars	Project Duration	Target Level	Source Lines	R1=Project Cost/SLOC	R2=Project Duratoin/100 SLOC	
CIBC Information Warehouse	55890	223.675	3	300000	0.1863	0.074558	best
WINFAST (Replacing Lending Advisor)	514188	655.5	2	200000	2.57094	0.32775	intermediate
GASPER4	111780	810.175	3	300000	0.3726	0.270058	intermediate
Electronic Banking PC/Internet	335340	247.25	3	40000	8.3835	0.618125	worst
GST Input Collection & Calc/Decalc	67068	346.725	2	49095	1.366086	0.706233	intermediate
CIBC Online (SCC-MVS)	68185.8	309.35	2	56425	1.208432	0.54825	intermediate
Client Mgmt. System	27945	241.5	3	63000	0.443571	0.383333	intermediate
BASE24 Remote Banking	1922616	566.95	3	1626000	1.182421	0.034868	intermediate
COINS - Com Facil	111780	266.225	3	10000	11.178	2.66225	worst
Deposit Acceleration (Replacing Part of 26)	84952.8	274.275	3	21000	4.045371	1.306071	intermediate
415 Statistics (Replacing Part of 26)	97248.6	250.125	3	7000	13.89266	3.573214	worst
Statement on COM (Replacing Part of 26)	87188.4	254.15	3	8000	10.89855	3.176875	worst
RDS	45829.8	492.2	3	16500	2.777564	2.98303	worst
ICBS (International Comprehensive Banking System)	726570	411.7	3	1635137	0.444348	0.025178	best
Financial Model System	11178	63.825	2	10000	1.1178	0.63825	intermediate
Secret Code Selectors	33534	404.225	3	20000	1.6767	2.021125	intermediate
Credit Data Warehouse (Previously Part of PIF)	78246	230.575	2	10000	7.8246	2.30575	worst
Collections-Property Administration	8942.4	653.2	3	53250	0.167932	1.226667	intermediate

APPENDIX A *Performance Ratios*

Application Name	Input		Output		Ratio		Classification
	FTE in dollars	Project Duration	Target Level	Source Lines	R1=Project Cost/SLOC	R2=Project Duratoin/100 SLOC	
Collections-Auto-IBP Replacement	257094	808.45	3	20000	12.8547	4.04225	worst
T4RIF Printing	22356	51.175	2	982	22.76578	5.211303	worst
GIS TXN Conf Printing	22356	99.475	2	2803	7.97574	3.548876	worst
CIBC Workflow	55890	325.45	3	99	564.5455	328.7374	worst

Appendix B DEA Results

The DEA results of the three models are presented here. The efficient scores and peers are included.

I. Part A: VRS Results for the First Two Level Estimated Model

Application Name	FTE in level 1and 2	Duration	Source Lines	Score	Efficient Peers					
					Branch Clearing	Cage II Control	HUMAN RESOURCES	Bankcard	GMAC	CIBC Wood Gundy Securities Operations
GL Data Collect	11178	154.675	70000	0.883	0.6423972	0	1.07E-02	0	0	0.3469
Rapidtrans	194497.2	311.65	150000	0.2	0	0.4183895	8.88E-02	0	0	0.4928
Inter Branch Banking	167670	106.375	9804	0.308	0	0.2617122	0	0	0	0.7383
Branch Clearing	5589	189.175	83000	1	1	0	7.91E-18	0	0	8.00E-17
Auto 412	65950.2	207	22000	0.204	3.92E-02	0	0.0117094	0	0	0.9491
US Dollar Float	92777.4	374.325	65000	0.186	0.168945	0	3.30E-02	0	0	0.798
DACS/GL	32416.2	167.9	16743	0.335	0.1480485	0	2.37E-03	0	0	0.8496
VISA Front End	201204	447.925	128000	0.142	2.66E-02	0	8.22E-02	0	0	0.8912
Sundry Clearing	48065.4	276	36665	0.257	0.2230578	0	1.14E-02	0	0	0.7655
Cheque Imaging	17884.8	345	14000	0.313	0.218232	0	0	0	0.782	0
Customer Profitability	188908.2	242.075	260000	0.347	0	0.8482792	0.1517208	0	0	0
CAMP Stop/Holds/etc.	78246	185.15	244400	0.551	0.1229306	0	0.1536008	0	0	0.7235
Portfolio Info Facility	24591.6	320.275	19525	0.292	0.2240951	0	0	0	0.492	0.2835
Business and Farm Loans Life Insurance System	169905.6	241.5	122500	0.229	0	0.6485111	6.56E-02	0	0	0.2859
Geographical Distribution	5589	143.175	17000	1	0.558011	0	0	0	0.442	0
General Clearing	11178	121.9	3000	0.616	2.16E-02	0	0	0	0.746	0.2319
RRSP	325279.8	517.5	180000	0.133	0	0.4268987	0.1083865	0	0	0.4647
Historical Results	48065.4	189.75	242733	0.776	0.4503347	0	0.1348292	0	0	0.4148
IMS COLT	748926	335.8	1244000	0.895	0	0.1858135	0.8141865	0	0	0
Cage II Control	32416.2	34.5	34640	1	0	1	1.51E-18	0	0	2.44E-17
Branch Details	67068	165.025	14000	0.21	0	6.65E-02	7.08E-03	0	0	0.9264
Portfolio Manager	33534	147.2	12000	0.329	9.92E-02	0	1.89E-03	0	0	0.8989

Appendix B DEA Results

Application Name	FTE in level 1and 2	Duration	Source Lines	Score	Efficient Peers					
					Branch Clearing	Cage II Control	HUMAN RESOURCES	Bankcard	GMAC	CIBC Wood Gundy Securities Operations
HUMAN RESOURCES	223560	361.1	1520000	1	0	0	1	0	0	1.51E-15
Deposit Account (STB)	191143.8	220.8	103500	0.225	0	0.9536409	0.0463591	0	0	0
Unclaimed Balances	11178	147.2	19500	0.638	0.2237576	0	0	0	0.501	0.275
Invest Products System	354342.6	448.5	1550000	0.824	0	0	0.9603896	3.96E-02	0	0
CDIC Prem Reduct	52536.6	120.75	10880	0.279	0	0.1273115	3.68E-03	0	0	0.869
Inventory Asset Management	185554.8	310.5	120000	0.181	0	0.3497378	7.06E-02	0	0	0.5797
TPSS	40240.8	443.9	200000	0.58	0.9185804	0	0.0814196	0	0	0
NISA	16767	148.925	35000	0.593	0.3506941	0	3.45E-03	0	0	0.6459
Corporate Credit Processing (CCP)	44712	448.5	9954	0.171	0.1072596	0	0	0	0.524	0.3689
Mutual Funds Order Entry & Transfer System (MOTE)	148667.4	414	42000	0.11	0.0322094	0	2.53E-02	0	0	0.9425
Tracing	22356	43.7	14197	0.773	0	0.2573567	2.99E-03	0	0	0.7397
Bankcard	361049.4	569.25	2277377	1	0	0	0	1	0	0
C/A Bulk Filing	134136	127.075	50281	0.299	0	0.9894699	1.05E-02	0	0	0
GMAC	5589	85.1	1303	1	0	0	0	0	1	4.05E-17
VISA – AS/400 ImagePlus	718745.4	465.175	300000	0.2	0	0.8213497	0.1786503	0	0	0
Statement Reprint System	11178	414	2600	0.5	1	0	0	0	0	0
Kiting Detection System	20120.4	131.675	13280	0.477	0.1492579	0	0	0	0.135	0.7159
Integrated Profitability Management System (EFIP)	262683	179.4	450000	0.701	0	0.7203641	0.2796359	0	0	0
National Trust Back Office	55890	241.5	48049	0.268	0.161276	0	2.23E-02	0	0	0.8165

Appendix B DEA Results

Application Name	FTE in level 1and 2	Duration	Source Lines	Score	Efficient Peers					
					Branch Clearing	Cage II Control	HUMAN RESOURCES	Bankcard	GMAC	CIBC Wood Gundy Securities Operations
New Mellon Bank Interface System (Replacing 75 & 270)	45829.8	893.55	10000	0.122	0.2293491	0	0	0	0.771	0
WINFAST (Replacing Lending Advisor)	527601.6	655.5	200000	0.108	0	0.8886735	0.1113265	0	0	0
GST Input Collection & Calc/Decalc	27945	346.725	49095	0.328	0.5116925	0	4.04E-03	0	0	0.4843
Consolidated Bill Payment	17884.8	87.4	46120	0.791	0.195382	0	0.0191565	0	0	0.7855
CIBC Online (SCC-MVS)	68185.8	309.35	56425	0.229	0.19239	0	2.61E-02	0	0	0.7815
Deposit Acceleration (Replacing Part of 26)	95013	109.25	21000	0.307	0	0.5945303	0	0	0	0.4055
415 Statistics (Replacing Part of 26)	95013	100.625	7000	0.324	0	0.1783591	0	0	0	0.8216
Statement on COM (Replacing Part of 26)	95013	104.65	8000	0.312	0	0.2080856	0	0	0	0.7919
EFIP Infra. - Technical Architecture	400172.4	374.9	1080000	0.705	0	0.2962245	0.7037755	0	0	0
CIBC Wood Gundy Securities Operations	11178	32.2	1000	1	0	0	0	0	0	1
Credit Data Warehouse (Previously Part of PIF)	63714.6	230.575	10000	0.181	5.40E-02	0	3.01E-03	0	0	0.943

Appendix B DEA Results

I Part B: CRS Results for the First Two Level Estimated Model

Application Name	FTE in level 1and 2	Duration	Source Lines	score	Efficient Peers	
					Branch Clearing	HUMAN RESOURCES
GL Data Collect	11178	154.675	70000	0.63563	0.4820478	1.97E-02
Rapidtrans	194497.2	311.65	150000	0.114343	0	9.87E-02
Inter Branch Banking	167670	106.375	9804	2.19E-02	0	0.00645
Branch Clearing	5589	189.175	83000	1	1	0
Auto 412	65950.2	207	22000	0.046463	2.59E-02	0.0130586
US Dollar Float	92777.4	374.325	65000	9.46E-02	0.117914	3.63E-02
DACS/GL	32416.2	167.9	16743	6.72E-02	4.31E-02	8.66E-03
VISA Front End	201204	447.925	128000	9.15E-02	6.24E-02	8.08E-02
Sundry Clearing	48065.4	276	36665	9.74E-02	0.1072736	1.83E-02
Cheque Imaging	17884.8	345	14000	6.98E-02	0.1224868	2.52E-03
Customer Profitability	188908.2	242.075	260000	0.255157	0	0.1710526
CAMP Stop/Holds /etc.	78246	185.15	244400	0.447063	0.1458341	0.1528262
Portfolio Info Facility	24591.6	320.275	19525	8.23E-02	0.1281493	5.85E-03
Business and Farm Loans Life Insurance System	169905.6	241.5	122500	0.120504	0	8.06E-02
Geographical Distribution	5589	143.175	17000	0.237731	0.1770272	1.52E-03
General Clearing	11178	121.9	3000	2.94E-02	1.70E-02	1.05E-03
RRSP	325279.8	517.5	180000	8.26E-02	0	0.1184211
Historical Results	48065.4	189.75	242733	0.68413	0.4257633	0.1364438
IMS COLT	748926	335.8	1244000	0.880083	0	0.8184211
Cage II Control	32416.2	34.5	34640	0.23853	0	2.28E-02
Branch Details	67068	165.025	14000	2.98E-02	9.37E-03	8.70E-03
Portfolio Manager	33534	147.2	12000	0.047763	2.47E-02	6.55E-03

Appendix B DEA Results

Application Name	FTE in level 1and 2	Duration	Source Lines	score	Efficient Peers	
					Branch Clearing	HUMAN RESOURCES
HUMAN RESOURCES	223560	361.1	1520000	1	0	1
Deposit Account (STB)	191143.8	220.8	103500	0.111359	0	6.81E-02
Unclaimed Balances	11178	147.2	19500	0.180122	0.1291269	5.78E-03
Invest Products System	354342.6	448.5	1550000	0.821019	0	1.0197368
CDIC Prem Reduct	52536.6	120.75	10880	0.029713	5.92E-03	6.83E-03
Inventory Asset Management	185554.8	310.5	120000	9.49E-02	5.68E-03	7.86E-02
TPSS	40240.8	443.9	200000	0.543112	1.1423214	6.92E-02
NISA	16767	148.925	35000	0.242322	0.1638944	1.41E-02
Corporate Credit Processing (CCP)	44712	448.5	9954	2.50E-02	5.22E-02	0.0036961
Mutual Funds Order Entry & Transfer System (MOTE)	148667.4	414	42000	3.98E-02	3.85E-02	2.55E-02
Tracing	22356	43.7	14197	9.23E-02	3.89E-03	9.13E-03
Bankcard	361049.4	569.25	2277377	0.95042	0	1.4982743
C/A Bulk Filing	134136	127.075	50281	9.40E-02	0	3.31E-02
GMAC	5589	85.1	1303	2.29E-02	9.65E-03	3.30E-04
VISA -- AS/400 ImagePlus	718745.4	465.175	300000	0.153211	0	0.1973684
Statement Reprint System	11178	414	2600	1.57E-02	3.13E-02	0
Kiting Detection System	20120.4	131.675	13280	8.22E-02	4.52E-02	6.27E-03
Integrated Profitability Management System (EFIP)	262683	179.4	450000	0.595901	0	0.2960526

Appendix B DEA Results

Application Name	FTE in level 1and 2	Duration	Source Lines	score	Efficient Peers	
					Branch Clearing	HUMAN RESOURCES
National Trust Back Office	55890	241.5	48049	0.115012	0.0965466	2.63E-02
New Mellon Bank Interface System (Replacing 75 & 270)	45829.8	893.55	10000	1.94E-02	8.81E-02	1.77E-03
WINFAST (Replacing Lending Advisor)	527601.6	655.5	200000	7.25E-02	0	0.1315789
GST Input Collection & Calc/Decalc	27945	346.725	49095	0.18503	0.3097616	1.54E-02
Consolidated Bill Payment	17884.8	87.4	46120	0.33858	0.1099709	2.43E-02
CIBC Online (SCC-MVS)	68185.8	309.35	56425	0.109913	0.1215458	3.05E-02
Deposit Acceleration (Replacing Part of 26)	95013	109.25	21000	4.57E-02	0	1.38E-02
415 Statistics (Replacing Part of 26)	95013	100.625	7000	1.65E-02	0	4.61E-03
Statement on COM (Replacing Part of 26)	95013	104.65	8000	1.82E-02	0	5.26E-03
EFIP Infra. - Technical Architecture	400172.4	374.9	1080000	0.684372	0	0.7105263
CIBC Wood Gundy Securities Operations	11178	32.2	1000	0.012573	9.87E-04	6.04E-04

Application Name	FTE in level 1and 2	Duration	Source Lines	score	Efficient Peers	
					Branch Clearing	HUMAN RESOURCES
Credit Data Warehouse (Previously Part of PIF)	63714.6	230.575	10000	2.15E-02	1.52E-02	5.75E-03

II Part A: VRS Results for the First Two Level Actual Model

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers					
					Branch Clearing	IMS COLT	Invest Products System	Software Amortization System	Wood Gundy Rapid Confirms	Financial Model System
Rapidtrans	194497.2	150000	311.65	0.232407	0	0.1191626	0	0.880837	0	0
Branch Clearing	16767	83000	137.425	1	1	3.53E-17	0	0	5.31E-16	0
US Dollar Float	83835	65000	419.75	0.210338	0	4.66E-02	0	0	0.55985	0.39354
DACS/GL	31298.4	16743	120.75	0.402904	0	5.52E-03	0	9.03E-03	0	0.98544
Centralized Instr	251505	226550	379.5	0.239416	0	0.1807971	0	0.819203	0	0
EFT	423646.2	1301692	524.975	0.699212	0	0.8114641	0.18854	0	0	0
Geographical Distribution	11178	17000	91.425	0.775129	0	7.27E-03	0	0	0.43718	0.55555
General Clearing	11178	3000	109.25	0.587636	0	0	0	0.541818	0.45818	0
RRSP	385641	180000	525.55	0.151559	0	0.1433172	0	0.856683	0	0
Account Info Facility	131900.4	69700	201.25	0.263842	0	5.45E-02	0	0.945491	0	0
IMS COLT	270507.6	1244000	335.8	1	0	1	0	0	0	0
Cage II Control	43594.2	34640	310.5	0.260015	0	2.20E-02	0	0	0.55088	0.42714
Branch Details	116251.2	14000	143.175	0.277205	0	9.66E-03	0	0.990338	0	0
Portfolio Manager	33534	12000	147.2	0.335976	0	1.75E-03	0	0	3.64E-02	0.96186
Deposit Account (STB)	140842.8	103500	201.25	0.304274	0	8.17E-02	0	0.918277	0	0
Invest Products System	406879.2	1550000	456.55	1	0	0	1	0	0	0
CDIC Prem Reduct	38005.2	10880	112.125	0.347271	0	7.15E-03	0	0.99285	0	0
Software Amortization System	11178	2000	36.8	1	0	0	0	1	0	0
NISA	14531.4	35000	143.75	0.642293	0	2.31E-02	0	0	0.77881	0.1981
Utility Bills	6706.8	460	93.15	0.776177	0	0	0	0.40634	0.59366	0

Appendix B DEA Results

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers					
					Branch Clearing	IMS COLT	Invest Products System	Software Amortization System	Wood Gundy Rapid Confirms	Financial Model System
Mutual Funds Order Entry & Transfer System (MOTE)	166552.2	42000	422.05	0.114836	0	3.06E-02	0	0.727572	0	0.24178
Tracing	17884.8	14197	169.05	0.4287	0	5.16E-03	0	0	0.48196	0.51288
C/A Bulk Filing	111780	50281	116.15	0.416902	0	3.89E-02	0	0.961126	0	0
GMAC	5589	1303	85.1	0.87257	0	0	0	0.37365	0.62635	0
RICS FEE	6706.8	1200	110.4	0.687075	0	0	0	0.346939	0.65306	0
Kiting Detection System	27945	13280	128.8	0.400764	0	2.93E-03	0	0	7.33E-02	0.92379
National Trust Back Office	43594.2	48049	339.25	0.279428	0	3.36E-02	0	0	0.7672	0.19916
Float	8942.4	30280	108.1	0.871841	0	1.95E-02	0	0	0.83862	0.14189
New Mellon Bank Interface System (Replacing 75 & 270)	122958	10000	893.55	6.93E-02	0	1.06E-03	0	0	0.29195	0.70699
Wood Gundy Rapid Confirms	1117.8	5500	96.6	1	0	0	0	0	1	6.00E-16
Consolidated Bill Payment	17884.8	46120	139.15	0.669869	0	3.20E-02	0	0	0.74478	0.22324
CIBC Online (SCC-MVS)	68185.8	56425	309.35	0.253223	0	3.91E-02	0	0	0.40246	0.55846
Deposit Acceleration (Replacing Part of 26)	33534	21000	127.65	0.39708	0	8.98E-03	0	0	1.91E-02	0.97192
415 Statistics (Replacing Part of 26)	33534	7000	99.475	0.382043	0	4.03E-03	0	0.995974	0	0
Statement on COM (Replacing Part of 26)	33534	8000	99.475	0.384463	0	4.83E-03	0	0.995169	0	0

Appendix B DEA Results

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers					
					Branch Clearing	IMS COLT	Invest Products System	Software Amortization System	Wood Gundy Rapid Confirms	Financial Model System
Financial Model System	11178	10000	47.15	1	0	0	0	4.69E-17	0	1
GIS TXN Conf Printing	12295.8	2803	99.475	0.598297	0	0	0	0.620141	0.37986	0

II Part B: CRS Results for the First Two Level Actual Model

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers	
					Branch Clearing	IMS COLT
Rapidtrans	194497.2	150000	311.65	0.167039	0.1005678	0.1138689
Branch Clearing	16767	83000	137.425	1	1	1.88E-17
US Dollar Float	83835	65000	419.75	0.1618973	0.4382753	2.30E-02
DACS/GL	31298.4	16743	120.75	0.1130731	7.94E-02	8.16E-03
Centralized Instr	251505	226550	379.5	0.1952997	0.1126959	0.174595
EFT	423646.2	1301692	524.975	0.669314	0	1.0463762
Geographical Distribution	11178	17000	91.425	0.3072827	0.2043501	3.13E-05
General Clearing	11178	3000	109.25	5.42E-02	0.0361446	0
RRSP	385641	180000	525.55	0.1013606	4.07E-02	0.1419788
Account Info Facility	131900.4	69700	201.25	0.1145488	3.68E-02	5.36E-02
IMS COLT	270507.6	1244000	335.8	1	0	1
Cage II Control	43594.2	34640	310.5	0.1622978	0.3568315	4.04E-03
Branch Details	116251.2	14000	143.175	2.64E-02	0	1.13E-02
Portfolio Manager	33534	12000	147.2	7.52E-02	6.81E-02	5.10E-03
Deposit Account (STB)	140842.8	103500	201.25	0.159467	3.61E-02	0.0807895
Invest Products System	406879.2	1550000	456.55	0.9164392	0	1.2459807
CDIC Prem Reduct	38005.2	10880	112.125	6.11E-02	0.0340316	6.48E-03
Software Amortization System	11178	2000	36.8	3.80E-02	7.48E-03	1.11E-03
NISA	14531.4	35000	143.75	0.4865616	0.4216867	0
Utility Bills	6706.8	460	93.15	0.0138554	5.54E-03	0
Mutual Funds Order Entry & Transfer System (MOTE)	166552.2	42000	422.05	5.41E-02	9.98E-02	2.71E-02
Tracing	17884.8	14197	169.05	0.1603577	0.1710482	0
C/A Bulk Filing	111780	50281	116.15	0.1168544	0	4.04E-02
GMAC	5589	1303	85.1	4.71E-02	1.57E-02	0
RICS FEE	6706.8	1200	110.4	0.0361446	1.45E-02	0
Kiting Detection System	27945	13280	128.8	9.96E-02	8.04E-02	5.31E-03
National Trust Back Office	43594.2	48049	339.25	0.2236006	0.5467412	2.15E-03
Float	8942.4	30280	108.1	0.6840361	0.3648193	0
New Mellon Bank Interface System (Replacing 75 & 270)	122958	10000	893.55	1.66E-02	0.105387	1.01E-03

Appendix B DEA Results

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers	
					Branch Clearing	IMS COLT
Wood Gundy Rapid Confirms	1117.8	5500	96.6	0.9939759	6.63E-02	0
Consolidated Bill Payment	17884.8	46120	139.15	0.5231543	0.524668	2.07E-03
CIBC Online (SCC-MVS)	68185.8	56425	309.35	0.1736554	0.3346294	2.30E-02
Deposit Acceleration (Replacing Part of 26)	33534	21000	127.65	0.1324405	9.77E-02	1.04E-02
415 Statistics (Replacing Part of 26)	33534	7000	99.475	0.0445468	2.21E-02	4.15E-03
Statement on COM (Replacing Part of 26)	33534	8000	99.475	5.09E-02	2.53E-02	4.75E-03
Financial Model System	11178	10000	47.15	0.1883723	5.38E-02	4.45E-03
GIS TXN Conf Printing	12295.8	2803	99.475	4.61E-02	3.33E-02	3.19E-05

III Part: VRS Results for the Whole Project Estimated Model

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
GL Data Collect	16767	2	70000	154.675	0.7679324	0	0	0	0
Canada Savings Bonds	65950.2	3	13660	419.75	0.3997782	0	0.8399535	0	0
Project Control System	84952.8	2	110000	255.3	0.281881	0	0	0	6.55E-04
Inter Branch Banking	143078.4	3	9804	307.05	0.4336513	0	0.4943625	0	0
Bulk Filing	156492	3	152840	389.275	0.3897178	0	0.3462103	0	0
Auto 412	115133.4	2	22000	207	0.2179147	0	0	0	5.87E-02
CLASS	1683406.8	3	1759400	719.9	0.6281374	0	0	0	0
DACS/GL	33534	2	16743	167.9	0.3766223	0	0	0	0
Centralized Instr	314101.8	3	226550	659.525	0.2282502	0	0.1591191	0	0
VISA Front End	178848	3	128000	499.675	0.3086162	0	0.4305587	0	0
PCA/Savings	690800.4	3	297390	458.275	0.2583685	0	0	0	0
Cheque Imaging	22356	2	14000	345	0.4825806	0	0	0	0
IBTSS	908771.4	3	2301000	659.525	1	1	0	0	0
Customer Profitability	190026	2	260000	242.075	0.4197227	0	0	0	0.6998918
Portfolio Info Facility	33534	2	19525	320.275	0.3348601	0	0	0	0
Business and Farm Loans Life Insurance System	413586	2	122500	241.5	0.2322797	0	0	0	0.9216001
Foreign Exchange	413586	3	456000	610.075	0.2790437	0	0	0	1.20E-16
Geographical Distribution	11178	2	17000	143.175	0.9784009	0	0	0	0
General Clearing	11178	3	3000	181.125	1	0	1	0	0
RRSP	479536.2	3	180000	806.725	0.1685348	0	0.1223759	0	0
Historical Results	109544.4	2	242733	189.75	0.5291939	0	0	0	0.6894785
IDT Systems	570078	3	137000	619.85	0.1783579	0	0	0	0
ECIF	950130	3	1000000	249.55	1	0	0	1	0

Appendix B DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
Account Info Facility	315219.6	3	69700	426.075	0.2742352	0	0.1912751	0	0
IMS COLT	479536.2	3	1244000	556.6	0.6933606	0.3347674	0	0	0
Loan Accounting System	614790	3	146765	834.325	0.1469842	0	6.66E-02	0	0
Cage II Control	67068	2	34640	34.5	1	0	0	0	1
Branch Details	247033.8	2	14000	165.025	0.2237613	0	0	0	0.7362813
COINS - Op Cntrl	111780	3	152800	102.925	1	0	0	0	0
HUMAN RESOURCES	760104	2	1520000	361.1	1	0	0	0	0
POS Merchant	558900	3	150000	858.475	0.1503991	0	0.1244479	0	0
Deposit Account (STB)	377816.4	3	103500	426.075	0.2586045	0	4.36E-02	0	0
ATM Systems-NON-TANDEM	558900	3	215000	974.05	0.1442431	0	8.51E-02	0	0
Unclaimed Balances	16767	2	19500	147.2	0.6727536	0	0	0	0
Invest Products System	743337	3	1550000	737.725	0.670239	0.5309182	0	0	0
CDIC Prem Reduct	79363.8	2	10880	120.75	0.352349	0	0	0	0.1254195
Special Debts	90541.8	3	400000	393.875	0.5012569	0	0.2210413	0	0
Inventory Asset Management	182201.4	2	120000	310.5	0.2230079	0	0	0	0.3729675
Base 24-ATM	970250.4	3	650000	1104	0.1924036	0	0	0	0
Base24 POS Online	1313415	3	550000	1344.925	0.1380912	0	0	0	0
Acquisition Management System	225795.6	2	130000	310.5	0.2221578	0	0	0	0.5840346
Cheque Processing (Upgrading)	122958	3	76644	224.25	0.5864956	0	0.3232096	0	0

Appendix B DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
CRIBS DDA (Replaced by 284)	447120	3	221706	172.5	0.5175986	0	0	0	0
Info Capture System (Replaced by 283)	111780	3	20000	86.25	1	0	4.68E-17	0	0
CRIBS Savings (Replaced by 284)	245916	3	154535	69	1	0	0	0	0
West Indies Retail System (Replaced by 283)	402408	3	395000	207	0.6432827	0	0	0	0
West Indies General Ledger (Replaced by 287)	223560	3	127049	86.25	0.8951429	0	0	0	0
Corporate Credit Processing (CCP)	44712	2	9954	448.5	0.2460526	0	0	0	0
Centralized Rates	48065.4	3	171853	181.7	0.9334562	0	0.4820649	0	0
Returned Item System	55890	3	72900	480.7	0.3752075	0	0.826093	0	0
Mutual Funds Order Entry & Transfer System (MOTE)	243680.4	3	42000	703.225	0.2097146	0	0.5669485	0	0
PMDB (Portfolio Management Data Base)	1159158.6	3	159000	688.275	0.1349657	0	0	0	4.66E-16
CSP (Cardholder Service Platform)	111780	3	225000	810.175	0.2390806	0	0.5993352	0	0
Clearing	357696	3	463050	519.8	0.3293738	0	0	0	2.16E-16

Appendix B DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
RICS	22356	3	10000	446.2	0.4955578	0	0.911855	0	0
Tracing	22356	2	14197	43.7	1	0	0	0	0
Bankcard	1633105.8	3	2277377	621	1	3.38E-17	0	0	0
C/A Bulk Filing	134136	3	50281	186.3	0.6266224	0	0.2363831	0	0
Collection (TCS Year 2000 Upgrade)	1542564	3	1000000	792.35	0.3347254	0	0	0	0
Merchant System	1509030	3	412000	489.325	0.2584404	0	0	0.140772 1	0
Statement Reprint System	22356	2	2600	414	0.4773017	0	0	0	0
RICS FEE	11178	2	1200	69	0.9982841	0	0	0	0
Kiting Detection System	53654.4	2	13280	131.675	0.3678531	0	0	0	0
SFT-Calculators	33534	3	700000	246.1	1	0	0	0	0
Integrated Profitability Management System (EFIP)	675151.2	2	450000	179.4	0.7013885	0	0	0	0.7203641
National Trust Back Office	55890	2	48049	241.5	0.2800826	0	0	0	0
CIBC Information Warehouse	55890	3	300000	223.675	0.824236	0	0.3265904	0	0
WINFAST (Replacing Lending Advisor)	514188	2	200000	655.5	0.130443	0	0	0	0.7648552
GASPER4	111780	3	300000	810.175	0.2492236	0	0.504132	0	0
Electronic Banking PC/Internet	335340	3	40000	247.25	0.3524088	0	0	0	6.35E-16
GST Input Collection & Calc/Decalc	67068	2	49095	346.725	0.2061896	0	0	0	0
CIBC Online (SCC-MVS)	68185.8	2	56425	309.35	0.228112	0	0	0	0

Appendix B DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
Client Mgmt. System	27945	3	63000	241.5	0.7426219	0	0.8393241	0	0
BASE24 Remote Banking	1922616	3	1626000	566.95	0.7220519	0	0	1.44E-02	0
COINS - Com Facil	111780	3	10000	266.225	0.5157298	0	0.538078	0	0
Deposit Acceleration (Replacing Part of 26)	84952.8	3	21000	274.275	0.545059	0	0.6373033	0	0
415 Statistics (Replacing Part of 26)	97248.6	3	7000	250.125	0.5606953	0	0.5691057	0	0
Statement on COM (Replacing Part of 26)	87188.4	3	8000	254.15	0.5698006	0	0.617284	0	0
RDS	45829.8	3	16500	492.2	0.3608939	0	0.9325738	0	0
ICBS (International Comprehensive Banking System)	726570	3	1635137	411.7	1	0	0	0	0
Financial Model System	11178	2	10000	63.825	1	0	0	0	0
Secret Code Selectors	33534	3	20000	404.225	0.4444165	0	0.9446049	0	0
Credit Data Warehouse (Previously Part of PIF)	78246	2	10000	230.575	0.2260062	0	1.38E-16	0	0
Collections -Property Administration	8942.4	3	53250	653.2	1	0	0	0	0
Collections -Auto-IBP Replacement	257094	3	20000	808.45	0.1836706	0	0.6294905	0	0

Appendix B DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers			
						IBTSS	General Clearing	ECIF	Cage II Control
T4RIF Printing	22356	2	982	51.175	0.918239	0	0	0	0
GIS TXN Conf Printing	22356	2	2803	99.475	0.600823	0	0	0	0
CIBC Workflow	55890	3	99	325.45	0.5068424	0	0.829532	0	0

Continued

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
GL Data Collect	0	0	0	0	0	0	8.27E-02	0	0.84962	6.77E-02
Canada Savings Bonds	0	0	0.148371	0	4.40E-17	0	1.17E-02	0	0	0
Project Control System	0	0	0	0	0.85967	0	0.139675	0	0	0
Inter Branch Banking	0	0	0.505637	0	0	0	0	0	0	0
Bulk Filing	0	0	0.449781	0	1.33E-15	0	0.204008	0	0	0
Auto 412	0	0	0	0	0.93165	0	9.63E-03	0	0	0
CLASS	0	0	0	0	0	0.193484	0	0.806516	0	0
DACS/GL	0	0	0	0	0.11168	0	9.09E-03	0	0.87923	0
Centralized Instr	0	0	0.533153	0	4.15E-16	0	0.307728	0	0	0
VISA Front End	0	0	0.399854	0	2.06E-16	0	0.169587	0	0	0
PCA/Savings	8.76E-02	0	0	0.6502	0	0	0.262175	0	0	0
Cheque Imaging	0	0	0	0	0	0	0	0	0.82581	0.17419
IBTSS	0	0	0	0	0	0	0	0	0	0
Customer Profitability	0	3.13E-02	0	0	0	0	0.268791	0	0	0
Portfolio Info Facility	0	0	0	0	0	0	9.37E-03	0	0.91985	7.08E-02

Appendix B DEA Results

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Business and Farm Loans Life Insurance System	0	4.35E-02	0	0	0	0	0.034868	0	0	0
Foreign Exchange	9.74E-02	0	0	0.349626	0	0	0.552985	0	0	0
Geographical Distribution	0	0	0	0	0	0	0.002075	0	0.86918	0.12875
General Clearing	0	0	0	0	0	0	0	0	0	0
RRSP	0	0	0.639271	0	0	0	0.238354	0	0	0
Historical Results	0	1.81E-03	0	0	0	0	0.308711	0	0	0
IDT Systems	0.219935	0	0.650958	0	0	0	0.129107	0	0	0
ECIF	0	0	0	0	0	0	0	0	0	0
Account Info Facility	0	0	0.730855	0	0	0	7.79E-02	0	0	0
IMS COLT	0	0	0	0	0	0	0.656638	8.59E-03	0	0
Loan Accounting System	0	0	0.745329	0	0	0	0.188084	0	0	0
Cage II Control	0	0	0	0	0	0	2.54E-19	0	0	0
Branch Details	0	0	5.06E-16	0	0.26372	0	0	0	0	0
COINS - Op Cntrl	1	0	0	0	0	0	0	0	0	0
HUMAN RESOURCES	0	1	0	0	0	0	0	2.24E-17	0	0
POS Merchant	0	0	0.681264	0	2.42E-15	0	0.194288	0	0	0
Deposit Account (STB)	0	0	0.832563	0	5.87E-16	0	0.123883	0	0	0
ATM Systems-NON-TANDEM	0	0	0.626042	0	0	0	0.288891	0	0	0
Unclaimed Balances	0	0	0	0	0	0	1.02E-02	0	0.93321	5.66E-02

Appendix B DEA Results

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Invest Products System	0	0	0	0	0	0	0.469082	0	0	0
CDIC Prem Reduct	0	0	6.24E-17	0	0.87458	0	0	0	0	0
Special Debts	0	0	0.214609	0	1.85E-16	0	0.56435	0	0	0
Inventory Asset Management	0	0	0	0	0.48387	0	0.143158	0	0	0
Base 24-ATM	0	0	0	0.308453	0	0	0.565095	0.126452	0	0
Base24 POS Online	0	0	0	0.42003	0	0	0.495371	0.084599	0	0
Acquisition Management System	0	0	0	0	0.26452	0	0.151448	0	0	0
Cheque Processing (Upgrading)	0	0	0.58541	0	0	0	9.14E-02	0	0	0
CRIBS DDA (Replaced by 284)	0	0	0	0.895775	0	0	9.32E-02	1.10E-02	0	0
Info Capture System (Replaced by 283)	0	0	1	0	0	0	0	0	0	0
CRIBS Savings (Replaced by 284)	0	0	0	1	0	0	1.05E-17	0	0	0
West Indies Retail System (Replaced by 283)	0	0	0	0.731988	0	0	0.167199	0.100813	0	0
West Indies General Ledger (Replaced by 287)	0.138916	0	0.202512	0.658571	0	0	0	0	0	0

Appendix B DEA Results

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Corporate Credit Processing (CCP)	0	0	0	0	0	0	0	0	0.92105	7.89E-02
Centralized Rates	0	0	0.28257	0	2.73E-16	0	0.235365	0	0	0
Returned Item System	0	0	7.55E-02	0	3.05E-16	0	9.84E-02	0	0	0
Mutual Funds Order Entry & Transfer System (MOTE)	0	0	0.386525	0	1.87E-16	0	4.65E-02	0	0	0
PMDB (Portfolio Management Data Base)	0.650767	0	0	0.338978	0	0	1.03E-02	0	0	0
CSP (Cardholder Service Platform)	0	0	8.42E-02	0	7.64E-17	0	0.316454	0	0	0
Clearing	5.92E-02	0	0	0.37504	0	0	0.565788	0	0	0
RICS	0	0	0	0	0	0	3.97E-03	0	0	8.42E-02
Tracing	0	0	0	0	1	0	1.27E-18	0	6.36E-17	0
Bankcard	0	4.26E-16	0	0	0	1	0	0	0	0
C/A Bulk Filing	0	0	0.713176	0	0	0	5.04E-02	0	0	0
Collection (TCS Year 2000 Upgrade)	0	0	0	0.422408	0	0	1.04E-02	0.567199	0	0
Merchant System	0	6.55E-15	0	0.765721	0	0	0	9.35E-02	0	0
Statement Reprint System	0	0	0	0	0	0	0	0	0.77302	0.22698
RICS FEE	0	0	0	0	0	0	0	0	0.99142	8.58E-03

Appendix B DEA Results

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Kiting Detection System	0	0	0	0	0.7655	0	9.74E-05	0	0.2344	0
SFT-Calculators	0	0	0	0	0	0	1	0	0	0
Integrated Profitability Management System (EFIP)	0	0.27964	0	0	0	0	0	0	0	0
National Trust Back Office	0	0	0	0	0.2937	0	0.053357	0	0.65294	0
CIBC Information Warehouse	0	0	0.25348	0	0	0	0.419929	0	0	0
WINFAST (Replacing Lending Advisor)	0	1.09E-02	0	0	0	0	0.224286	0	0	0
GASPER4	0	0	7.15E-02	0	6.49E-17	0	0.424368	0	0	0
Electronic Banking PC/Internet	0.102291	0	0.850021	4.77E-02	0	0	0	0	0	0
GST Input Collection & Calc/Decalc	0	0	0	0	0.12534	0	5.59E-02	0	0.81876	0
CIBC Online (SCC-MVS)	0	0	0	0	0.26008	0	6.57E-02	0	0.67422	0
Client Mgmt. System	0	0	7.65E-02	0	0	0	8.42E-02	0	0	0
BASE24 Remote Banking	0	0	0	0	0	0	0	0.985614	0	0
COINS - Com Facil	0	0	0.461922	0	3.67E-16	0	0	0	0	0
Deposit Acceleration (Replacing Part of 26)	0	0	0.345294	0	0	0	1.74E-02	0	0	0

Application Name	Efficient Peers									
	COINS - Op Cntrl	HUMAN RESOURCES	Info Capture System (Replaced by 283)	CRIBS Savings (Replaced by 284)	Tracing	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
415 Statistics (Replacing Part of 26)	0	0	0.430894	0	0	0	0	0	0	0
Statement on COM (Replacing Part of 26)	0	0	0.382716	0	0	0	0	0	0	0
RDS	0	0	4.93E-02	0	0	0	1.82E-02	0	0	0
ICBS (International Comprehensive Banking System)	0	0	0	0	0	0	0	1	0	0
Financial Model System	0	0	0	0	0	0	0	0	1	0
Secret Code Selectors	0	0	0.03178	0	0	0	2.36E-02	0	0	0
Credit Data Warehouse (Previously Part of PIF)	0	0	0	0	0.58204	0	0	0	0.41796	0
Collections-Property Administration	0	0	0	0	0	0	6.32E-18	0	1.43E-16	1
Collections-Auto-IBP Replacement	0	0	0.354772	0	2.93E-16	0	1.57E-02	0	0	0
T4RIF Printing	0	0	0	0	0.83648	0	0	0	0.16352	0
GIS TXN Conf Printing	0	0	0	0	0.20165	0	0	0	0.79835	0
CIBC Workflow	0	0	0.170468	0	0	0	0	0	0	0

III Part B: CRS Results for the Whole Project Estimated Model

					Score	Efficient Peers			
Application Name	FTE	Target Level	Source Lines	Duration		General Clearing	ECIF	Cage II Control	HUMAN RESOURCES
GL Data Collect	16767	2	70000	154.675	0.6627246	0.289832	0	0	0
Canada Savings Bonds	65950.2	3	13660	419.75	0.2465455	0.090763	0	0	0
Project Control System	84952.8	2	110000	255.3	0.2702273	0	0	1.34E-02	0
Inter Branch Banking	143078.4	3	9804	307.05	0.2230143	0	0	0	0
Bulk Filing	156492	3	152840	389.275	0.2531671	0	0	0.136085	0
Auto 412	115133.4	2	22000	207	0.2169853	0	0	5.87E-02	0
CLASS	1683406.8	3	1759400	719.9	0.5894677	0	0.20427	0	1.010718
DACS/GL	33534	2	16743	167.9	0.3750047	0	0	0	0
Centralized Instr	314101.8	3	226550	659.525	0.1720067	0	0	0.458347	0
VISA Front End	178848	3	128000	499.675	0.1879418	0	0	1.77E-03	0
PCA/Savings	690800.4	3	297390	458.275	0.2439308	0	0	1.18762	0
Cheque Imaging	22356	2	14000	345	0.3518462	0.643977	0	0	0
IBTSS	908771.4	3	2301000	659.525	0.9415991	0	0	0	1.084652
Customer Profitability	190026	2	260000	242.075	0.402093	0	0	0.567881	0
Portfolio Info Facility	33534	2	19525	320.275	0.2912153	0.310755	0	0	0
Business and Farm Loans Life Insurance System	413586	2	122500	241.5	0.2296766	0	0	0.898077	0
Foreign Exchange	413586	3	456000	610.075	0.2707658	0	0	0.710573	0
Geographical Distribution	11178	2	17000	143.175	0.7721304	0.513377	0	0	0
General Clearing	11178	3	3000	181.125	1	1	0	0	0
RRSP	479536.2	3	180000	806.725	0.1232178	0	0	0.571511	0
Historical Results	109544.4	2	242733	189.75	0.5033512	0	0	0.544663	0
IDT Systems	570078	3	137000	619.85	0.1330566	0	0	0.946472	0

Appendix B DEA Results

					Score	Efficient Peers			
Application Name	FTE	Target Level	Source Lines	Duration		General Clearing	ECIF	Cage II Control	HUMAN RESOURCES
ECIF	950130	3	1000000	249.55	1	0	1	0	0
Account Info Facility	315219.6	3	69700	426.075	0.1689204	0	0	0.440889	0
IMS COLT	479536.2	3	1244000	556.6	0.6677133	0	0	0	0.379169
Loan Accounting System	614790	3	146765	834.325	0.106128	0	0	0.70926	0
Cage II Control	67068	2	34640	34.5	1	0	0	1	0
Branch Details	247033.8	2	14000	165.025	0.2237613	0	0	0.736281	0
COINS - Op Cntrl	111780	3	152800	102.925	0.7992487	0	0	1.248122	0
HUMAN RESOURCES	760104	2	1520000	361.1	1	0	0	0	1
POS Merchant	558900	3	150000	858.475	0.106358	0	0	0.579475	0
Deposit Account (STB)	377816.4	3	103500	426.075	0.1789788	0	0	0.762371	0
ATM Systems-NON-TANDEM	558900	3	215000	974.05	0.1106786	0	0	0.633482	0
Unclaimed Balances	16767	2	19500	147.2	0.6000857	0.254736	0	0	0
Invest Products System	743337	3	1550000	737.725	0.6092637	0	0	0	0.550911
CDIC Prem Reduct	79363.8	2	10880	120.75	0.352349	0	0	0.125419	0
Special Debts	90541.8	3	400000	393.875	0.4185712	0	0	9.76E-02	0
Inventory Asset Management	182201.4	2	120000	310.5	0.2138722	0	0	0.371529	0
Base 24-ATM	970250.4	3	650000	1104	0.1901338	0	0	0.515221	0
Base24 POS Online	1313415	3	550000	1344.925	0.1355856	0	0	0.700793	0
Acquisition Management System	225795.6	2	130000	310.5	0.2128519	0	0	0.574902	0
Cheque Processing (Upgrading)	122958	3	76644	224.25	0.3449935	0	0	0.198732	0

Appendix B DEA Results

					Score	Efficient Peers			
Application Name	FTE	Target Level	Source Lines	Duration		General Clearing	ECIF	Cage II Control	HUMAN RESOURCES
CRIBS DDA (Replaced by 284)	447120	3	221706	172.5	0.5022457	0	0	0.728468	8.26E-02
Info Capture System (Replaced by 283)	111780	3	20000	86.25	0.6631579	0	0	0.907895	0
CRIBS Savings (Replaced by 284)	245916	3	154535	69	1	0	0	5.66E-17	5.63E-17
West Indies Retail System (Replaced by 283)	402408	3	395000	207	0.6200417	0	0	1.226114	0.125531
West Indies General Ledger (Replaced by 287)	223560	3	127049	86.25	0.7685899	0	0	0.918078	2.49E-02
Corporate Credit Processing (CCP)	44712	2	9954	448.5	0.2094466	0.34221	0	0	0
Centralized Rates	48065.4	3	171853	181.7	0.6201545	0	0	0	0
Returned Item System	55890	3	72900	480.7	0.2913426	0.359019	0	0	0
Mutual Funds Order Entry & Transfer System (MOTE)	243680.4	3	42000	703.225	0.1155651	0	0	0	0
PMDB (Portfolio Managemen t Data Base)	1159158.6	3	159000	688.275	0.1130556	0	0	1.36604	0
CSP (Cardholder Service Platform)	111780	3	225000	810.175	0.1896335	0.134084	0	0	0
Clearing	357696	3	463050	519.8	0.3208733	0	0	0.703901	0
RICS	22356	3	10000	446.2	0.4955578	0.911855	0	0	0
Tracing	22356	2	14197	43.7	1	0	0	0	0
Bankcard	1633105.8	3	2277377	621	0.8712583	0	2.05E-03	0	1.496926

Appendix B DEA Results

					Score	Efficient Peers			
Application Name	FTE	Target Level	Source Lines	Duration		General Clearing	ECIF	Cage II Control	HUMAN RESOURCES
C/A Bulk Filing	134136	3	50281	186.3	0.3659168	0	0	0.34775	0
Collection (TCS Year 2000 Upgrade)	1542564	3	1000000	792.35	0.3323991	0	0	0.745454	0.352758
Merchant System	1509030	3	412000	489.325	0.2565751	0	9.45E-02	0	0.125302
Statement Reprint System	22356	2	2600	414	0.3299739	0.633072	0	0	0
RICS FEE	11178	2	1200	69	0.9784173	4.32E-02	0	0	0
Kiting Detection System	53654.4	2	13280	131.675	0.3678359	0	0	0	0
SFT-Calculators	33534	3	700000	246.1	1	0	0	0	0
Integrated Profitability Management System (EFIP)	675151.2	2	450000	179.4	0.6695466	0	0.4078	0	1.55E-03
National Trust Back Office	55890	2	48049	241.5	0.2737599	0	0	0	0
CIBC Information Warehouse	55890	3	300000	223.675	0.6226736	0	0	2.83E-02	0
WINFAST (Replacing Lending Advisor)	514188	2	200000	655.5	0.1250992	0	0	0.656628	0
GASPER4	111780	3	300000	810.175	0.2072401	0.109106	0	0	0
Electronic Banking PC/Internet	335340	3	40000	247.25	0.2290909	0	0	0.968182	0
GST Input Collection & Calc/Decalc	67068	2	49095	346.725	0.2013324	0	0	0	0
CIBC Online (SCC-MVS)	68185.8	2	56425	309.35	0.2219444	0	0	0	0
Client Mgmt. System	27945	3	63000	241.5	0.5729527	0.364618	0	0	0
BASE24 Remote Banking	1922616	3	1626000	566.95	0.6921336	0	0.51094	0	0.733594

Appendix B DEA Results

					Score	Efficient Peers			
Application Name	FTE	Target Level	Source Lines	Duration		General Clearing	ECIF	Cage II Control	HUMAN RESOURCES
COINS - Com Facil	111780	3	10000	266.225	0.2693727	0	0	0	0
Deposit Acceleration (Replacing Part of 26)	84952.8	3	21000	274.275	0.2965178	0	0	0	0
415 Statistics (Replacing Part of 26)	97248.6	3	7000	250.125	0.296146	0	0	0	0
Statement on COM (Replacing Part of 26)	87188.4	3	8000	254.15	0.3062937	0	0	0	0
RDS	45829.8	3	16500	492.2	0.2993503	0.58251	0	0	0
ICBS (International Comprehensive Banking System)	726570	3	1635137	411.7	1	0	0	0	6.25E-17
Financial Model System	11178	2	10000	63.825	1	0	0	0	0
Secret Code Selectors	33534	3	20000	404.225	0.3926396	0.703006	0	0	0
Credit Data Warehouse (Previously Part of PIF)	78246	2	10000	230.575	0.2260062	0	0	0	0
Collections-Property Administration	8942.4	3	53250	653.2	1	0	0	0	0
Collections-Auto-IBP Replacement	257094	3	20000	808.45	9.94E-02	0	0	0	0
T4RIF Printing	22356	2	982	51.175	0.918239	0	0	0	0
GIS TXN Conf Printing	22356	2	2803	99.475	0.600823	0	0	0	0
CIBC Workflow	55890	3	99	325.45	0.298391	1.61E-02	0	0	0

Continued

Application Name	Efficient Peers					
	CRIBS Savings (Replaced by 284)	Tracing	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
GL Data Collect	0	0	9.27E-02	0	0.426249	0
Canada Savings Bonds	0	0	0	0	1.363856	0
Project Control System	0	0.775441	0.140751	0	0	0
Inter Branch Banking	0	1.354582	0	0	0.145418	0
Bulk Filing	0	1.079338	0.189718	0	0	0
Auto 412	0	0.926671	9.73E-03	0	0	0
CLASS	0.12192	0	0	0	0	0
DACS/GL	0	0.111271	9.16E-03	0	0.874986	0
Centralized Instr	0	0.60873	0.288615	0	0	0
VISA Front End	0	1.262486	0.157165	0	0	0
PCA/Savings	0	0	9.01E-02	0.118136	0	0
Cheque Imaging	0	0	1.71E-02	0	8.35E-03	0
IBTSS	0	0	0.931899	0	0	0
Customer Profitability	0	0	0.246723	4.14E-02	0	0
Portfolio Info Facility	0	0	1.93E-02	0	0.504844	0
Business and Farm Loans Life Insurance System	0	0	2.11E-02	0.046867	0	0
Foreign Exchange	0	0	0.458929	6.74E-02	0	0
Geographical Distribution	0	0	1.92E-02	0	0.201117	0
General Clearing	0	0	0	0	6.42E-17	0
RRSP	0	0.603559	0.21662	0	0	0
Historical Results	0	0	0.291394	1.22E-02	0	0
IDT Systems	0	0.340573	0.14197	0	0	0
ECIF	0	0	0	0	0	0
Account Info Facility	0	0.972052	0.058039	0	0	0
IMS COLT	0	0	0.953805	0	0	0
Loan Accounting System	0	0.545486	0.163503	0	0	0
Cage II Control	0	0	1.59E-18	0	0	0

Appendix B DEA Results

Application Name	Efficient Peers					
	CRIBS Savings (Replaced by 284)	Tracing	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Branch Details	0	0.263719	0	0	0	0
COINS - Op Cntrl	0	1.76E-02	0.156164	0	0	0
HUMAN RESOURCES	0	0	7.68E-17	0	0	0
POS Merchant	0	0.662258	0.172178	0	0	0
Deposit Account (STB)	0	0.590395	0.098157	0	0	0
ATM Systems-NON-TANDEM	0	0.467034	0.266322	0	0	0
Unclaimed Balances	0	0	1.83E-02	0	0.590399	0
Invest Products System	0	0	1.018021	0	0	0
CDIC Prem Reduct	0	0.874581	0	0	0	0
Special Debts	0	0.569831	0.555041	0	0	0
Inventory Asset Management	0	0.411422	0.144699	0	0	0
Base 24-ATM	0	0	0.471959	0.18456	0	0
Base24 POS Online	0	0	0.369448	0.163357	0	0
Acquisition Management System	0	0.195137	0.153307	0	0	0
Cheque Processing (Upgrading)	0	1.187921	7.56E-02	0	0	0
CRIBS DDA (Replaced by 284)	0.459314	0	0	0	0	0
Info Capture System (Replaced by 283)	0	0.592105	0	0	0	0
CRIBS Savings (Replaced by 284)	1	0	0	0	0	0
West Indies Retail System (Replaced by 283)	0	0	0	9.89E-02	0	0
West Indies General Ledger (Replaced by 287)	0.371342	0	0	0	0	0

Appendix B DEA Results

Application Name	Efficient Peers					
	CRIBS Savings (Replaced by 284)	Tracing	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Corporate Credit Processing (CCP)	0	0	5.93E-03	0	0.477793	0
Centralized Rates	0	0.830826	0.223892	0	0.333336	0
Returned Item System	0	0	0.090815	0	0.825249	0
Mutual Funds Order Entry & Transfer System (MOTE)	0	0.969101	3.35E-02	0	0.480682	0
PMDB (Portfolio Management Data Base)	0	0	3.67E-02	5.26E-02	0	0
CSP (Cardholder Service Platform)	0	0	0.308918	0	0.835496	0
Clearing	0	0	0.458921	7.18E-02	0	0
RICS	0	0	3.97E-03	0	0	8.42E-02
Tracing	0	1	1.90E-19	0	0	0
Bankcard	0	0	0	0	0	0
C/A Bulk Filing	0	1.103901	3.22E-02	0	0	0
Collection (TCS Year 2000 Upgrade)	0	0	0	0.267858	0	0
Merchant System	0.821944	0	0	0	0	0
Statement Reprint System	0	0	0	0	0	3.36E-02
RICS FEE	0	0	0	0	0.935252	0
Kiting Detection System	0	0.765465	9.83E-05	0	0.234387	0
SFT-Calculators	0	0	1	0	0	0
Integrated Profitability Management System (EFIP)	0.257836	0	0	0	0	0

Appendix B DEA Results

Application Name	Efficient Peers					
	CRIBS Savings (Replaced by 284)	Tracing	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
National Trust Back Office	0	0.288128	5.38E-02	0	0.631201	0
CIBC Information Warehouse	0	0.856976	0.409788	0	0	0
WINFAST (Replacing Lending Advisor)	0	0	0.21072	1.82E-02	0	0
GASPER4	0	0	0.41797	0	0.709386	0
Electronic Banking PC/Internet	0	0.531818	0	0	0	0
GST Input Collection & Calc/Decalc	0	0.12352	5.63E-02	0	0.792005	0
CIBC Online (SCC-MVS)	0	0.25454	6.62E-02	0	0.646139	0
Client Mgmt. System	0	0	7.65E-02	0	0.838383	0
BASE24 Remote Banking	0	0	0	0	0	0
COINS - Com Facil	0	1.193727	0	0	0.306273	0
Deposit Acceleration (Replacing Part of 26)	0	0.747264	4.18E-03	0	0.746465	0
415 Statistics (Replacing Part of 26)	0	1.076471	0	0	0.423529	0
Statement on COM (Replacing Part of 26)	0	0.889091	0	0	0.610909	0
RDS	0	0	1.24E-02	0	0.607643	0
ICBS (International Comprehensive Banking System)	0	0	2.70E-17	1	0	0
Financial Model System	0	0	0	0	1	0
Secret Code Selectors	0	0	1.96E-02	0	0.416069	0

Application Name	Efficient Peers					
	CRIBS Savings (Replaced by 284)	Tracing	SFT-Calculators	ICBS (International Comprehensive Banking System)	Financial Model System	Collections-Property Administration
Credit Data Warehouse (Previously Part of PIF)	0	0.582043	0	0	0.417957	0
Collections-Property Administration	0	0	1.49E-19	0	0	1
Collections-Auto-IBP Replacement	0	0.782578	2.50E-03	0	0.713665	0
T4RIF Printing	0	0.836478	0	0	0.163522	0
GIS TXN Conf Printing	0	0.201646	0	0	0.798354	0
CIBC Workflow	0	0	0	0	1.475865	0

Appendix C *Comparisons between Estimated and Actual Data*

The comparison between the estimated and actual data on the first two levels of the projects is given here. The VRS results are also shown here.

Appendix C Comparisons between Estimated Data and Actual Data

Application Name	Estimated VRS score	Actual VRS score	Estimated FTE (in dollars) in Level 1&2	Estimated Source Lines	Estimated Duration Level 1&2	Actual FTE (in dollars) in Level 1&2	Actual Source Lines	Actual Duration level 1 & 2
Rapidtrans	0.20015	0.232407	194497.2	150000	311.65	194497.2	150000	311.65
Branch Clearing	1	1	5589	83000	189.175	16767	83000	137.425
US Dollar Float	0.185876	0.210338	92777.4	65000	374.325	83835	65000	419.75
DACS/GL	0.334842	0.402904	32416.2	16743	167.9	31298.4	16743	120.75
Geographical Distribution	1	0.775129	5589	17000	143.175	11178	17000	91.425
General Clearing	0.615948	0.587636	11178	3000	121.9	11178	3000	109.25
RRSP	0.133005	0.151559	325279.8	180000	517.5	385641	180000	525.55
IMS COLT	0.89462	1	748926	1244000	335.8	270507.6	1244000	335.8
Cage II Control	1	0.260015	32416.2	34640	34.5	43594.2	34640	310.5
Branch Details	0.21017	0.277205	67068	14000	165.025	116251.2	14000	143.175
Portfolio Manager	0.32875	0.335976	33534	12000	147.2	33534	12000	147.2
Deposit Account (STB)	0.224823	0.304274	191143.8	103500	220.8	140842.8	103500	201.25
Invest Products System	0.823511	1	354342.6	1550000	448.5	406879.2	1550000	456.55
CDIC Prem Reduct	0.279128	0.347271	52536.6	10880	120.75	38005.2	10880	112.125
NISA	0.59349	0.642293	16767	35000	148.925	14531.4	35000	143.75
Mutual Funds Order Entry & Transfer System (MOTE)	0.110052	0.114836	148667.4	42000	414	166552.2	42000	422.05
Tracing	0.77288	0.4287	22356	14197	43.7	17884.8	14197	169.05
C/A Bulk Filing	0.298557	0.416902	134136	50281	127.075	111780	50281	116.15
GMAC	1	0.87257	5589	1303	85.1	5589	1303	85.1
Kiting Detection System	0.476643	0.400764	20120.4	13280	131.675	27945	13280	128.8
National Trust Back Office	0.268489	0.279428	55890	48049	241.5	43594.2	48049	339.25
New Mellon Bank Interface System (Replacing 75 & 270)	0.121951	0.0693	45829.8	10000	893.55	122958	10000	893.55
Consolidated Bill Payment	0.791426	0.669869	17884.8	46120	87.4	17884.8	46120	139.15
CIBC Online (SCC-MVS)	0.229466	0.253223	68185.8	56425	309.35	68185.8	56425	309.35
Deposit Acceleration (Replacing Part of 26)	0.307253	0.39708	95013	21000	109.25	33534	21000	127.65
415 Statistics (Replacing Part of 26)	0.324077	0.382043	95013	7000	100.625	33534	7000	99.475

Appendix C Comparisons between Estimated Data and Actual Data

Application Name	Estimated VRS score	Actual VRS score	Estimated FTE (in dollars) in Level 1&2	Estimated Source Lines	Estimated Duration Level 1&2	Actual FTE (in dollars) in Level 1&2	Actual Source Lines	Actual Duration level 1 & 2
Statement on COM (Replacing Part of 26)	0.312266	0.384463	95013	8000	104.65	33534	8000	99.475

Appendix D *Refined DEA Results*

After size division, we got the refined DEA results. They are presented here.

Appendix D Refined DEA Results

I. Refined DEA results for the first two levels (estimated data)

a. VRS results of small project

Application Name	FTE in level 1and 2	Duration	Source Lines	Score	Efficient Peers					
					Inter Branch Banking	General Clearing	Corporate Credit Processing (CCP)	GMAC	Statement on COM (Replacing Part of 26)	CIBC Wood Gundy Securities Operations
Inter Branch Banking	167670	106	9804	1	1	0	0	0	1.22E-16	8.78E-16
General Clearing	11178	122	3000	1	0	1	0	0	0	0
Corporate Credit Processing (CCP)	44712	449	9954	1	0	0	1	0	8.67E-19	0
GMAC	5589	85	1303	1	0	0	0	1	0	4.05E-17
Statement Reprint System	11178	414	2600	0.8821	0	0.76429	0	0.2357	0	0
415 Statistics (Replacing Part of 26)	95013	101	7000	0.9221	8.95E-02	0	0	0	0.744522	0.165934
Statement on COM (Replacing Part of 26)	95013	105	8000	1	0	7.02E-16	0	0	1	3.10E-17
CIBC Wood Gundy Securities Operations	11178	32	1000	1	0	0	0	0	0	1

b. CRS results of the small projects

Application Name	FTE in level 1and 2	Duration	Source Lines	Score	Efficient Peers		
					Inter Branch Banking	General Clearing	Statement on COM (Replacing Part of 26)
Inter Branch Banking	167670	106	9804	1	1	0	0
General Clearing	11178	122	3000	1	0	1	0
Corporate Credit Processing (CCP)	44712	449	9954	0.8835879	0	3.2190963	3.71E-02
GMAC	5589	85	1303	0.8686667	0	0.4343333	0
Statement Reprint System	11178	414	2600	0.8666667	0	0.8666667	0
415 Statistics (Replacing Part of 26)	95013	101	7000	0.899944	4.63E-02	0	0.8183076
Statement on COM (Replacing Part of 26)	95013	105	8000	1	0	6.61E-17	1
CIBC Wood Gundy Securities Operations	11178	32	1000	0.7605634	0	0.1380282	7.32E-02

c. VRS results of the medium projects

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers				
					Branch Clearing	Geographical Distribution	Cage II Control	Tracing	Consolidated Bill Payment
GL Data Collect	11178	70000	155	0.97816	0.6768954	0	0.0944167	0	0.2286879
Branch Clearing	5589	83000	189	1	1	0	8.67E-19	0	0
Auto 412	65950.2	22000	207	0.30154	0	8.40E-02	0.00E+00	0.678902	0.2370523
US Dollar Float	92777.4	65000	374	0.35158	0.6277916	0	0.3722084	0	0
DACS/GL	32416.2	16743	168	0.49177	0	0.36997	0	0.5827608	4.73E-02
Sundry Clearing	48065.4	36665	276	0.33526	0	0.1889939	0	0.1237821	0.6872239
Cheque Imaging	17884.8	14000	345	0.39089	0	0.9163834	0	8.36E-02	0
Portfolio Info Facility	24591.6	19525	320	0.38199	0	0.746037	0	0.1525672	0.1013958
Geographical Distribution	5589	17000	143	1	0	1	0	0	0
Cage II Control	32416.2	34640	35	1	0	0	1	6.48E-17	2.87E-17
Branch Details	67068	14000	165	3.13E-01	0	8.04E-02	0	0.9196459	0
Portfolio Manager	33534	12000	147	0.50941	0	0.3145072	0	0.6854928	0
Unclaimed Balances	11178	19500	147	0.83391	0	0.7506702	0	0.149124	0.1002059
CDIC Prem Reduct	52536.6	10880	121	0.40777	0	5.57E-02	0	0.9443312	0
NISA	16767	35000	149	0.75318	2.01E-02	0.4073528	0	0	0.5725248
Mutual Funds Order Entry & Transfer System (MOTE)	148667.4	42000	414	0.16115	2.49E-02	0	0.4389946	0	0.5360689
Tracing	22356	14197	44	1	0	3.09E-17	0	1	3.23E-17
C/A Bulk Filing	134136	50281	127	6.65E-01	0.3234285	0	0.6765715	0	0
Kiting Detection System	20120.4	13280	132	0.7024	0	0.4904566	0	0.5095434	0

Appendix D Refined DEA Results

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers				
					Branch Clearing	Geographical Distribution	Cage II Control	Tracing	Consolidated Bill Payment
National Trust Back Office	55890	48049	242	0.36022	0.1363736	0	2.70E-01	0	0.5935516
New Mellon Bank Interface System (Replacing 75 & 270)	45829.8	10000	894	0.1513	0	0.9197777	0	8.02E-02	0
GST Input Collection & Calc/Decalc	27945	49095	347	0.38514	0.3006416	0.2785941	0	0	0.4207643
Consolidated Bill Payment	17884.8	46120	87	1	0	0	7.91E-18	4.73E-17	1
CIBC Online (SCC-MVS)	68185.8	56425	309	0.33676	0.4504756	0	0.5495244	0	0
Deposit Acceleration (Replacing Part of 26)	95013	21000	109	3.27E-01	0	0	0.8664495	0.1335505	0
Credit Data Warehouse (Previously Part of PIF)	63714.6	10000	231	0.28975	0	0.2323003	0.00E+00	0.7676997	0

d. CRS results of the medium projects

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers	
					Branch Clearing	Cage II Control
GL Data Collect	11178	70000	155	0.9726523	0.7579341	0.204719
Branch Clearing	5589	83000	189	1	1	3.46E-16
Auto 412	65950.2	22000	207	0.17189	0.1283455	0.3275786
US Dollar Float	92777.4	65000	374	0.3023312	0.4547236	0.786892
DACS/GL	32416.2	16743	168	0.1845555	0.1343674	0.1613887
Sundry Clearing	48065.4	36665	276	0.2513257	0.3084118	0.3194809
Cheque Imaging	17884.8	14000	345	8.97E-02	0.1595071	2.20E-02
Portfolio Info Facility	24591.6	19525	320	0.130238	0.2090488	6.28E-02
Geographical Distribution	5589	17000	143	0.267036	0.1999952	1.16E-02
Cage II Control	32416.2	34640	35	1	0	1
Branch Details	67068	14000	165	0.1260839	6.44E-02	0.2497529
Portfolio Manager	33534	12000	147	0.1450802	8.83E-02	0.1348598
Unclaimed Balances	11178	19500	147	0.2833244	0.2092204	6.16E-02
CDIC Prem Reduct	52536.6	10880	121	0.1304595	4.62E-02	0.2034751
NISA	16767	35000	149	0.4793031	0.3428929	0.188796
Mutual Funds Order Entry & Transfer System (MOTE)	148667.4	42000	414	0.1576618	0.2200884	0.6851231
Tracing	22356	14197	44	0.4401022	4.78E-02	0.2952747
C/A Bulk Filing	134136	50281	127	0.3940805	0	1.45153
Kiting Detection System	20120.4	13280	132	0.1957145	0.117776	0.1011717
National Trust Back Office	55890	48049	242	0.3526706	0.3503427	0.5476489
New Mellon Bank Interface System (Replacing 75 & 270)	45829.8	10000	894	2.47E-02	0.1140905	1.53E-02
GST Input Collection & Calc/Decalc	27945	49095	347	0.300974	0.5206874	0.1696867
Consolidated Bill Payment	17884.8	46120	87	0.9638002	0.3596129	0.4697496
CIBC Online (SCC-MVS)	68185.8	56425	309	0.3272817	0.422941	0.6154993
Deposit Acceleration (Replacing Part of 26)	95013	21000	109	0.200098	8.88E-03	0.5849636

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers	
					Branch Clearing	Cage II Control
Credit Data Warehouse (Previously Part of PIF)	63714.6	10000	231	7.33E-02	6.51E-02	0.1327628

e. VRS results of the large projects

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers					
					CAMP Stop/Holds/etc.	Historical Results	HUMAN RESOURCES	TPSS	Bankcard	Integrated Profitability Management System (EFIP)
Rapidtrans	194497.2	150000	312	0.590435	0.8016014	0	0	0	0	0.1983986
VISA Front End	201204	128000	448	0.413013	0.9736832	0	0	0.00E+00	0	2.63E-02
Customer Profitability	188908.2	260000	242	0.756517	6.49E-01	0	0	0	0	0.3506149
CAMP Stop/Holds/ etc.	78246	244400	185	1	1.00E+00	0	0	0	0	0
Business and Farm Loans Life Insurance System	169905.6	122500	242	0.760096	0.7240328	0	0	0	0	0.2759672
RRSP	325279.8	180000	518	0.355525	0.7972261	0	0	0	0	0.2027739
Historical Results	48065.4	242733	190	1	4.21E-17	1	0	0	0	0
IMS COLT	748926	1244000	336	0.93577	0	0	0.7420561	0	0	0.2579439
HUMAN RESOURCES	223560	1520000	361	1	0	0	1	0	0	0
Deposit Account (STB)	191143.8	103500	221	0.827263	0.5668972	0	0	0	0	0.4331028
Invest Products System	354342.6	1550000	449	0.823511	0	0	0.9603896	0	3.96E-02	0
Inventory Asset Management	185554.8	120000	311	0.593103	0.8275452	0	0	0	0	0.1724548
TPSS	40240.8	200000	444	1	0	4.21E-17	0	1	0	0
Bankcard	361049.4	2277377	569	1	0.00E+00	0	9.97E-17	0	1	0
VISA -- AS/400 ImagePlus	718745.4	300000	465	0.385661	0	0	0.00E+00	0.00E+00	0	1
Integrated Profitability Management System (EFIP)	262683	450000	179	1	0	0	0	0	0	1

Appendix D Refined DEA Results

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers					
					CAMP Stop/Holds/etc.	Historical Results	HUMAN RESOURCES	TPSS	Bankcard	Integrated Profitability Management System (EFIP)
WINFAST (Replacing Lending Advisor)	527601.6	200000	656	0.279172	0.6256405	0.00E+00	0	0	0	0.3743595
EFIP Infra. - Technical Architecture	400172.4	1080000	375	0.76389	0	0	0.588785	0	0	0.411215

f. CRS results of the large projects

Application Name	FTE in level 1and 2	Source Lines	Duration	Score	Efficient Peers
					HUMAN RESOURCES
Rapidtrans	194497.2	150000	311.65	0.1143426	9.87E-02
VISA Front End	201204	128000	447.925	9.36E-02	8.42E-02
Customer Profitability	188908.2	260000	242.075	0.2551569	0.1710526
CAMP Stop/Holds/etc.	78246	244400	185.15	0.4593985	0.1607895
Business and Farm Loans Life Insurance System	169905.6	122500	241.5	0.1205044	8.06E-02
RRSP	325279.8	180000	517.5	8.26E-02	0.1184211
Historical Results	48065.4	242733	189.75	0.742757	0.1596928
IMS COLT	748926	1244000	335.8	0.8800829	0.8184211
HUMAN RESOURCES	223560	1520000	361.1	1	1
Deposit Account (STB)	191143.8	103500	220.8	0.111359	6.81E-02
Invest Products System	354342.6	1550000	448.5	0.8210189	1.0197368
Inventory Asset Management	185554.8	120000	310.5	9.51E-02	7.89E-02
TPSS	40240.8	200000	443.9	0.7309942	0.1315789
Bankcard	361049.4	2277377	569.25	0.9504205	1.4982743
VISA -- AS/400 ImagePlus	718745.4	300000	465.175	1.53E-01	1.97E-01
Integrated Profitability Management System (EFIP)	262683	450000	179.4	0.5959008	0.2960526
WINFAST (Replacing Lending Advisor)	527601.6	200000	655.5	7.25E-02	0.1315789
EFIP Infra. - Technical Architecture	400172.4	1080000	374.9	0.684372	0.7105263

II Refined DEA results for the first two levels (actual data)

a. VRS results of the small projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers		
					Software Amortization System	Wood Gundy Rapid Confirms	Statement on COM (Replacing Part of 26)
General Clearing	11178	3000	109.25	0.5876364	0.5418182	0.4581818	0
Software Amortizatio n System	11178	2000	36.8	1	1	0	0
Utility Bills	6706.8	460	93.15	0.7761768	0.4063401	0.5936599	0
GMAC	5589	1303	85.1	0.8725702	0.3736501	0.6263499	0
RICS FEE	6706.8	1200	110.4	0.6870748	0.3469388	0.6530612	0
Wood Gundy Rapid Confirms	1117.8	5500	96.6	1	1.56E-17	1	1.49E-17
415 Statistics (Replacing Part of 26)	33534	7000	99.475	0.8949904	1.67E-01	0	0.8333333
Statement on COM (Replacing Part of 26)	33534	8000	99.475	1	8.03E-17	0	1
GIS TXN Conf Printing	12295.8	2803	99.475	0.5982969	0.6201407	0.3798593	0

b. CRS results of the small projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers	
					Wood Gundy Rapid Confirms	Statement on COM (Replacing Part of 26)
General Clearing	11178	3000	109.25	0.4325581	0.3528366	0.1324248
Software Amortizatio n System	11178	2000	36.8	6.97E-01	2.72E-02	0.2313032
Utility Bills	6706.8	460	93.15	8.06E-02	6.33E-02	1.40E-02
GMAC	5589	1303	85.1	0.2516698	0.1848612	3.58E-02
RICS FEE	6706.8	1200	110.4	0.1797101	0.1743561	3.01E-02
Wood Gundy Rapid Confirms	1117.8	5500	96.6	1	1	7.59E-19
415 Statistics (Replacing Part of 26)	33534	7000	99.475	8.75E-01	0	0.875
Statement on COM (Replacing Part of 26)	33534	8000	99.475	1.00E+00	9.68E-17	1
GIS TXN Conf Printing	12295.8	2803	99.475	4.33E-01	0.2926906	0.1491502

c. VRS results of the medium projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers		
					Branch Clearing	Float	Financial Model System
Branch Clearing	16767	83000	137.425	1	1	0	0
US Dollar Float	83835	65000	419.75	0.2743667	0.7534247	0	0.2465753
DACS/GL	31298.4	16743	120.75	0.4595337	9.24E-02	0	0.9076301
Geographical Distribution	11178	17000	91.425	0.8882438	0	0.5587808	0.4412192
Account Info Facility	131900.4	69700	201.25	0.6011311	0.8178082	0	0.1821918
Cage II Control	43594.2	34640	310.5	0.2783495	0.2693298	0.245509	0.4851612
Branch Details	116251.2	14000	143.175	0.3638664	0.0547945	0	0.9452055
Portfolio Manager	33534	12000	147.2	0.337651	2.68E-02	2.20E-03	0.9710136
CDIC Prem Reduct	38005.2	10880	112.125	0.4302185	1.21E-02	0	0.9879452
NISA	14531.4	35000	143.75	0.7180949	1.48E-01	0.7014063	0.1509844
Mutual Funds Order Entry & Transfer System (MOTE)	166552.2	42000	422.05	0.2054795	0.4383562	0	0.5616438
Tracing	17884.8	14197	169.05	0.5359019	0	0.7127846	0.2872154
C/A Bulk Filing	111780	50281	116.15	0.8348106	0.5517945	0	0.4482055
Kiting Detection System	27945	13280	128.8	0.4052466	3.73E-02	0.0275869	0.9351454
National Trust Back Office	43594.2	48049	339.25	0.3026841	0.4555249	0.2364733	0.3080017
Float	8942.4	30280	108.1	1	0	1	0
New Mellon Bank Interface System (Replacing 75 & 270)	122958	10000	893.55	8.29E-02	0	0.4414951	0.5585049
Consolidated Bill Payment	17884.8	46120	139.15	0.7255973	0.4239362	0.2550619	0.3210018
CIBC Online (SCC-MVS)	68185.8	56425	309.35	0.3380029	0.6359589	0	0.3640411
Deposit Acceleration (Replacing Part of 26)	33534	21000	127.65	0.4759348	0.1506849	0	0.8493151
Financial Model System	11178	10000	47.15	1	0	0	1

d. CRS results of the medium projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers
					Branch Clearing
Branch Clearing	16767	83000	137.425	1	1
US Dollar Float	83835	65000	419.75	0.2563954	0.7831325
DACS/GL	31298.4	16743	120.75	0.2295799	0.2017229
Geographical Distribution	11178	17000	91.425	0.307873	0.2048193
Account Info Facility	131900.4	69700	201.25	0.5734355	0.839759
Cage II Control	43594.2	34640	310.5	0.1847158	0.4173494
Branch Details	116251.2	14000	143.175	0.1619006	0.1686747
Portfolio Manager	33534	12000	147.2	0.1349774	0.1445783
CDIC Prem Reduct	38005.2	10880	112.125	0.1606623	0.1310843
NISA	14531.4	35000	143.75	0.4865616	0.4216867
Mutual Funds Order Entry & Transfer System (MOTE)	166552.2	42000	422.05	0.1647681	0.5060241
Tracing	17884.8	14197	169.05	0.1603577	0.1710482
C/A Bulk Filing	111780	50281	116.15	0.7167577	0.6057952
Kiting Detection System	27945	13280	128.8	0.1707143	0.16
National Trust Back Office	43594.2	48049	339.25	0.234505	0.5789036
Float	8942.4	30280	108.1	0.6840361	0.3648193
New Mellon Bank Interface System (Replacing 75 & 270)	122958	10000	893.55	0.0185297	0.1204819
Consolidated Bill Payment	17884.8	46120	139.15	0.5487743	0.5556627
CIBC Online (SCC-MVS)	68185.8	56425	309.35	0.3020015	0.6798193
Deposit Acceleration (Replacing Part of 26)	33534	21000	127.65	0.2723868	0.253012
Financial Model System	11178	10000	47.15	0.3511607	0.1204819

e. VRS results of the large projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers		
					IMS COLT	Deposit Account (STB)	Invest Products System
Rapidtrans	194497.2	150000	311.65	0.7303564	4.08E-02	0.9592284	0
Centralized Instr	251505	226550	379.5	0.5727257	0.1078913	0.8921087	0
EFT	423646.2	1301692	524.975	0.6830148	0.8114641	0.00E+00	1.89E-01
RRSP	385641	180000	525.55	0.4001048	6.71E-02	0.9329242	0.00E+00
IMS COLT	170507.6	1244000	335.8	1	1	7.91E-18	0
Deposit Account (STB)	140842.8	103500	201.25	1	0	1	0
Invest Products System	406879.2	1550000	456.55	1	0.00E+00	0	1.00E+00

f. CRS results of the large projects

Application Name	FTE in level 1& 2	Source Lines	Duration level 1 & 2	Score	Efficient Peers
					IMS COLT
Rapidtrans	194497.2	150000	311.65	0.1299225	0.1205788
Centralized Instr	251505	226550	379.5	0.1611434	0.1821141
EFT	423646.2	1301692	524.975	0.669314	1.0463762
RRSP	385641	180000	525.55	9.25E-02	0.1446945
IMS COLT	170507.6	1244000	335.8	1	1
Deposit Account (STB)	140842.8	103500	201.25	0.1388241	8.32E-02
Invest Products System	406879.2	1550000	456.55	0.9164392	1.2459807

III Refined DEA results for the whole project

a. VRS results of the small projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers						
						Inter Branch Banking	General Clearing	Corporate Credit Processing (CCP)	RICS FEE	Statement on COM (Replacing Part of 26)	T4RIF Printing	GIS TXN Conf Printing
Inter Branch Banking	143078.4	3	9804	307	1	1	0	0.00E+00	0	1.62E-16	0.00E+00	0
General Clearing	11178	3	3000	181	1	0	1	0	0	0	0	0
Corporate Credit Processing (CCP)	44712	2	9954	449	1	0	0.00E+00	1	0	0	0	1.57E-16
Statement Reprint System	22356	2	2600	414	0.5	0	1.00E+00	0	0	0	0	0
RICS FEE	11178	2	1200	69	1	0	0	0	1	0	6.32E-17	1.22E-19
415 Statistics (Replacing Part of 26)	97248.6	3	7000	250	0.958	0	0.2	0	0	0.8	8.40E-17	0
Statement on COM (Replacing Part of 26)	87188.4	3	8000	254	1	5.58E-18	0	0.00E+00	0	1	0	2.62E-17
T4RIF Printing	22356	2	982	51.2	1	0	0	0	1.62E-17	0	1	1.60E-18
GIS TXN Conf Printing	22356	2	2803	99.5	1	0	0	0	0	0	0	1
CIBC Workflow	55890	3	99	325	0.557	0	1.00E+00	0	0	0	4.44E-16	0

b. CRS results of the small projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers						
						Inter Branch Banking	General Clearing	Corporate Credit Processing (CCP)	RICS FEE	Statement on COM (Replacing Part of 26)	T4RIF Printing	GIS TXN Conf Printing
Inter Branch Banking	143078	3	9804	307.05	1	1	0	0	0	0	0	0
General Clearing	11178	3	3000	181.125	1	0	1	0	0	0	0	1.83E-17
Corporate Credit Processing (CCP)	44712	2	9954	448.5	1	0	0	1	0	0	0	8.10E-16
Statement Reprint System	22356	2	2600	414	0.433	0.00E+00	0.86667	0	0	0	0	0
RICS FEE	11178	2	1200	69	1	0	0	0	1	0	9.62E-17	0
415 Statistics (Replacing Part of 26)	97249	3	7000	250.125	0.906	0	0	0	0	0.73653	0	0.395205
Statement on COM (Replacing Part of 26)	87188	3	8000	254.15	1	0	0	0	0	1	0	0
T4RIF Printing	22356	2	982	51.175	1	0	0	0	3.24E-16	0	1	0
GIS TXN Conf Printing	22356	2	2803	99.475	1	0	0	0	0	0	0	1
CIBC Workflow	55890	3	99	325.45	0.314	0	0	0	1.429265	0	7.07E-02	0

c. VRS results of the medium projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers				
						GL Data Collect	Cage II Control	Cheque Processing (Upgrading)	Info Capture System (Replaced by 283)	Returned Item System
GL Data Collect	16767	2	70000	154.675	1	1	0	0	0	0
Canada Savings Bonds	65950.2	3	13660	419.75	0.54117	0	0	0	9.24E-02	0
Auto 412	115133.4	2	22000	207	2.49E-01	8.39E-02	0.152539	0	0	0
DACS/GL	33534	2	16743	167.9	0.41171	9.94E-02	0	0	0	0
Cheque Imaging	22356	2	14000	345	0.48258	0	0	0	0	0
Portfolio Info Facility	33534	2	19525	320.275	0.34796	0.1130773	0	0	0	0
Geographical Distribution	11178	2	17000	143.175	0.98681	2.47E-02	0	0	0	0
Account Info Facility	315219.6	3	69700	426.075	0.48661	0.00E+00	1.09E-16	0.87741	0.12259	0.00E+00
Cage II Control	67068	2	34640	34.5	1	5.42E-20	1	0	0	0
Branch Details	247033.8	2	14000	165.025	2.24E-01	0	0.7362813	0	0	0
Unclaimed Balances	16767	2	19500	147.2	0.70157	0.1238501	0	0	0	0
CDIC Prem Reduct	79363.8	2	10880	120.75	0.35235	0	0.1254195	0	0	0
Cheque Processing (Upgrading)	122958	3	76644	224.25	1	0	0	1.00E+00	0	0
Info Capture System (Replaced by 283)	111780	3	20000	86.25	1	0	0	0	1	0
Returned Item System	55890	3	72900	480.7	1	1.22E-17	0	5.77E-18	0	1

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers				
						GL Data Collect	Cage II Control	Cheque Processing (Upgrading)	Info Capture System (Replaced by 283)	Returned Item System
Mutual Funds Order Entry & Transfer System (MOTE)	243680.4	3	42000	703.225	0.25401	0	0	0	0.404987	0
RICS	22356	3	10000	446.2	0.91015	0	0	0	0	0
Tracing	22356	2	14197	43.7	1	0	4.91E-17	0	0	0
C/A Bulk Filing	134136	3	50281	186.3	8.64E-01	0	1.29E-15	0.519604	0.460662	0
Kiting Detection System	53654.4	2	13280	131.675	0.36821	1.02E-03	0	0	0	0
National Trust Back Office	55890	2	48049	241.5	0.43589	0.5643553	0.1154077	0	0	0
Electronic Banking PC/Internet	335340	3	40000	247.25	5.46E-01	0	0	0.353082	0.646918	0
GST Input Collection & Calc/Decalc	67068	2	49095	346.725	0.31851	0.6057844	5.35E-02	0	0	0
CIBC Online (SCC-MVS)	68185.8	2	56425	309.35	0.38478	0.6931954	0.1734391	0	0	0
Client Mgmt. System	27945	3	63000	241.5	1	6.61E-18	0	0	0	0.00E+00
COINS - Com Facil	111780	3	10000	266.225	0.61968	0	0	0	0.492912	0
Deposit Acceleration (Replacing Part of 26)	84952.8	3	21000	274.275	0.67946	0	0	0	0.355183	0
RDS	45829.8	3	16500	492.2	0.57028	0	0	0	0	0
Financial Model System	11178	2	10000	63.825	1	0	0	0	0	0
Secret Code Selectors	33534	3	20000	404.225	0.74901	0	0	0	0	0

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers				
						GL Data Collect	Cage II Control	Cheque Processing (Upgrading)	Info Capture System (Replaced by 283)	Returned Item System
Credit Data Warehouse (Previously Part of PIF)	78246	2	10000	230.575	0.22601	0	0	0	0	0
Collections-Property Administration	8942.4	3	53250	653.2	1	2.01E-17	0	0	0	0
Collections-Auto-IBP Replacement	257094	3	20000	808.45	0.22829	0	0	0	0.366756	0.00E+00

Continued

Application Name	Efficient Peers			
	Tracing	Client Mgmt. System	Financial Model System	Collections-Property Administration
GL Data Collect	0	0	0	0
Canada Savings Bonds	0	0.9076118	0	0
Auto 412	0.763511	0	0	0
DACS/GL	0.18541	0	0.7151761	0
Cheque Imaging	0	0	0.8258065	0.1741935
Portfolio Info Facility	0	0	0.8235617	6.34E-02
Geographical Distribution	0	0	0.8477041	0.1276271
Account Info Facility	0	0	0	0
Cage II Control	2.06E-16	0	0	0
Branch Details	0.263719	0	0	0
Unclaimed Balances	0	0	0.8283119	4.78E-02
CDIC Prem Reduct	0.874581	0	0	0
Cheque Processing (Upgrading)	0	0	0	0

Application Name	Efficient Peers			
	Tracing	Client Mgmt. System	Financial Model System	Collections-Property Administration
Info Capture System (Replaced by 283)	0	1.44E-16	0	0
Returned Item System	0	4.38E-17	0	0
Mutual Funds Order Entry & Transfer System (MOTE)	0	0.5950128	8.10E-16	0
RICS	0	0.6001745	4.05E-16	0.3998255
Tracing	1	0	0	0
C/A Bulk Filing	0	0.0197342	0	0
Kiting Detection System	0.766897	0	0.2320806	0
National Trust Back Office	0.320237	1.62E-17	0	0
Electronic Banking PC/Internet	0	0	0	0
GST Input Collection & Calc/Decalc	0.34073	1.05E-16	0	0
CIBC Online (SCC-MVS)	0.133365	0	0	0
Client Mgmt. System	0	1	0	0
COINS - Com Facil	0	0.5070879	0	0
Deposit Acceleration (Replacing Part of 26)	0	0.6448175	4.37E-16	0
RDS	0	0.9048009	9.22E-16	0.0951991
Financial Model System	0	0	1	0
Secret Code Selectors	0	0.851186	0	0.148814
Credit Data Warehouse (Previously Part of PIF)	0.582043	0	0.4179567	0
Collections-Property Administration	0	0	0	1
Collections-Auto-IBP Replacement	0	0.6332438	3.89E-16	0

d. CRS results of the medium projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers				
						GL Data Collect	Cage II Control	Tracing	Financial Model System	Collections-Property Administration
GL Data Collect	16767	2	70000	154.675	1	1	1.36E-16	0	0	0
Canada Savings Bonds	65950.2	3	13660	419.75	0.2520923	0	0	0	1.4728818	1.81E-02
Auto 412	115133.4	2	22000	207	2.49E-01	8.39E-02	0.152539	0.7635113	0	0
DACS/GL	33534	2	16743	167.9	0.4117056	9.94E-02	0	0.18541	0.7151761	0
Cheque Imaging	22356	2	14000	345	0.4439169	0	0	0	0.7596439	0.1602374
Portfolio Info Facility	33534	2	19525	320.275	0.3391451	0.1199902	0	0	0.7888102	6.08E-02
Geographical Distribution	11178	2	17000	143.175	0.9366293	4.05E-02	0	0	0.7802956	0.119464
Account Info Facility	315219.6	3	69700	426.075	2.55E-01	0.4602659	1.0820261	0	0	0
Cage II Control	67068	2	34640	34.5	1.00E+00	2.37E-17	1	2.56E-16	0	0
Branch Details	247033.8	2	14000	165.025	0.2237613	0	0.7362813	0.2637187	0	0
Unclaimed Balances	16767	2	19500	147.2	0.6880728	0.1288863	0	0	0.8018266	0.0461914
CDIC Prem Reduct	79363.8	2	10880	120.75	3.52E-01	0	0.1254195	0.8745805	0	0
Cheque Processing (Upgrading)	122958	3	76644	224.25	0.5845084	0.64434	0.9105138	0	0	0
Info Capture System (Replaced by 283)	111780	3	20000	86.25	0.6631579	0	0.9078947	0.5921053	0	0
Returned Item System	55890	3	72900	480.7	0.3940482	0.9573287	0	0	0.5246212	1.20E-02
Mutual Funds Order Entry & Transfer System (MOTE)	243680.4	3	42000	703.225	1.46E-01	0.3394384	8.62E-02	1.0743306	0	0
RICS	22356	3	10000	446.2	0.6328257	0	0	0	0.9978245	0.3347837
Tracing	22356	2	14197	43.7	1	0	4.91E-17	1	0	0
C/A Bulk Filing	134136	3	50281	186.3	4.73E-01	0.2620563	0.7025373	0.5354063	0	0

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers				
						GL Data Collect	Cage II Control	Tracing	Financial Model System	Collections-Property Administration
Kiting Detection System	53654.4	2	13280	131.675	0.3682101	1.02E-03	0	0.7668972	0.2320806	0
National Trust Back Office	55890	2	48049	241.5	0.4358906	0.5643553	0.1154077	0.320237	0	0
Electronic Banking PC/Internet	335340	3	40000	247.25	2.29E-01	0	0.9681818	0.5318182	0	0
GST Input Collection & Calc/Decalc	67068	2	49095	346.725	0.3185085	0.6057844	5.35E-02	0.3407297	0	0
CIBC Online (SCC-MVS)	68185.8	2	56425	309.35	0.3847801	0.6931954	0.1734391	0.1333655	0	0
Client Mgmt. System	27945	3	63000	241.5	0.7496942	0.7838774	0	0	0.6781871	2.53E-02
COINS - Com Facil	111780	3	10000	266.225	0.2693727	0	0	1.1937269	0.3062731	0
Deposit Acceleration (Replacing Part of 26)	84952.8	3	21000	274.275	0.3051967	4.42E-02	0	0.7973833	0.6583936	0
RDS	45829.8	3	16500	492.2	0.3434081	0	0	0	1.3027994	0.131467
Financial Model System	11178	2	10000	63.825	1	0	0	0	1	0
Secret Code Selectors	33534	3	20000	404.225	0.4619185	0	0	0	1.2551903	0.1632065
Credit Data Warehouse (Previously Part of PIF)	78246	2	10000	230.575	2.26E-01	0	0	0.5820433	0.4179567	0
Collections-Property Administration	8942.4	3	53250	653.2	1	7.69E-17	0	0	3.66E-17	1
Collections-Auto-IBP Replacement	257094	3	20000	808.45	1.01E-01	2.64E-02	0	0.8132164	0.6603347	0

e. VRS results of the large projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers		
						IBTSS	ECIF	COINS - Op Cntrl
Project Control System	84952.8	2	110000	255.3	0.6691769	0	0	0.1378499
Bulk Filing	156492	3	152840	389.275	0.4137686	0	0	0.2618879
CLASS	1683407	3	1759400	719.9	0.6281374	0	0.00E+00	0
Centralized Instr	314101.8	3	226550	659.525	0.2353926	0	0	0.4332429
VISA Front End	178848	3	128000	499.675	0.3345276	0	0	0.1846389
PCA/Savings	690800.4	3	297390	458.275	2.58E-01	0	0	8.76E-02
IBTSS	908771.4	3	2301000	659.525	1	1	0	0.00E+00
Customer Profitability	190026	2	260000	242.075	0.5354479	0	0	0.7647948
Business and Farm Loans Life Insurance System	413586	2	122500	241.5	3.79E-01	0	0	0.6645438
Foreign Exchange	413586	3	456000	610.075	0.2790437	0.00E+00	0	9.74E-02
RRSP	479536.2	3	180000	806.725	0.1734624	0	0	5.59E-01
Historical Results	109544.4	2	242733	189.75	0.7637242	0	0	0.5941805
IDT Systems	570078	3	137000	619.85	0.1820266	0	0	0.8742727
ECIF	950130	3	1000000	249.55	1	0	1	0
IMS COLT	479536.2	3	1244000	556.6	0.6933606	0.3347674	0	0
Loan Accounting System	614790	3	146765	834.325	0.1512303	0	0.00E+00	0.7048533
COINS - Op Cntrl	111780	3	152800	102.925	1	0	0	1
HUMAN RESOURCES	760104	2	1520000	361.1	1	0	0	0
POS Merchant	558900	3	150000	858.475	0.1556175	0	0.00E+00	0.6106796
Deposit Account (STB)	377816.4	3	103500	426.075	0.2699592	0	0	0.8464249
ATM Systems-NON-TANDEM	558900	3	215000	974.05	0.1476616	0	0	0.564165

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers		
						IBTSS	ECIF	COINS - Op Cntrl
Invest Products System	743337	3	1550000	737.725	0.670239	0.5309182	0.00E+00	0
Special Debts	90541.8	3	400000	393.875	0.5166227	0	0	7.89E-02
Inventory Asset Management	182201.4	2	120000	310.5	0.4500574	0	0	0.5326204
Base 24-ATM	970250.4	3	650000	1104	0.1924036	0	0	0
Base24 POS Online	1313415	3	550000	1344.925	0.1380912	0	0	0
Acquisition Management System	225795.6	2	130000	310.5	0.4089198	0	0	0.6947685
CRIBS DDA (Replaced by 284)	447120	3	221706	172.5	0.5175986	0	0	0
CRIBS Savings (Replaced by 284)	245916	3	154535	69	1	0	0	0
West Indies Retail System (Replaced by 283)	402408	3	395000	207	6.43E-01	0	0	0
West Indies General Ledger (Replaced by 287)	223560	3	127049	86.25	0.9187919	0	0	0.3020134
Centralized Rates	48065.4	3	171853	181.7	1	0	0	0
PMDB (Portfolio Management Data Base)	1159159	3	159000	688.275	1.35E-01	0	0	0.6507666
CSP (Cardholder Service Platform)	111780	3	225000	810.175	0.3023342	0	0	0
Clearing	357696	3	463050	519.8	0.3293738	0	0	5.92E-02
Bankcard	1633106	3	2277377	621	1	1.51E-16	0	0.00E+00
Collection (TCS Year 2000 Upgrade)	1542564	3	1000000	792.35	0.3347254	0	0	0

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	duration	Score	Efficient Peers		
						IBTSS	ECIF	COINS - Op Cntrl
Merchant System	1509030	3	412000	489.325	2.58E-01	0	0.1407721	0
SFT-Calculators	33534	3	700000	246.1	1	0	0	0
Integrated Profitability Management System (EFIP)	675151.2	2	450000	179.4	7.36E-01	0	0.3494704	0
CIBC Information Warehouse	55890	3	300000	223.675	0.8624011	0	0	5.79E-02
WINFAST (Replacing Lending Advisor)	514188	2	200000	655.5	0.1896902	0	0	0.7951444
GASPER4	111780	3	300000	810.175	0.3023342	0	0	0.00E+00
BASE24 Remote Banking	1922616	3	1626000	566.95	0.7220519	0	0.0143859	0
ICBS (International Comprehensive Banking System)	726570	3	1635137	411.7	1	0	0	0

Continued

Application Name	Efficient Peers					
	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)
Project Control System	0	0	0.8621501	0	0	0
Bulk Filing	0	0	0.7381121	0	0	0
CLASS	0	0	0	0.1934837	0	0.8065163
Centralized Instr	0	0	0.4475638	0	0.1191933	0
VISA Front End	0	0	0.8153611	0	0	0
PCA/Savings	0	0.6501995	0	0	0.2621745	0
IBTSS	0	0	0	0	3.71E-17	0
Customer Profitability	0	3.94E-02	0	0	0.1957814	0
Business and Farm Loans Life Insurance System	0	0.3354562	0	0	0	0
Foreign Exchange	0	0.3496259	0	0	0.552985	0
RRSP	0	0	0.405132	0	3.56E-02	0
Historical Results	0	0	0.2501792	0	0.1556402	0
IDT Systems	0	0	0.1257273	0	0	0
ECIF	0	0	0	0	0	0
IMS COLT	0	0	0	0	0.6566377	8.59E-03
Loan Accounting System	0	0	0.2951467	0	0	0
COINS - Op Cntrl	0	7.47E-17	0	0	0	0
HUMAN RESOURCES	1	0	0	0	2.37E-19	5.15E-17
POS Merchant	0	0	0.3893204	0	0	0
Deposit Account (STB)	0	0	0.1535751	0	0	0
ATM Systems-NON-TANDEM	0	0	0.3337876	0	0.1020474	0
Invest Products System	0	0	0	0	0.4690818	0
Special Debts	0	0	0.4862438	0	0.4348238	0
Inventory Asset Management	0	0	0.4673796	0	0	0
Base 24-ATM	1.40E-17	0.3084525	0	0	0.5650954	0.1264521

Appendix D Refined DEA Results

Application Name	Efficient Peers					
	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)
Base24 POS Online	0	0.4200301	0	0	0.4953709	8.46E-02
Acquisition Management System	0	0	0.3052315	0	0	0
CRIBS DDA (Replaced by 284)	0	0.8957751	0	0	9.32E-02	0.0110358
CRIBS Savings (Replaced by 284)	0	1	0	0	0	0
West Indies Retail System (Replaced by 283)	0	0.7319882	0	0	0.1671989	0.1008129
West Indies General Ledger (Replaced by 287)	0	0.6979866	0	0	0	0
Centralized Rates	0	0	1	0	0	0
PMDB (Portfolio Management Data Base)	0	0.3389778	0	0	1.03E-02	0
CSP (Cardholder Service Platform)	0	0	1.80E-02	0	0.9820442	0
Clearing	0	0.3750399	0	0	0.5657882	0
Bankcard	4.48E-16	0	0	1	0	0
Collection (TCS Year 2000 Upgrade)	6.23E-17	0.4224083	0	0	1.04E-02	0.5671992
Merchant System	0	0.7657206	0	0	0	9.35E-02
SFT-Calculators	5.68E-17	0	0	0	1	0
Integrated Profitability Management System (EFIP)	0	0.6505296	0	0	0	0
CIBC Information Warehouse	0	0	0.6973548	0	0.2447246	0

Appendix D Refined DEA Results

Application Name	Efficient Peers					
	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	Bankcard	SFT-Calculators	ICBS (International Comprehensive Banking System)
WINFAST (Replacing Lending Advisor)	0	0	0.1228768	0	8.20E-02	0
GASPER4	0	0	1.80E-02	0	0.9820442	0
BASE24 Remote Banking	0	0	0	0	0	0.9856141
ICBS (International Comprehensive Banking System)	0	0	0	0	0	1

f. CRS results of the large projects

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers						
						ECIF	COINS - Op Cntrl	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	SFT-Calculators	ICBS (International Comprehensive Banking System)
Project Control System	84952.8	2	110000	255	0.446118	0	0.0919	0	0	0.574767	0	0
Bulk Filing	156492	3	152840	389	0.4137686	0	0.261888	0	0	0.738112	0	0
CLASS	1683407	3	1759400	720	5.89E-01	0.20427	0	1.010718	0.12192	0	0	0
Centralized Instr	314102	3	226550	660	0.2353926	0	0.433243	0	0	0.447564	0.119193	0
VISA Front End	178848	3	128000	500	0.3345276	0	0.184639	0	0	0.815361	0	0
PCA/Savings	690800	3	297390	458	2.58E-01	0	8.76E-02	0	0.6502	0	0.262175	0
IBTSS	908771	3	2301000	660	0.9415991	0	0	1.084652	0	0	0.931899	0
Customer Profitability	190026	2	260000	242	0.4240679	0	0.164969	0	0.213388	0	0.28831	0
Business and Farm Loans Life Insurance System	413586	2	122500	242	2.66E-01	0	0.344307	0	0.285558	0	3.68E-02	0
Foreign Exchange	413586	3	456000	610	0.2790437	0	9.74E-02	0	0.349626	0	0.552985	0
RRSP	479536	3	180000	807	0.1734624	0	0.559267	0	0	0.405132	3.56E-02	0
Historical Results	109544	2	242733	190	0.5482072	0	0.367132	0	4.22E-02	0	0.257297	0
IDT Systems	570078	3	137000	620	0.1820266	0	0.874273	0	0	0.125727	0	0
ECIF	950130	3	1000000	250	1.00E+00	1	0	0	4.63E-17	0	0	0
IMS COLT	479536	3	1244000	557	0.6677133	0	0	0.379169	0	0	0.953805	0
Loan Accounting System	614790	3	146765	834	0.1512303	0	0.704853	0	0	0.295147	0	0
COINS - Op Cntrl	111780	3	152800	103	1	0	1	0	7.47E-17	0	0	0
HUMAN RESOURCES	760104	2	1520000	361	1.00E+00	0	0	1	0	0	7.68E-17	0

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers						
						ECIF	COINS - Op Cntrl	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	SFT-Calculators	ICBS (International Comprehensive Banking System)
POS Merchant	558900	3	150000	858	0.1556175	0	0.61068	0	0	0.38932	0	0
Deposit Account (STB)	377816	3	103500	426	0.2699592	0	0.846425	0	0	0.153575	0	0
ATM Systems-NON-TANDEM	558900	3	215000	974	0.1476616	0	0.564165	0	0	0.333788	0.102047	0
Invest Products System	743337	3	1550000	738	0.6092637	0	0	0.550911	0	0	1.018021	0
Special Debts	90541.8	3	400000	394	0.5166227	0	7.89E-02	0	0	0.486244	0.434824	0
Inventory Asset Management	182201	2	120000	311	0.3020747	0	0.366263	0	0	0.276907	2.35E-02	0
Base 24-ATM	970250	3	650000	1104	0.1924036	0	0	0	0.308453	0	0.565095	0.126452
Base24 POS Online	1313415	3	550000	1345	0.1380912	0	0	0	0.42003	0	0.495371	8.46E-02
Acquisition Management System	225796	2	130000	311	0.2762972	0	0.486904	0	0	0.132979	4.68E-02	0
CRIBS DDA (Replaced by 284)	447120	3	221706	173	0.5175986	0	0	0	0.895775	0	0.093189	1.10E-02
CRIBS Savings (Replaced by 284)	245916	3	154535	69	1	0	0	0	1	0	0	0
West Indies Retail System (Replaced by 283)	402408	3	395000	207	6.43E-01	0	0	0	0.731988	0	0.167199	0.100813
West Indies General Ledger (Replaced by 287)	223560	3	127049	86.3	0.9187919	0	0.302013	0	0.697987	0	0	0
Centralized Rates	48065.4	3	171853	182	1	0	0	0	0	1	0	0

Appendix D Refined DEA Results

Application Name	FTE	Target Level	Source Lines	Duration	Score	Efficient Peers						
						ECIF	COINS - Op Cntrl	HUMAN RESOURCES	CRIBS Savings (Replaced by 284)	Centralized Rates	SFT-Calculators	ICBS (International Comprehensive Banking System)
PMDB (Portfolio Management Data Base)	1159159	3	159000	688	1.35E-01	0	0.650767	0	0.338978	0	1.03E-02	0
CSP (Cardholder Service Platform)	111780	3	225000	810	0.3023342	0	0	0	0	1.80E-02	0.982044	0
Clearing	357696	3	463050	520	0.3293738	0	5.92E-02	0	0.37504	0	0.565788	0
Bankcard	1633106	3	2277377	621	8.71E-01	2.05E-03	0	1.496926	0	0	0	0
Collection (TCS Year 2000 Upgrade)	1542564	3	1000000	792	3.35E-01	0	0	0	0.422408	0	1.04E-02	0.567199
Merchant System	1509030	3	412000	489	2.57E-01	9.45E-02	0	0.125302	0.821944	0	0	0
SFT-Calculators	33534	3	700000	246	1	0	0	0	1.21E-18	0	1	0
Integrated Profitability Management System (EFIP)	675151	2	450000	179	0.6695466	0.4078	0	1.55E-03	0.257836	0	0	0
CIBC Information Warehouse	55890	3	300000	224	0.8624011	0	5.79E-02	0	0	0.697355	0.244725	0
WINFAST (Replacing Lending Advisor)	514188	2	200000	656	0.1394684	0	0.404062	0	8.35E-02	0	0.179072	0
GASPER4	111780	3	300000	810	0.3023342	0	0	0	0	1.80E-02	0.982044	0
BASE24 Remote Banking	1922616	3	1626000	567	0.6921336	0.51094	0	0.733594	0	0	0	0
ICBS (International Comprehensive Banking System)	726570	3	1635137	412	1	0	0	6.25E-17	0	0	2.70E-17	1

APPENDIX E *Raw Data of Software Projects*

The original data of the software projects are presented here. The subset used in our analysis is shown, along with the information that was used to conduct to the DEA analysis.

Appendix E *Raw Data of Software Projects*

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
1	GL Data Collect	70000	0.05	0.05	0	0
2	Canada Savings Bonds	13660	0	0.51	0.31	0
3	Rapidtrans	150000	0.1	1.64	0	0
4	Plan Data Analysis	20000	0	0	0	0
5	Project Control System	110000	0.1	0.4	0	0
6	Letters of Credit (Replaced by 281)	2250000	0	0.01	0.01	0
7	EDI/NETPAY	40000	0.3	0.63	0.14	0
8	General Analysis	20000	0	0	0	0
9	Position of Account	73800	0	1	0.72	0
10	Account Recon	150000	0.1	0.91	0.13	0
11	AutoRIL: Ret of Irr Liabilities	576000	0	1	0.47	0
12	Inter Branch Banking	9804	0	1.5	0.11	0
13	Branch Clearing	83000	0	0.05	0	0
14	Bulk Filing	152840	0	1.7	0.09	0
15	Fix Assets & Payment Processing	1501500	0	0.75	3.83	0
16	Auto 412	22000	0	0.59	0.22	0
17	GINI	0	0	0	0	0
18	CLASS	1759400	0	6.5	3.78	0
19	US Dollar Float	65000	0.1	0.73	0	0
20	Cash Flow Mgmt	570000	0.1	2.27	0	0
21	DACS/GL	16743	0	0	0.29	0
22	Centralized Instr	226550	0	2.33	0.3	0
24	VISA Front End	128000	0	1.3	0.5	0
25	Sundry Clearing	36665	0	0	0.43	0
26	DDA	221200	0	1.4	0	0
27	PCA/Savings	297390	0	5.33	0.91	0
29	Cheque Imaging	14000	0	0	0.16	0
30	IBTSS	2301000	0.2	2.5	0.42	0
31	EFT	1301692	0.4	2.8	0.17	0
32	Customer Profitability	260000	0	0.94	0.75	0
33	CAMP Stop/Holds/etc.	244400	0	0.7	0	0
34	Portfolio Info Facility	19525	0	0.15	0.07	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
35	Business and Farm Loans Life Insurance System	122500	0	0	1.52	0
36	Foreign Exchange	456000	0	1.04	1.68	0
39	Geographical Distribution	17000	0	0.05	0	0
40	Autom Branch GL	360438	0	1.81	2.22	0
41	General Clearing	3000	0	0.1	0	0
43	GST Reporting	56000	0	0	0	0
44	RRSP	180000	0.35	2.56	0.69	0
45	COINS - Host Facilities	176500	2	1.2	0	0
46	PEGA Investigations	8645	0.1	0	0	0
48	Historical Results	242733	0	0.43	0	0
49	IDT Systems	137000	0.7	0.9	0	0
50	Lending Advisor (Replaced by 291)	0	0	0	0	0
51	HMIS (306)	200000	0	0	0	0
52	ECIF	1000000	0	5.5	2	0
53	Account Info Facility	69700	0	2.68	0.31	0
54	Tor Expense Anal	100000	0	0	0	0
56	Tor Geogr Distr	0	0	0	0	0
57	Lock Box - Xerox	2177	0	0.1	0	0
58	IMS COLT	1244000	2	4.7	0.7	0
59	Tor Branch Clear	0	0	0	0	0
60	Loan Accounting System	146765	0	4.5	0.59	0
61	Audit Req System	100000	0	0	0	0
62	Cage II Control	34640	0	0	0.29	0
63	Branch Details	14000	0	0.6	0.3	0
64	Mechanical Equipment	25023	0	0	0	0
65	Mortgage Loans (Replaced by 277)	395843	0	0	0	0
66	Marketing Info Facil	25000	0	0	0.72	0
67	Portfolio Manager	12000	0	0.3	0	0
69	Audit Info System	0	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
70	Perf Binder Reptg	45000	0	0	0	0
71	COINS - Op Cntrl	152800	0	0.5	0.25	0
72	Pre-Auth Cheques	32842	0	0	0	0
73	HUMAN RESOURCES	1520000	0	2	0	0
74	POS Merchant	150000	0	3	0.4	0
75	Securities Safekeeping/SM AC (Replaced by 278)	300000	0	0	0.21	0
76	Deposit Account (STB)	103500	0	1.71	0.44	0
78	ATM Systems-NON-TANDEM	215000	0	3	0.66	0
79	Unclaimed Balances	19500	0.05	0.05	0	0
80	Unissuable Notes	0	0	0	0	0
81	Vector 10	125535	0	0	0	0
82	Invest Products System	1550000	0.3	2.87	2.02	0
83	CDIC Prem Reduct	10880	0	0.47	0.17	0
84	Code Control System	115000	0	0	0	0
85	FACTS	382000	0	0	0	0
86	MIF Info Facility	12531	0	0	0.72	0
87	Special Debts	400000	0	0.4	0.17	0
88	Planning & Forecast	215000	0	0	0.37	0
89	Inventory Asset Management	120000	0	0	1.66	0
90	Accrual Accounting System	45000	0	0	0	0
91	Software Amortization System	2000	0	0	0	0
92	IWS	3000000	0	0.11	0.19	0
93	Base 24-ATM	650000	0	2.5	1.27	0
94	Base24 POS Online	550000	0	2.5	3.7	0
96	Integrated Cardholder Authorization File	100000	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
97	COINS-ICF	500000	0	0.4	0	0
98	Catalyst	1000	0	0	0	0
99	Backup & Restore	2000	0	0	0	0
100	Desktop Install	2000	0	0	0	0
101	Branch Platform Workstation Desktop	2000	0	0	0	0
102	File Copy Utility	300	0	0	0	0
103	Commcash II	39523	0	0	0	0
104	CBEC Controller (Being Replaced)	30008	0	0	0	0
105	TPSS	200000	0	0.16	0.2	0
107	Infoman/Computerland Link	3000	0	0	0	0
111	CIBC Install Program	2000	0	0	0	0
113	Auto Safety Deposit Box	4000	0	0	0	0
114	RIO Commission	6000	0	0	0	0
115	NISA	35000	0	0.15	0	0
117	VOSTRO Account Analysis System	60000	0	0	0	0
118	Sales Management System	25000	0	0	0	0
119	Acquisition Management System	130000	0	0	0	0
120	Issues & Opportunities Tracking System	10000	0	0	0	0
121	Link-up Registration	50000	0	0	0	0
125	Cheque Processing (Upgrading)	76644	0	1	0.1	0
126	CRIBS DDA (Replaced by 284)	221706	0	0	0	0
127	Info Capture System (Replaced by 283)	20000	0	0	0	0
128	Interface (Replaced by 284)	60000	0	0	0	0.2

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
129	Plastic Card	80000	0	0	0	0
130	CRIBS Savings (Replaced by 284)	154535	0	0	0	0.2
131	West Indies Retail System (Replaced by 283)	395000	0	0	0	0.6
132	West Indies General Ledger (Replaced by 287)	127049	0	0	0	0
133	Schedule Exec Lib	0	0	0	0	0
134	Inspection (Misc.)	0	0	0	0	0
135	SIN Data Capture	0	0	0	0	0
136	Computer Based Training	0	0	0	0	0
138	PAC2/TRS/WINGS	0	0	0	0	0
139	Payroll - Comcheq (Replaced by 279)	80000	0	0	0	0
140	BUNDL	0	0	0	0	0
141	Telephone Banking IVR	172000	0	0	0	0
145	Corporate Credit Processing (CCP)	9954	0	0.4	0	0
147	EFIP Infrastructure - Bridges	500000	0	0	3.58	0
148	CIBC Securities Mote/Discount Brokerage IVR	150000	0	0	0	0
150	Prod Mgmt (MIF)/Corp Delvry	0	0	0	0	0
152	Centralized Rates	171853	0	0	0.12	0
153	Custm Delvry Platform (EDS)	153000	0	0	0	0
154	Disbursement Services	0	0	0	0	0
155	AIS	0	0	0	0	0
156	System W Applications	500000	0	0	0	0
157	CIF Private banking	0	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
158	PAXUS-Prop & Caslty	3000000	0	0	0	0
159	Precious Metals	0	0	0	0	0
160	Branch Productivity	0	0	0	0	0
162	Autom Remittance Process	0	0	0	0	0
164	Gifts	0	0	0	0	0
165	PAXUS - Life	3000000	0	0	0	0
166	Country Limits	0	0	0	0	0
167	Returned Item System	72900	0	0	0.1	0
168	Payroll (Core)	0	0	0	0	0
170	Payroll Input PTI	0	0	0	0	0
171	IATS	0	0	0	0	0
172	Utility Bills	460	0	0.06	0	0
173	Mutual Funds Order Entry & Transfer System (MOTE)	42000	0	1.33	0.42	0
174	Downline Load	0	0	0	0	0
175	PMDB (Portfolio Management Data Base)	159000	0	3	2.79	0
176	Auto Billing	73800	0	0	0	0
177	Branch LAN	0	0	0	0	0
179	Email	0	0	0	0	0
180	Telephone Banking -Batch	144000	0	0	0	0
181	CSP (Cardholder Service Platform)	225000	0	0	0.34	0
187	PMR	0	0	0	0	0
189	IBIS 412	0	0	0	0	0
191	MICS Job Accounting-Reporting	187200	0	0	0	0
193	Safety Deposit Box	0	0	0	0	0
194	Clearing	463050	0	0.2	1.22	0
195	RICS	10000	0	0	0.1	0
196	Tracing	14197	0	0	0.2	0
202	Consigned Cheques	0	0	0	0	0
203	Commstar	0	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
204	Bankers Acceptance (see Commstar)	0	0	0	0	0
206	CIBC Trust - MLMS	172000	0	0	0	0
208	TAL	0	0	0	0	0
209	Bankcard	2277377	0	0.2	3.03	0
211	Stock Cheque	0	0	0	0	0
214	Hot Cards (Replaced by 209)	2200	0	0	0	0
216	Performance Binder	0	0	0	0	0
217	C/A Bulk Filing	50281	0	1.2	0.1	0
219	Historical Results (CAD)	0	0	0	0	0
220	Bank Plan Loans	0	0	0	0	0
221	Dealer Plan Loans	0	0	0	0	0
222	Floor Plan	0	0	0	0	0
223	Lease Financing	0	0	0	0	0
224	HRMS	0	0	0	0	0
225	DAS Reporting	0	0	0	0	0
228	AIS	20000	0	0	0	0
229	Collection (TCS Year 2000 Upgrade)	1000000	0	9.7	4.4	0
230	PMS-Month End & On Request Reporting	267800	0	0	0	0
232	AXIS -- Life	500000	0	0	0	0
234	WIM -- Life	60000	0	0	0	0
235	Growth Savings	12000	0	0	0	0
236	Branch Resourcing Profile	18000	0	0	0	0
237	CIBC Trust - BRS	19000	0	0	0	0
238	CIBC Trust - IMGR	175000	0	0	0	0
239	CIBC Trust - TRAC - Finance	225000	0	0	0	0
240	Life -- Creditor	4000	0	0	0	0
241	Fast -- Life	0	0	0	0	0
242	GMAC	1303	0	0.05	0	0
243	VISA -- AS/400 ImagePlus	300000	0	0.3	6.13	0
244	Merchant System	412000	0	1	6.38	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
245	Statement Reprint System	2600	0	0.1	0	0
247	RICS FEE	1200	0	0	0	0
248	Kiting Detection System	13280	0	0.18	0.19	0
249	SFT-Calculators	700000	0	0.1	0	0
250	CIBC Trust -- Trust Operations Systems (TOPS)	1300000	0	0	0	0
251	VISA Customer Services IVR (PC Board)	12300	0	0.2	0	0
252	VISA Authorization IVR (PC Board)	11400	0	0.2	0	0
253	SAM -- Life	40000	0	0	0	0
254	RHOSP	0	0	0	0	0
255	Integrated Profitability Management System (EFIP)	450000	0	0	2.35	0
256	DEC - Nabnasset CTI - Telephone Banking	200000	0	0	0	0
259	ACD Accept	0	0	0	0	0
260	SACS and TLS	0	0	0	0	0
261	SPMS	1000	0	0	0	0
262	Falcon	23000	0	0	0	0
263	Consolidated Statements	33000	0	0	0	0
269	Telephone Banking Agent Desktop	200000	0	0	0	0
270	SS/SMAC - MIC Processing (Replaced by 278)	70000	0	0	0.21	0
271	Safety Deposit Box (New)	10000	0	0.24	0.12	0
272	National Trust Back Office	48049	0	0.3	0.2	0
273	CIBC Information Warehouse	300000	0	0.25	0.25	0
274	Float	30280	0	0	0	0
275	CMIS/X-Reference System	12000	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
277	New Mortgages EXCAIBUR (Replacing 65)	10000	0	0	0	0
278	New Mellon Bank Interface System (Replacing 75 & 270)	10000	0	0	0.41	0
279	New Payroll/Commch eq (Replacing 139)	0	0	0	0	0
281	Trade Innovations (Letters of Credit) (Replacing 6)	10000	0	0	1.15	0
282	OASYS System (Replacing Part of 26)	1100000	0	0	0	0
283	PS Teller (replacing 131,127)	500000	0	0	0	0
284	Int'l Comprehensive Banking System (Replacing 126,128,130)	500000	0	0	0	0
285	MONDEX	500000	0	0.75	1.14	0
286	EIS - Executive Information System	0	0	0	0	0
287	D&B Smartstreams (Replacing 132)	500000	0	0	0	0
288	ADAM	0	0	0	0	0
289	CREAM	0	0	0	0	0
290	CPM	0	0	0	0	0
291	WINFAST (Replacing Lending Advisor)	200000	0	4.5	0.22	0
292	Inspection System	0	0	0	0	0
293	Internet Site	30000	0	0	0	0
294	Wood Gundy Rapid Confirms	5500	0	0	0	0
295	GASPER4	300000	0	0	0.4	0
296	Electronic Banking PC/Internet	40000	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
297	Thin Client	0	0	0	0	0
298	EFIP Infra. GL:M	1246361	0	0	3.58	0
299	EFIP Infra. CCIS	1023000	0	0	3.58	0
300	EFIP Technical Architecture & Smartstream	1580000	0	0	3.58	0
301	GST Calc/Decalc	21055	0	0	0	0
302	GST Input Collection & Calc/Decalc	49095	0	0.25	0	0
303	Consolidated Bill Payment	46120	0	0.16	0	0
304	CIBC Online (SCC-MVS)	56425	0	0.61	0	0
305	TeleBank Predictive Dialer	10000	0	0	0	0
306	Client Mgmt. System	63000	0	0	0.25	0
307	CAMRA	0	0	0	0	0
308	Hyperion Enterprise	0	0	0	0	0
309	ORACLE Financial Applications	0	0	0	0	0
310	BASE24 Remote Banking	1626000	0	4.6	1.7	0
311	PMS-Group Bill	267800	0	0	0	0
312	PMS-Telemarketing	267800	0	0	0	0
313	PMS-Online, Daily & Weekly	267800	0	0	0	0
314	PMS-Motor Vehicle Records	267800	0	0	0	0
315	Predictive Dialer	800	0	0	0	0
316	MICS Job Accounting-Vendor Appl.	124800	0	0	0	0
317	SFT - Product Book	30000	0	0.25	0	0
318	Client Notes/ Contact History	13000	0	0.5	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
319	SFT - Relationship Admin. (Being Replaced)	10000	0	0	0	0
320	COINS - Com Facil	10000	0	0.5	0.25	0
321	Deposit Acceleration (Replacing Part of 26)	21000	0	0.85	0.01	0
322	415 Statistics (Replacing Part of 26)	7000	0	0.85	0.01	0
323	Statement on COM (Replacing Part of 26)	8000	0	0.85	0.01	0
324	Electronic Banking Data Warehouse	683000	0	0	0	0
325	RDS	16500	0	0	0.12	0
326	ICBS (International Comprehensive Banking System)	1635137	0	0	0	0
327	Mondex Card Management System	10000	0	0	0	0
328	Mondex IVR	10000	0	0	0	0
329	Financial Model System	10000	0	0	0	0
330	Direct Banking Telephone Agent Desktop	496000	0	0	0	0
331	Quality Monitoring	10000	0	0	0	0
332	Workforce Management - TCS	10000	0	0	0	0
333	CIBC Trust - SIT - Deposit	0	0	0	0	0
334	Direct Bank IVR	172000	0	0	0	0
335	HP Data Mart	90000	0	0	0	0
336	Direct Bank Workflow	0	0	0	0	0
337	Direct Bank Consolidated Statement	4500	0	0	0	0

ID	Application Name	Source Lines	FTE Planned To Date 1996	FTE Planned To Date 1997	FTE Planned To Date 1998	FTE Planned To Date 1999
338	GMAC - Demand Note	10000	0	0	0	0
339	EFIP Infra. - Technical Architecture	1080000	0	0	3.58	0
340	PS/2 Gateway	10000	0	0	0	0
341	CIBC Wood Gundy Securities Operations	1000	0	0	0.1	0
342	Inter Member Network Shared Cash Dispenser	200000	0	0	1.61	0
343	Secret Code Selectors	20000	0	0	0.11	0
344	Credit Data Warehouse (Previously Part of PIF)	10000	0	0	0.57	0
345	Collections-Property Administration	53250	0	0	0.6	0
346	Collections-Auto-IBP Replacement	20000	0	0	1.5	0
347	Collections-Recovery Management System	0	0	0	1.7	0
348	T4RIF Printing	982	0	0	0	0
349	GIS TXN Conf Printing	2803	0	0	0	0
350	POS - $2TM - MIS Reporting	150000	0	0	0.1	0
351	POS Cardholder	150	0	0	0.35	0
352	Client Access (Replacing 340)	10000	0	0	0	0
353	CIBC Workflow	99	0	0	0	0

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
1	GL Data Collect	2	01-Aug-96	16-Apr-97	02-Apr-97	16-Apr-97		
2	Canada Savings Bonds	3	16-Jun-97	10-Jul-98	06-Jul-98	02-Oct-98	06-Jul-98	26-Mar-99
3	Rapidtrans	3	01-Nov-96	31-May-97	01-Nov-96	03-Oct-97	02-Jul-98	
4	Plan Data Analysis	3						
5	Project Control System	2	01-Aug-96	30-Jul-97	01-Jul-98	26-Sep-98		
6	Letters of Credit (Replaced by 281)	0		31-Mar-99				
7	EDI/NETPAY	3	01-Aug-96	30-Jun-98	01-Nov-97	30-Jun-98	02-Jul-98	
8	General Analysis	3						
9	Position of Account	3	01-Nov-96	19-Feb-97	01-Apr-97	14-Jul-98	02-Jul-98	
10	Account Recon	3	01-Nov-96	31-Dec-97	01-Nov-96	31-May-98	02-Jul-98	
11	AutoRIL: Ret of Irr Liabilities	3	01-Nov-96	19-Feb-97	24-Mar-97	31-Jul-98	24-Apr-98	
12	Inter Branch Banking	3	06-Jan-97	02-May-97	08-Sep-97	17-Nov-97	04-May-98	23-Apr-99
13	Branch Clearing	3	01-Aug-96	04-Jun-97	08-May-97	04-Jun-97	01-Nov-98	
14	Bulk Filing	3	01-May-97	05-Sep-97	01-May-97	31-Jul-98	03-Jul-98	16-Oct-98
15	Fix Assets & Payment Processing	3	01-May-97	15-Nov-98	01-May-97	15-Nov-98	01-Dec-98	
16	Auto 412	2	06-Jan-97	07-Nov-97	08-Sep-97	07-Nov-97	02-Jul-98	
17	GINI	3						
18	CLASS	3	01-Jan-97	29-May-98	01-Nov-97	30-Aug-98	01-Dec-97	26-Feb-99
19	US Dollar Float	3	01-Nov-96	22-Aug-97	01-Nov-96	31-Oct-97	02-Jul-98	
20	Cash Flow Mgmt	3	02-Jan-97	31-Oct-97	15-Sep-97	30-Aug-98	02-Jul-98	
21	DACS/GL	2	01-Oct-97	27-Feb-98	01-Oct-97	27-Feb-98		
22	Centralized Instr	3	15-Jan-97	01-Feb-98	15-Jan-97	15-Dec-97	02-Feb-98	23-Apr-99
24	VISA Front End	3	02-Jan-97	31-Mar-98	01-Nov-97	01-Oct-98	01-Jan-99	31-Mar-99
25	Sundry Clearing	3	01-Nov-97	01-Jul-98	01-Nov-97	01-Jul-98		
26	DDA	0	29-Sep-97	01-Oct-98				
27	PCA/Savings	3	01-Jan-97	10-Oct-97	01-Jun-98	18-Sep-98	04-May-98	25-Jun-99
29	Cheque Imaging	2	01-Oct-97	01-Aug-98	01-Oct-97	01-Aug-98		
30	IBTSS	3	01-Nov-96	31-Oct-98	24-Nov-97	31-Oct-98	01-Oct-98	31-Dec-98
31	EFT	3	01-Nov-96	31-Dec-97	01-Nov-96	30-Apr-98	02-Jul-98	
32	Customer Profitability	2	01-Feb-97	19-Feb-97	01-Jun-97	14-Jul-98		
33	CAMP Stop/Holds/etc.	3	01-Jan-97	31-Jan-97	01-Jul-96	23-Apr-97		

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ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
34	Portfolio Info Facility	2	01-Nov-96	19-Feb-97	01-Apr-97	30-Jun-98		
35	Business and Farm Loans Life Insurance System	2	01-Nov-97	31-Aug-98	01-Jul-98	31-Oct-98		
36	Foreign Exchange	3	01-Jun-97	27-Nov-98	01-Jun-98	27-Nov-98	06-Jul-98	25-Jun-99
39	Geographical Distribution	2	01-Aug-96	26-Mar-97	12-Mar-97	26-Mar-97		
40	Autom Branch GL	3	01-Jul-97	30-Sep-98	14-May-98	30-Sep-98	01-Nov-98	
41	General Clearing	3	01-Jan-97	17-Apr-97	01-Jan-97	17-Apr-97	03-Jul-98	16-Oct-98
43	GST Reporting	0						
44	RRSP	3	01-May-96	01-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	25-Jun-99
45	COINS - Host Facilities	3	07-Jul-96	23-Apr-97				31-Dec-98
46	PEGA Investigations	1	01-Jul-97	31-Oct-97		31-Dec-98		
48	Historical Results	2	01-Nov-97	31-Jul-98	01-Jun-98	31-Jul-98		
49	IDT Systems	3	01-Nov-96	29-Aug-97	01-Nov-96	31-May-98	01-Jun-98	31-Dec-98
50	Lending Advisor (Replaced by 291)	0						
51	HMIS (306)	1	01-Jan-97	01-Mar-98				
52	ECIF	3	01-Jan-97	15-Nov-97	01-Jan-98	01-Apr-98	30-Nov-98	31-Dec-98
53	Account Info Facility	3	01-Jan-97	20-Aug-97	16-Jun-97	21-Nov-97	01-Jun-98	28-May-99
54	Tor Expense Anal	3						
56	Tor Geogr Distr	3						
57	Lock Box - Xerox	3	01-Nov-96	15-Jan-97	01-Nov-96			
58	IMS COLT	3	01-Jul-96	23-Apr-97	01-Jul-96	23-Apr-97	01-Jun-98	25-Jun-99
59	Tor Branch Clear	3						
60	Loan Accounting System	3	01-Jan-96	31-Oct-97	01-Mar-97	31-Jan-98	15-Nov-97	26-Feb-99
61	Audit Req System	3	01-Nov-97	01-Oct-98	01-Jun-98	01-Oct-98		
62	Cage II Control	2	01-Mar-98	31-Mar-98	01-Mar-98	31-Mar-98		
63	Branch Details	2	01-Jan-97	22-Aug-97	05-Aug-97	01-Oct-97		
64	Mechanical Equipment	0						

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
65	Mortgage Loans (Replaced by 277)	3						
66	Marketing Info Facil	3	01-Nov-96	19-Feb-97	01-Apr-97	14-Jul-98	02-Jul-98	
67	Portfolio Manager	3	01-Dec-96	09-Apr-97	01-Dec-96	09-Apr-97	02-Jul-98	
69	Audit Info System	3						
70	Perf Binder Reptg	0						
71	COINS - Op Cntrl	3	01-Jan-97	01-Feb-97	01-Jan-98	30-Apr-98	30-Nov-98	31-Dec-98
72	Pre-Auth Cheques	3						
73	HUMAN RESOURCES	2	01-Mar-97	26-Aug-98	12-Jun-98	15-Sep-98		
74	POS Merchant	3	01-Nov-96	10-Mar-98	01-Nov-96	15-May-98	01-Jan-98	01-Apr-99
75	Securities Safekeeping/SM AC (Replaced by 278)	3	01-Dec-97	01-Mar-99				
76	Deposit Account (STB)	3	01-Jan-97	20-Aug-97	16-Jun-97	21-Nov-97	01-Jun-98	28-May-99
78	ATM Systems-NON-TANDEM	3	01-Jan-97	31-May-98	01-Jan-97	15-Jun-98	01-Jan-97	31-Oct-98
79	Unclaimed Balances	2	01-Aug-96	26-Mar-97	05-Mar-97	26-Mar-97		
80	Unissuable Notes	3						
81	Vector 10	3						
82	Invest Products System	3	01-Sep-96	01-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	25-Jun-99
83	CDIC Prem Reduct	2	01-Jan-97	13-Jun-97	25-Aug-97	13-Oct-97		
84	Code Control System	3	01-Jan-98	01-Sep-98				
85	FACTS	3	01-Aug-96	13-May-97	14-May-97	01-Apr-97		
86	MIF Info Facility	3	01-Nov-96	19-Feb-97	01-Apr-97	14-Jul-98	02-Jul-98	
87	Special Debts	3	01-Nov-96	19-Feb-97	24-Mar-97	31-Oct-97	01-Nov-97	31-Oct-98
88	Planning & Forecast	1	01-Apr-97	15-Oct-98				
89	Inventory Asset Management	2	01-Apr-98	31-Dec-98	01-Apr-98	31-Dec-98		

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
90	Accrual Accounting System	0						
91	Software Amortization System	2	01-Nov-97	03-Jun-97				
92	IWS	3	31-Oct-97	31-Aug-98	31-Oct-97	31-Aug-98	01-Oct-98	
93	Base 24-ATM	3	01-Jan-97	31-Aug-98	01-Jan-97	31-Oct-98	01-Jan-97	31-Oct-98
94	Base24 POS Online	3	01-Nov-96	31-Oct-98	01-Nov-96	30-Nov-98	01-Nov-96	01-Apr-99
96	Integrated Cardholder Authorization File	3						
97	COINS-ICF	3	01-Sep-96	15-Sep-97	01-Oct-97	30-Apr-98		31-Dec-98
98	Catalyst	3	01-Nov-97	01-Oct-98				
99	Backup & Restore	3	01-Nov-97	01-Oct-98				
100	Desktop Install	3	01-Nov-97	01-Oct-98				
101	Branch Platform Workstation Desktop	3	01-Nov-97	01-Oct-98				
102	File Copy Utility	3	01-Nov-97	01-Oct-98				
103	Commcash II	0	01-Nov-96	28-Feb-97				
104	CBEC Controller (Being Replaced)	3						
105	TPSS	3	07-Apr-97	30-Sep-98	01-Feb-98	30-Sep-98		28-Feb-99
107	Infoman/Computerland Link	3						
111	CIBC Install Program	3						
113	Auto Safety Deposit Box	3						
114	RIO Commission	3	01-Nov-97	01-Oct-98				
115	NISA	3	01-Jun-97	15-Oct-97	01-Jun-97	06-Oct-97		
117	VOSTRO Account Analysis System	3						
118	Sales Management System	3						

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
119	Acquisition Management System	2	01-Feb-98	31-Dec-98	01-Jun-98	31-Dec-98		
120	Issues & Opportunities Tracking System	3						
121	Link-up Registration	3						
125	Cheque Processing (Upgrading)	3	01-Nov-97	01-Oct-98	01-Mar-98	01-Apr-98	01-Apr-98	01-May-98
126	CRIBS DDA (Replaced by 284)	3	01-Nov-97	01-Jul-98	01-Jul-98	01-Aug-98	01-Sep-98	01-Oct-98
127	Info Capture System (Replaced by 283)	3	01-Nov-97	01-Feb-98	01-Jan-98	01-Feb-98	01-Jan-98	01-Feb-98
128	Interface (Replaced by 284)	3	01-May-98	01-Oct-98	01-Oct-98	01-Nov-98	01-Nov-98	01-Dec-98
129	Plastic Card	3						
130	CRIBS Savings (Replaced by 284)	3	01-Jun-98	01-Oct-98	01-Oct-98	01-Oct-98	01-Nov-98	01-Nov-98
131	West Indies Retail System (Replaced by 283)	3	01-Jan-98	01-Dec-98	01-Sep-98	01-Sep-98	01-Nov-98	01-Dec-98
132	West Indies General Ledger (Replaced by 287)	3	01-Nov-97	01-Apr-98	01-Mar-98	01-Mar-98	01-Apr-98	01-Apr-98
133	Schedule Exec Lib	3						
134	Inspection (Misc.)	3						
135	SIN Data Capture	3						
136	Computer Based Training	3						
138	PAC2/TRS/WINGS	3						
139	Payroll - Comcheq (Replaced by 279)	3	01-Feb-97	01-Feb-97				

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140	BUNDL	3						
141	Telephone Banking IVR	3	01-Nov-97	01-Jun-98	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
145	Corporate Credit Processing (CCP)	2	01-Jul-97	31-Jul-98	01-Jul-97	31-Jul-98		
147	EFIP Infrastructure - Bridges	3	05-Jan-98	01-Nov-98	05-Jan-98	01-Nov-98	01-Dec-98	
148	CIBC Securities Mote/Discount Brokerage IVR	3	01-Nov-97	01-Oct-98				
150	Prod Mgmt (MIF)/Corp Delvry	3						
152	Centralized Rates	3	15-Dec-97	12-Jun-98	15-Dec-98	12-Jun-98	04-May-98	26-Mar-99
153	Custm Delvry Platform (EDS)	3						
154	Disbursement Services	3						
155	AIS	3						
156	System W Applications	0						
157	CIF Private banking	3						
158	PAXUS-Prop & Caslty	3	01-Jan-98	01-Jun-98				
159	Precious Metals	3						
160	Branch Productivity	3						
162	Autom Remittance Process	3						
165	PAXUS - Life	3	01-Aug-96	01-Oct-97				
166	Country Limits	3						
167	Returned Item System	3	01-Jan-98	30-Oct-98	01-Jan-98	30-Oct-98	02-Mar-98	30-Oct-98
168	Payroll (Core)	3						
170	Payroll Input PTI	3						
172	Utility Bills	2	01-Aug-98	15-Jul-97	01-Aug-98	15-Jul-97		

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173	Mutual Funds Order Entry & Transfer System (MOTE)	3	01-Nov-96	01-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	25-Jun-99
175	PMDB (Portfolio Management Data Base)	3	01-Nov-96	31-Oct-98	01-Nov-97	31-Oct-98	01-Nov-98	28-Feb-99
176	Auto Billing	3	01-Jan-97	19-Feb-97	01-Apr-97	01-Oct-98	02-Jul-98	
180	Telephone Banking -Batch	3	01-Feb-97	02-Jul-98	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
181	CSP (Cardholder Service Platform)	3	01-Nov-95	30-Jun-98	01-Jan-98	01-Jun-98	01-Jan-98	31-Oct-98
187	PMR	3						
189	IBIS 412	3						
191	MICS Job Accounting-Reporting	3	01-Aug-96	01-Jan-97		01-Jan-97		
193	Safety Deposit Box	3						
194	Clearing	3	01-Oct-97	01-Nov-98	01-Oct-97	01-Nov-98	12-Jun-98	16-Oct-98
195	RICS	3	01-Feb-98	30-Oct-98	01-Feb-98	30-Oct-98	02-Mar-98	30-Oct-98
196	Tracing	2	01-Jan-98	09-Feb-98	01-Jan-98	09-Feb-98		
202	Consigned Cheques	3						
203	Commstar	3						
204	Bankers Acceptance (see Commstar)	3						
206	CIBC Trust - MLMS	3	01-Dec-96	15-May-97				
208	TAL	3						
209	Bankcard	3	01-Mar-97	01-Oct-98	01-Nov-97	31-Dec-98	01-Jan-99	31-Mar-99
211	Stock Cheque	3						
214	Hot Cards (Replaced by 209)	3	01-Dec-96	01-Apr-97				
216	Performance Binder	3						
217	C/A Bulk Filing	3	01-Jan-97	18-Apr-97	01-Jan-97	25-Apr-97	03-Jul-98	16-Oct-98
219	Historical Results (CAD)	3						
220	Bank Plan Loans	3						

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
221	Dealer Plan Loans	3						
222	Floor Plan	3						
223	Lease Financing	3						
224	HRMS	3						
225	DAS Reporting	3						
228	AIS	3	01-Mar-98	30-Apr-98	01-Mar-98	30-Apr-98		
229	Collection (TCS Year 2000 Upgrade)	3	02-Jan-97	31-Oct-98	01-Apr-97	31-Oct-98	01-Dec-98	30-Apr-99
230	PMS-Month End & On Request Reporting	3	01-Mar-96	01-Sep-97		01-Feb-97		
232	AXIS -- Life	3	01-Aug-96	01-Oct-97				
234	WIM -- Life	3	01-Aug-96	01-Oct-97				
235	Growth Savings	0						
236	Branch Resourcing Profile	3						
237	CIBC Trust - BRS	3	01-Dec-96	15-May-97				
238	CIBC Trust - IMGR	3	01-Dec-96	01-Dec-97				
239	CIBC Trust - TRAC - Finance	3	01-Dec-96	01-Nov-97				
240	Life -- Creditor	3	01-Aug-96	01-Oct-97				
241	Fast -- Life	3	01-Aug-96	01-Oct-97				
242	GMAC	3	01-Nov-96	15-Jan-97	01-Nov-96	15-Jan-97	02-Jul-98	
243	VISA -- AS/400 ImagePlus	3	01-Feb-97	30-Sep-98	28-Feb-98	30-Sep-98		
244	Merchant System	3	01-Mar-97	31-Oct-98	31-Mar-98	31-Oct-98	19-Nov-98	30-Dec-98
245	Statement Reprint System	2	01-Aug-97	31-Jul-98	01-Aug-97	31-Jul-98		
247	RICS FEE	2	01-Feb-98	31-Mar-98	01-Feb-98	31-Mar-98		
248	Kiting Detection System	2	01-Jan-97	18-Jul-97	22-Sep-97	24-Oct-97		
249	SFT-Calculators	3	06-Jan-97	15-Feb-97	01-Sep-97	30-Jul-98	01-Jun-98	31-Jul-98
250	CIBC Trust -- Trust Operations Systems (TOPS)	3	01-Dec-96	01-Dec-98				

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
251	VISA Customer Services IVR (PC Board)	3	01-Oct-97	01-Oct-98		31-Dec-98	01-Jan-99	31-Mar-99
252	VISA Authorization IVR (PC Board)	3	01-Oct-97	01-Oct-98		31-Dec-98	01-Jan-99	31-Mar-99
253	SAM -- Life	3	01-Aug-96	01-Oct-97				
254	RHOSP	3						
255	Integrated Profitability Management System (EFIP)	2	05-Jan-98	01-Oct-98	15-Aug-98	01-Oct-98		
256	DEC - Nabnasset CTI - Telephone Banking	3	01-Jun-96	30-Jun-98	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
259	ACD Accept	3						
260	SACS and TLS	3						
261	SPMS	3						
262	Falcon	3		01-Oct-98	01-Nov-97	01-Oct-98	01-Jan-99	31-Mar-99
263	Consolidated Statements	3	01-Jan-98	01-Oct-98			30-Nov-98	31-Dec-98
269	Telephone Banking Agent Desktop	3	01-Oct-97	30-Jun-98	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
270	SS/SMAC - MIC Processing (Replaced by 278)	3	01-Dec-97	01-Mar-99				
271	Safety Deposit Box (New)	3		01-Aug-97	06-Apr-98	14-Aug-98	06-Apr-98	23-Apr-99
272	National Trust Back Office	2	01-Sep-97	31-Mar-98	01-Sep-97	31-Mar-98		
273	CIBC Information Warehouse	3	01-Feb-96	01-Oct-96	01-Jan-98	30-Apr-98	30-Nov-98	31-Dec-98
274	Float	2	01-Sep-98	17-Oct-97	01-Sep-98	17-Oct-97		
275	CMIS/X-Reference System	3	01-Nov-97	01-May-98				
277	New Mortgages EXCAIBUR (Replacing 65)	3						

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
278	New Mellon Bank Interface System (Replacing 75 & 270)	3	01-Jan-96	28-Feb-98	01-Jan-96	28-Feb-98		
279	New Payroll/Commc heq (Replacing 139)	3		01-Dec-98				
280		3						
281	Trade Innovations (Letters of Credit) (Replacing 6)	3	01-Jan-96	31-Jan-99	01-Dec-98	31-Jan-99	01-Dec-98	31-Jan-99
282	OASYS System (Replacing Part of 26)	3	02-Jul-96	31-Oct-98	01-Jun-98	31-Oct-98	01-Jun-98	25-Jun-99
283	PS Teller (replacing 131,127)	3	01-Sep-96	01-Oct-98	01-Feb-98	01-Oct-98		01-Oct-98
284	Int'l Comprehensive Banking System (Replacing 126,128,130)	3	01-Sep-96	01-Oct-98	01-Feb-98	01-Oct-98		01-Oct-98
285	MONDEX	3	01-Jun-97	30-Jun-98	01-Aug-97	01-Nov-98	01-Aug-98	01-May-99
286	EIS - Executive Information System	3						
287	D&B Smartstreams (Replacing 132)	3	01-Sep-96	01-Oct-98	01-Feb-98	01-Oct-98		01-Oct-98
288	ADAM	3						
289	CREAM	3						
290	CPM	3						
291	WINFAST (Replacing Lending Advisor)	2	01-Nov-96	01-Jun-98	01-Nov-96	01-Jun-98		
292	Inspection System	3						
293	Internet Site	3	01-Mar-98	31-Aug-98	01-Sep-98	31-Dec-98	01-Sep-98	31-Dec-98
294	Wood Gundy Rapid Confirms	3	01-Jul-97	01-Aug-97	01-Jul-97	01-Aug-97		

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
295	GASPER4	3	01-Jul-96	30-Sep-98	01-Jan-98	31-Oct-98	01-Jan-98	31-Oct-98
296	Electronic Banking PC/Internet	3	01-Jun-97	15-Aug-97	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
297	Thin Client	3						
298	EFIP Infra. GL:M	3	05-Jan-98	01-Nov-98	05-Jan-98	01-Nov-98	01-Dec-98	
299	EFIP Infra. CCIS	3	01-Jun-98	01-Nov-98	01-Jun-98	01-Nov-98	01-Dec-98	
300	EFIP Technical Architecture & Smartstream	3	05-Jan-98	01-Dec-98	15-Oct-98	01-Dec-98	01-Dec-98	
301	GST Calc/Decalc	2	15-May-97	31-May-98	14-Apr-98	31-May-98		
302	GST Input Collection & Calc/Decalc	2	15-May-97	31-Jul-98	14-May-98	31-Oct-98		
303	Consolidated Bill Payment	3	01-Mar-97	04-Apr-97	01-Jun-97	30-Sep-97	02-Jul-98	
304	CIBC Online (SCC-MVS)	2	01-Jan-97	30-Sep-97	01-Jan-97	30-Sep-97		
305	TeleBank Predictive Dialer	3						
306	Client Mgmt. System	3	01-Jan-97	31-Oct-97	01-Jan-98	01-Apr-98	30-Nov-98	31-Dec-98
307	CAMRA	3						
308	Hyperion Enterprise	3						
309	ORACLE Financial Applications	3						
310	BASE24 Remote Banking	3	01-Nov-96	31-Jul-98	01-Jul-98	31-Oct-98	01-Jul-98	27-Feb-99
311	PMS-Group Bill	3	01-Aug-96	01-Sep-96		01-Aug-96		
312	PMS-Telemarketing	3	01-Aug-96	01-Sep-96		01-Aug-96		
313	PMS-Online, Daily & Weekly	3	01-May-96	01-Jun-96		01-May-96		
314	PMS-Motor Vehicle Records	3	01-Dec-96	01-Jan-97		01-Dec-96		
315	Predictive Dialer	3	01-Nov-97	31-Mar-99	01-Nov-98	31-Mar-99	01-Nov-98	31-Mar-99

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
316	MICS Job Accounting-Vendor Appl.	3	01-Nov-97	31-Aug-98				
317	SFT - Product Book	3	01-Sep-97	30-Oct-97	03-Feb-98	28-Sep-98		30-Oct-98
318	Client Notes/ Contact History	3	01-Sep-97	30-Oct-97		28-Sep-98		30-Oct-98
319	SFT - Relationship Admin. (Being Replaced)	0	01-Nov-97	01-Dec-97				
320	COINS - Com Facil	3	01-Jan-97	15-Nov-97	01-Jan-98	30-Apr-98	30-Nov-98	31-Dec-98
321	Deposit Acceleration (Replacing Part of 26)	3	14-Apr-97	29-Aug-97	29-Aug-97	24-Oct-97	06-Jul-98	23-Apr-99
322	415 Statistics (Replacing Part of 26)	3	14-Apr-97	08-Aug-97	02-Sep-97	03-Nov-97	06-Jul-98	26-Mar-99
323	Statement on COM (Replacing Part of 26)	3	14-Apr-97	15-Aug-97	02-Sep-97	03-Nov-97	06-Jul-98	26-Mar-99
324	Electronic Banking Data Warehouse	2	01-Mar-97	31-Mar-98	01-Apr-98	31-Dec-98		
325	RDS	3	24-Nov-96	19-Dec-97	06-Apr-98	07-Aug-98	06-Apr-98	26-Mar-99
326	ICBS (International Comprehensive Banking System)	3	01-Feb-98	31-Jul-98	01-Apr-98	31-Oct-98	01-Apr-98	27-Feb-99
327	Mondex Card Management System	3	01-Nov-95	31-Oct-97	01-Feb-98	15-Jun-98	01-Nov-98	01-Jan-99
328	Mondex IVR	3	01-May-98	01-Jul-98	01-Jun-98	30-Jul-98	01-Aug-98	01-May-99
329	Financial Model System	2	01-Jun-97	23-Jun-97	01-Jun-97	30-Aug-97		
330	Direct Banking Telephone Agent Desktop	3	01-Nov-96	30-Mar-98	01-Apr-98	31-Oct-98	01-Apr-98	28-Feb-99
331	Quality Monitoring	3	01-Apr-98	31-Dec-98	01-Apr-98	31-Dec-98	01-Apr-98	31-Dec-98
332	Workforce Management - TCS	3	01-Jan-98	30-Apr-98	01-Apr-98	31-Dec-98	01-Apr-98	31-Dec-98

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
333	CIBC Trust - SIT - Deposit	3	01-Dec-96	01-Jan-98				
334	Direct Bank IVR	3	01-Nov-96	30-Mar-98	01-Apr-98	31-Oct-98	01-Jul-98	27-Feb-99
335	HP Data Mart	3	01-Sep-97	01-Aug-98	01-Nov-98	27-Feb-99		31-Oct-98
336	Direct Bank Workflow	3	01-Nov-96	31-Mar-98	01-Apr-98	31-Oct-98	01-Apr-98	27-Feb-99
337	Direct Bank Consolidated Statement	3	01-Nov-96	31-Mar-98	01-Apr-98	30-Oct-98	01-Apr-98	27-Feb-99
338	GMAC - Demand Note	3	01-Jun-97	29-Sep-97	01-Jun-97	29-Sep-97	02-Jul-98	
339	EFIP Infra. - Technical Architecture	3	05-Jan-98	01-Dec-98	05-Jan-98	01-Dec-98		
340	PS/2 Gateway	3						
341	CIBC Wood Gundy Securities Operations	3	01-Nov-97	01-Nov-97	02-Jan-98	28-Feb-98		
342	Inter Member Network Shared Cash Dispenser	3	01-Nov-97	15-Oct-98	01-Dec-97	31-Oct-98	01-Dec-97	########
343	Secret Code Selectors	3	01-Dec-97	15-Jun-98	01-Dec-97	30-May-98	01-Dec-97	31-Oct-98
344	Credit Data Warehouse (Previously Part of PIF)	2	25-Nov-97	01-Jun-98	25-Nov-97	30-Jun-98		
345	Collections-Property Administration	3	02-Jan-97	30-Jun-98	01-Apr-97	30-Jun-98	01-Dec-98	30-Apr-99
346	Collections-Auto-IBP Replacement	3	02-Jan-97	15-Nov-98	01-Apr-97	15-Nov-98	01-Dec-98	30-Apr-99
347	Collections-Recovery Management System	3	01-Mar-98	30-Jun-98	01-Mar-98	30-Jun-98	01-Dec-98	30-Apr-99
348	T4RIF Printing	2	01-Dec-97	19-Dec-97	02-Jan-98	13-Mar-98		
349	GIS TXN Conf Printing	2	01-Dec-97	13-Mar-98	02-Jan-98	13-Mar-98		
350	POS - $2TM - MIS Reporting	3	01-Nov-96	31-Oct-98	01-Nov-96	30-Nov-98	01-Jan-98	28-Feb-99
351	POS Cardholder	3	01-Nov-96	10-Mar-98	01-Nov-96	15-May-98	01-Jan-98	01-Apr-99

Appendix E *Raw Data of Software Projects*

ID	Application Name	Target Level	Project Start Date Level 1(estimated)	Project End Date Level 1(estimated)	Project Start Date Level 2(estimated)	Project End Date Level 2(estimated)	Project Start Date Level 3(estimated)	Project End Date Level 3(estimated)
352	Client Access (Replacing 340)	3	08-May-98					
353	CIBC Workflow	3	01-Jun-98	31-Oct-98	01-Jun-98	31-Oct-98	01-Jun-98	27-Feb-99

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
1	GL Data Collect	01-Nov-96	16-Apr-97		16-Apr-97		
2	Canada Savings Bonds	16-Jun-97					
3	Rapidtrans	01-Nov-96	31-May-97	01-Nov-96	03-Oct-97		
4	Plan Data Analysis						
5	Project Control System	01-Aug-96	28-Jul-97				
6	Letters of Credit (Replaced by 281)						
7	EDI/NETPAY	01-Aug-96	16-Sep-97				
8	General Analysis						
9	Position of Account	01-Nov-96	19-Feb-97	01-Apr-97			
10	Account Recon	01-Nov-96	15-Nov-97	01-Nov-96			
11	AutoRIL: Ret of Irr Liabilities		22-Dec-97	16-Jun-97			
12	Inter Branch Banking	06-Jan-97	02-May-97	08-Sep-97	12-Dec-97		
13	Branch Clearing	01-Nov-96	04-Jun-97	08-May-97	04-Jun-97		
14	Bulk Filing	14-Apr-97	30-Sep-97	14-Apr-97			
15	Fix Assets & Payment Processing	15-Jun-97					
16	Auto 412	06-Jan-97	24-Oct-97	08-Sep-97	14-Nov-97		
17	GINI						
18	CLASS	01-Jan-97		01-Oct-97		01-Nov-97	
19	US Dollar Float	01-Nov-96	10-Sep-97	01-Nov-96	02-Jan-98		
20	Cash Flow Mgmt	02-Jan-97	10-Oct-97	15-Sep-97			
21	DACS/GL	01-Oct-97	16-Jan-98	01-Oct-97	16-Jan-98		
22	Centralized Instr	15-Jan-97	15-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	
23	VISA Front End	02-Jan-97	31-Mar-98	05-Jan-98			
24	Sundry Clearing	19-Sep-97		19-Sep-97			
25	DDA						

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
26	PCA/Savings	06-Jan-97	10-Oct-97				
27	Cheque Imaging	01-Oct-97		01-Oct-97			
28	IBTSS	01-Nov-96					
29	EFT	01-Nov-96	24-Nov-97	01-Nov-96	21-Apr-98		
30	Customer Profitability	01-Nov-96	19-Feb-97	01-Jun-97			
31	CAMP Stop/Holds/etc.	01-Jan-97	31-Jan-97	01-Jul-96	23-Apr-97		
32	Portfolio Info Facility	01-Nov-96	30-Sep-97	09-Jun-97			
33	Business and Farm Loans Life Insurance System	17-Nov-97					
34	Foreign Exchange	10-Mar-97		10-Mar-97			
36	Geographical Distribution	01-Nov-96	26-Mar-97	12-Mar-97	26-Mar-97		
37	Autom Branch GL	19-Aug-97					
38	General Clearing	20-Jan-97	25-Apr-97	20-Jan-97	25-Apr-97	02-Mar-98	
39	GST Reporting						
40	RRSP	01-May-96	15-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	
41	COINS - Host Facilities	07-Jul-96	23-Apr-97		20-Nov-97		
42	PEGA Investigations		17-Jun-97				
44	Historical Results	19-Aug-97					
45	IDT Systems	01-Nov-96	01-Aug-97	01-Sep-97			
48	ECIF			01-Jan-98	30-Apr-98		
49	Account Info Facility	06-Jan-97	30-Jun-97	16-Jun-97	12-Dec-97	13-Apr-98	
52	Lock Box - Xerox	01-Nov-96		01-Nov-96			
53	IMS COLT	01-Jul-96	23-Apr-97	01-Jul-96	23-Apr-97		
54	Tor Branch Clear						
55	Loan Accounting System	01-Jan-96	17-Oct-97	24-Mar-97	16-Jan-98	15-Dec-97	

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
56	Audit Req System						
57	Cage II Control	20-Jun-97	20-Mar-98	20-Jun-97	20-Mar-98		
58	Branch Details	06-Jan-97	11-Jul-97	05-Aug-97	09-Oct-97		
61	Marketing Info Facil	01-Nov-96	19-Feb-97	01-Apr-97			
62	Portfolio Manager	01-Dec-96	09-Apr-97	01-Dec-96	09-Apr-97		
65	COINS - Op Cntrl	01-Jan-97	01-Feb-97				
66	Pre-Auth Cheques						
67	HUMAN RESOURCES	01-Mar-97					
68	POS Merchant	01-Apr-97	10-Mar-98	01-Apr-97		01-Jan-98	
70	Deposit Account (STB)	06-Jan-97	30-Jun-97	16-Jun-97	12-Dec-97	13-Apr-98	
71	ATM Systems-NON-TANDEM	01-Mar-97	10-Apr-98	01-Mar-97		01-Mar-97	
72	Unclaimed Balances		26-Mar-97	05-Mar-97	26-Mar-97		
75	Invest Products System	01-Sep-96	15-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	
76	CDIC Prem Reduct	06-Jan-97	13-Jun-97	25-Aug-97	03-Oct-97		
77	Code Control System						
78	FACTS		13-May-97		01-Apr-97		
79	MIF Info Facility	01-Nov-96	19-Feb-97	01-Apr-97			
80	Special Debts	01-Nov-96	19-Feb-97	24-Mar-97	31-Oct-97	01-Nov-97	
81	Planning & Forecast	12-Jan-98					
82	Inventory Asset Management	01-Nov-97		01-Nov-97			
84	Software Amortization System	01-May-97	03-Jun-97	01-May-97	03-Jun-97		
85	IWS	31-Oct-97					
86	Base 24-ATM	01-Jan-97		01-Jan-97		01-Jan-97	
87	Base24 POS Online	01-Jan-97		01-Jan-97		01-Jan-97	

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
89	COINS-ICF	01-Sep-96	24-Aug-97				
96	CBEC Controller (Being Replaced)		01-Oct-97				
97	TPSS	07-Apr-97	26-Mar-98				
102	NISA	01-Jun-97	06-Oct-97	01-Jun-97	06-Oct-97		
108	Cheque Processing (Upgrading)	01-Nov-97					
121	Payroll - Comcheq (Replaced by 279)	01-Feb-97	01-Feb-97				
124	Corporate Credit Processing (CCP)	23-Jun-97		01-Jul-97			
128	Centralized Rates	15-Dec-97		15-Dec-98			
141	Returned Item System	12-Jan-98		12-Jan-98		02-Mar-98	
145	Utility Bills	17-Jun-97	08-Sep-97	17-Jun-97	08-Sep-97		
146	Mutual Funds Order Entry & Transfer System (MOTE)	01-Nov-96	15-Dec-97	15-Jan-97	15-Dec-97	02-Feb-98	
148	PMDB (Portfolio Management Data Base)	01-May-97		01-May-97			
149	Auto Billing	01-Jan-97	19-Feb-97	01-Apr-97			
153	CSP (Cardholder Service Platform)	01-Nov-95		01-Jan-98			
158	Clearing	15-Oct-97		15-Oct-97			
159	RICS	01-Feb-98		01-Feb-98		02-Mar-98	
160	Tracing	29-Sep-97	03-Mar-98	13-Oct-97	03-Mar-98		
166	Bankcard	01-Mar-97		05-Jan-98			
170	C/A Bulk Filing	28-Jan-97	09-May-97	28-Jan-97	09-May-97		
179	Collection (TCS Year 2000 Upgrade)	02-Jan-97		01-Apr-97			
190	GMAC	01-Nov-96	15-Jan-97	01-Nov-96	15-Jan-97		

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
191	VISA -- AS/400 ImagePlus	01-Feb-97					
192	Merchant System	01-Mar-97					
193	Statement Reprint System	01-Aug-97		01-Aug-97			
194	RICS FEE	23-Jun-97	29-Sep-97	23-Jun-97	29-Sep-97		
195	Kiting Detection System	06-Jan-97	18-Jul-97	22-Sep-97	24-Oct-97		
196	SFT-Calculators	06-Jan-97	15-Feb-97				
198	VISA Customer Services IVR (PC Board)	09-Oct-97					
199	VISA Authorization IVR (PC Board)	09-Oct-97					
202	Integrated Profitability Management System (EFIP)	06-Apr-98		06-Apr-98			
203	DEC - Nabnasset CTI - Telephone Banking	01-Dec-96					
210	SS/SMAC - MIC Processing (Replaced by 278)	01-Dec-97					
211	Safety Deposit Box (New)		01-Aug-97	28-Apr-98		28-Apr-98	
212	National Trust Back Office	06-Jun-97	31-Mar-98	06-Jun-97	31-Mar-98		
213	CIBC Information Warehouse	01-Feb-96	01-Oct-96				
214	Float	08-Aug-97	12-Nov-97	08-Aug-97	12-Nov-97		
217	New Mellon Bank Interface System (Replacing 75 & 270)	01-Jan-96	28-Feb-98	01-Jan-96	28-Feb-98		

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
220	Trade Innovations (Letters of Credit) (Replacing 6)	01-Jan-96					
221	OASYS System (Replacing Part of 26)	02-Jul-96		15-Apr-98			
222	PS Teller (replacing 131,127)	01-Sep-96					
223	Int'l Comprehensive Banking System (Replacing 126,128,130)	01-Sep-96					
224	MONDEX	01-Jun-97		01-Sep-97			
226	D&B Smartstreams (Replacing 132)	01-Sep-96					
230	WINFAST (Replacing Lending Advisor)	01-Nov-96					
232	Internet Site	01-Mar-98					
233	Wood Gundy Rapid Confirms	01-Apr-97	25-Jun-97	01-Apr-97	25-Jun-97		
234	GASPER4	01-Jul-96					
236	Thin Client						
237	EFIP Infra. GL:M	01-Dec-97					
240	GST Calc/Decalc	19-Aug-97					
241	GST Input Collection & Calc/Decalc	19-Aug-97					
242	Consolidated Bill Payment	01-Mar-97	04-Apr-97	01-Mar-97	30-Sep-97		
243	CIBC Online (SCC-MVS)	01-Jan-97	30-Sep-97	01-Jan-97	30-Sep-97		
256	SFT - Product Book	02-Sep-97	10-Nov-97				
257	Client Notes/ Contact History	02-Sep-97	10-Nov-97				

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ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
260	Deposit Acceleration (Replacing Part of 26)	14-Apr-97	01-Oct-97	29-Aug-97	24-Oct-97		
261	415 Statistics (Replacing Part of 26)	14-Apr-97	06-Aug-97	02-Sep-97	03-Nov-97		
262	Statement on COM (Replacing Part of 26)	14-Apr-97	06-Aug-97	02-Sep-97	03-Nov-97		
264	RDS	24-Nov-96	19-Dec-97	06-Apr-98		06-Apr-98	
266	Mondex Card Management System	01-Sep-95	15-Sep-97				
268	Financial Model System	01-Jun-97	23-Jun-97	01-Jun-97	01-Aug-97		
278	GMAC - Demand Note	01-Jun-97	29-Sep-97	01-Jun-97	29-Sep-97		
281	CIBC Wood Gundy Securities Operations		01-Nov-97	02-Jan-98	05-Mar-98		
283	Inter Member Network Shared Cash Dispenser	01-Nov-97		01-Dec-97		01-Dec-98	
284	Secret Code Selectors	01-Dec-97		01-Dec-97			
285	Credit Data Warehouse (Previously Part of PIF)	25-Nov-97		25-Nov-97			
286	Collections-Property Administration	02-Jan-97		01-Apr-97			
287	Collections-Auto-IBP Replacement	02-Jan-97		01-Apr-97			
289	Collections-Recovery Management System	01-Mar-98		01-Mar-98			
290	T4RIF Printing	01-Dec-97	19-Dec-97	02-Jan-98	13-Mar-98		
291	GIS TXN Conf Printing	01-Dec-97	13-Mar-98	02-Jan-98	13-Mar-98		

Appendix E *Raw Data of Software Projects*

ID	Application Name	Project Start Date (Actual) Level 1	Project End Date (Actual) Level 1	Project Start Date (Actual)Level 2	Project End Date (Actual) Level 2	Project Start Date (Actual) Level 3	Project End Date (Actual) Level 3
294	POS Cardholder	01-Nov-96	10-Mar-98	01-Apr-97		01-Jan-98	