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Labor Demand, Efficiency and Risk in Swedish Savings-Banks

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Contents

List of Tables 2

Preface 3

1. Introduction 4

2. The Model 7

3. Data 10

4. Estimation 12

5. Results 17
   - 5.a Labor Demand Elasticities and Productivity Growth 18
   - 5.b Marginal Risk Elasticities 19
   - 5.c Technical Efficiency 20

6. Summary and Conclusions 22

   References 25

List of Tables and Appendix

Table 1 Summary statistics of the Swedish Savings-banks, 1990-1994 (in 1990 prices) 26

Table 2 Mean output/input elasticities 27

Table 3 Mean marginal risk elasticities 28

Table 4 Frequency distribution of technical efficiency 29

Table 5 Pearson Correlation coefficients 30

Appendix A Production and risk functions parameter estimates 31-33

Preface

Labor Demand, Efficiency and Risk in Swedish Savings-Banks is a working paper within CEFOS research area 'Administrative and organizational aspects of public sector'. This study is concerned with the estimation of production risk and technical efficiency using panel data. A flexible translog demand function is used to represent the underlying technology. The demand for labor is a function of wages, outputs, quasi-fixed inputs and time variable. The risk (variance) function appears multiplicatively with the demand function and it accommodates both positive and negative marginal risks with respect to the determinants of risk. The model includes features of the usual panel data models. A multi-step procedure is used to estimate the parameters of the model. The time effects in the demand model are either represented by time dummies or by a single time trend. Estimation of bank- and time-specific technical efficiency is also considered. Our focus is on productivity and efficiency of labor in Swedish savings-banks. The labor productivity growth and labor efficiency is defined in terms of a shift in the labor demand and the distance from the labor demand frontier, respectively. The empirical results show that the average labor efficiency is about 96%. The working paper is written by Associate Professor Almas Heshmati.

Göteborg, March 1998

Lars Strömberg
Director, CEFOS

1. Introduction[1]

Deregulation of different sectors has made evaluation of productivity, efficiency and risk effects a developing research area. This study focuses on the impact of the recent deregulation and banking crisis of the performance of the Swedish savings-bank industry.

As in many other countries the banking industry in Sweden was deregulated in the mid 1980s. This deregulation was followed by a severe banking crisis in the fall of 1992. Prior to 1985 the Swedish Central Bank imposed quantitative restrictions on the amount that banks could expand their loan portfolios in each year. The interest rates of lending of banks were also strictly regulated. This removal of the official lending guidelines led to a dramatic increase in lending by Swedish banks. The strategy of a rapid growth in the banks' loan portfolios was undertaken without any effective risk management. The Swedish tax rules in combination with relatively high inflation and rising property values had created an excess demand for loans which was now satisfied. However, this strategy made the banks vulnerable to market volatility. The combination of a tax reform in 1990 which limited the tax deductibility of interest payments and high interest rates which existed from early 1990, contributed significantly to a collapse in real estate values. The crisis was at its apex in the fall of 1992, when the government introduced guarantees for the entire liability side of the balance sheets of Swedish banks as an emergency measure.

Both the deregulation and the anticipation of the deregulation affected the industry's choice of input and output volumes. At the same time the banking industry has been internationalized with a slowly growing international competition. The purpose of this paper is to analyze the impact of those factors on productive efficiency, productivity growth and production risk in the Swedish savings-banks industry. Thus, this paper is concerned with the estimation of production risk and technical efficiency using panel data. A flexible translog demand function is used to represent the underlying technology.

[1] Financial support from the Center for Public Sector Research (CEFOS), the Bank of Sweden Tercentenary Foundation, the Swedish Council of Research in Humanities and Social Sciences (HSFR), Jan Wallander's and Malmsten's Foundations are gratefully acknowledged. A longer version of this paper entitled "Labor Demand, Labor-Use, Efficiency and Risk in Swedish Saving Banks" is published as Memorandum 1997:243 at the Department of Economics, Göteborg University.

A key variable of interest in a study of the efficiency and productivity of the banking industry is labor demand. Labor is a significant variable in the cost structure of banks. Thus, we seek to measure the efficiency in the use of labor given production of relevant outputs. The demand for labor is a function of wages, outputs, quasi fixed inputs and time variables. The risk function appears multiplicatively with the demand function and it accommodates both positive and negative marginal risks. The risk function is a variance function which allow the labor demand model to be heteroscedastic of specified form. The variance of labor demand is specified to be a function of services produced, wages, quasi-fixed factors, bank characteristics and a time effect. A multi-step procedure is used to estimate the parameters of the model. In estimation of technical efficiency, our focus is on labor-use efficiency in 53 Swedish savings-banks observed during the period 1990-1994. The labor productivity growth and labor efficiency are defined in terms of a shift in labor demand over time and the distance from the demand frontier defined as the minimum labor required to produce a given level of output. The empirical results show that the average labor efficiency is about 96%.[2] In the evaluation of the results we are concerned whether different specifications of the time effects have a significant effect on the estimates of various elasticities, marginal risk and variances obtained.

This paper is a generalization of previous research concerning the issues of risk and efficiency. First, it is a generalization of the Just and Pope (1978) risk model to incorporate inefficiency effects. Second, it an extension of the Kumbhakar (1993) model by introducing time effects in the risk function to capture the temporal patterns of risk. Third, it introduces a labor demand model where the labor-use model of Kumbhakar and Hjalmarsson (1995) is a special case of it. Fourth, it generalizes the labor-use model to incorporate the production risk. Finally, it applies the model to the banking industry. To our knowledge this paper is the first in which the issues of labor demand combined with production risk and efficiency are analyzed. The application of the methodology to banking data and the empirical findings show that it has significant contribution to the literature of risk in general and efficiency in banking in particular.[3]

The remaining sections of this paper are organized as follows. The model of labor demand is developed incorporating production risk in Section 2. Section 3 describes the savings-banks

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[2] For efficiency analysis on banking industry in Nordic countries, see Berg, Førsund and Hjalmarsson (1993).

[3] For a recent survey of studies that apply various parametric and non-parametric frontier efficiency analyses to financial institutions in different countries, see Berger and Humphrey (1997).

data. The issues of model specification and estimation procedure are discussed in Section 4. Empirical results are discussed in Section 5. Finally, Section 6 summarizes this study.

2. The Model

Kumbhakar and Hjalmarsson (1995) characterized the production process in a service industry by

$$(1) \quad h = f(y_j)$$

where h is the labor-use measured in hours, f represents the production technology, and y_j (j = *1, 2, ..., M*) are M outputs (services) produced using labor. The relationship in (1) defines the production possibility frontier given the level of h. It can be viewed as the input requirement function (Diewert, 1974). The model in (1) can be generalized to incorporate some production characteristic variables. The relationship is then rewritten as

$$(2) \quad h = f(y_j, q, t)$$

where q is a vector of quasi-fixed factors and characteristic variables and t time effects. If information on wages is available and wages are added to the right hand side of (2), we can interpret it as labor demand function

$$(3) \quad h = f(y_j, w, q, t)$$

which the labor-use function (2) is a special case of (3). The labor demand function gives the minimum labor required to produce a given level of output vector y_0. A bank may use labor in excess to what is technically necessary to produce the output vector y_0. Thus, their demand for labor will depend on: (i) the production technology $f(.)$, (ii) technical inefficiency (μ) and (iii) factors outside the control of banks (ν), such as labor market conflicts, financial crisis, various types of unanticipated policies with impact on the banking industry, etc. The labor demand function (3) can be written as

$$\begin{aligned} h &= f(y_j, w, q, t)\exp(\varepsilon) \\ \varepsilon &= \mu + v \end{aligned} \quad (4)$$

where $\mu \geq 0$ following Aigner, Levell and Schmidt (1977) is interpreted as technical inefficiency. It represents the percentage of labor in excess of minimum amount of labor required to produce y_0. If $\mu = 0$ for a bank, it is fully technically efficient in the use of labor. Since random factors can be both favorable ($v < 0$) and unfavorable ($v > 0$), v takes both positive and negative values, i.e., $-\infty < v < \infty$. The labor demand frontier is obtained by setting $\mu = 0$. It is stochastic because of the presence of v. The function in (4) is specified without regard for risk considerations. It is restrictive for cases in which risk is important. Thus, incorporation of risk is an improvement of the stochastic component of the production (see, Robinson and Barry (1987)). Estimates based on a model taking into account risk are informative with respect to risk and in evaluation of policies which affects risk or risk-related services and inputs. The labor demand function can be generalized to incorporate production risk introduced by Just and Pope (1978) written as[4]

$$(5) \quad h = f(x; \alpha)\exp(g(x; \beta)\varepsilon)$$

where $x = (y, w, q, t)$, $f(x; \alpha)$ is the demand part and the $g(x; \beta)\varepsilon$ is the production risk (variance) part of the labor demand function. The model in (5) in logarithmic form can be rewritten as

$$(6) \quad \ln h = \ln f(x; \alpha) + g(x; \beta)\varepsilon.$$

The expected value of h, $E(h)$ and its variance, $V(h)$, are

[4] Just and Pope (1978) introduced eight postulates on the basis of *a priori* theorizing and observed behavior considering theoretical consistency of the stochastic production functions. Just and Pope showed that $h=f(x;\alpha)+g(x;\beta)\varepsilon$ satisfy all of the postulates. The model in (5) is a special case of the general model in which two of the postulates are violated and the remaining ones might be violated as well. The model in (5) is attractive because it is flexible and the demand part of it can be estimated using linear estimation techniques.

(7) $E(h) = f(x;\alpha)\exp(g^2(.)/2)$

and

(8) $V(h) = f^2(.)\exp(g^2(.)/2)\left[\exp(g^2(.)/2) - 1\right].$

Thus, if $E(h) \geq f(x;\alpha)$, marginal risk with respect to factor *j* is

(9) $$MR_j = \frac{\partial V(h)}{\partial x_j} = 2f(.)\exp(g^2(.)/2) \left[f_j(.)\left\{\exp(g^2(.)) - 1\right\} + f(.)g(.)g_j(.)\left\{2\exp(g^2(.)) - 1\right\}\right],$$

where $f_j(.)$ and $g_j(.)$ are partial derivatives of $f(.)$ and $g(.)$ functions with respect to $x_j(y_j, w, q, t)$. The MR_j can be positive or negative depending on the sign and size of the $g(.)g_j(.)$ term which varies with, x_j, across banks and over time. The sign is positive if $g(.)g_j(.) > 0$ and it is negative if $g(.)g_j(.) < 0$ and the term [.] is greater that the first term.

3. Data

The data used were obtained from the annual reports of a sample of savings-banks in Sweden. The variables are given for bank levels, rather than at the individual branch level. Thus, a complete analysis at the branch level although desirable has not been possible to perform. The panel is balanced and consists of 53 savings-banks observed for 5 years during 1990 to 1994. The sample consists of mainly regional banks, some of which involve only one branch and is identical to a branch. Thus no savings-bank with national coverage is included in the data set. The total number of observations used in the analysis is 265. Summary statistics of the data is presented in Table 1.

The variables used in the analysis include the total quantity of labor (h) used, wages (w), public loans (y_1), deposits (y_2), guarantees (y_3), number of branches (y_4) and inventories (q). Labor is measured in hours per year. The variable wage is defined as hourly wages measured in Swedish currency (SEK). It is an aggregate measure of the cost associated with hiring labor including payroll taxes. The quasi-fixed variable, q, is defined as the sum of inventories. The wages, public loans, deposits, guarantees and inventories were originally given in current money values, SEK. These were transformed to fixed 1990 prices using the consumer price index.

In this study, we regard the variables, public loans, deposits and guarantees as outputs.[5] In the literature of efficiency of banking in general there are two approaches considering the treatment of number of branches. One, consider number of branches as an output variable, while in the second, it is considered as an input variable. In our study we follow the first approach. Given the specification, any differences will show only in how the returns to scale is calculated.

In addition to the variables mentioned above a time trend (or a vector of time dummies) is used to represent the exogenous rate of technical change and to capture possible shifts in the risk function over time. In the presentation of the results a size variable is used. The size variable is

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[5] In recent years of technological advancements in the banking industry, access to electronic banking services has made new services available to the banks and their customers. In general there are difficulties associated with the measurement of such services. Although the traditional output services listed above cover the banking activities quite well, there exists risk for misspecification of the model, the magnitude of which and biases these might cause are difficult to foresee or to quantify.

defined based on the individual bank's average number of full-time employees over the period. The size intervals contain five size classes determined such that frequency of banks within each interval is about 20% of the sample.

4. Estimation

So far we have not assumed any functional form for $f(.)$ and $g(.)$. One important feature of the model in (6) is that, in order to impose minimum a priori restrictions on the technology, $f(x;\alpha)$ can be represented by a flexible functional form like a translog which is linear in parameters although not $g(x;\beta)$. Using a translog to approximate $f(.)$ and assuming panel data are available the relationship becomes

$$
\begin{aligned}
\ln h_{it} = {} & \alpha_0 + \sum\nolimits_j \alpha_j \ln y_{jit} + \alpha_w \ln w_{it} + \alpha_q \ln q_{it} + \lambda_t \\
& + 1/2\left\{\sum\nolimits_j \sum\nolimits_k \alpha_{jk} \ln y_{jit} \ln y_{kit} + \alpha_{ww} \ln w_{it}^2 + \alpha_{qq} \ln q_{it}^2\right\} \\
& + \sum\nolimits_j \alpha_{jw} \ln y_{jit} \ln w_{it} + \sum\nolimits_j \alpha_{jq} \ln y_{jit} \ln q_{it} + \alpha_{wq} \ln w_{it} \ln q_{it} \\
& + \left\{\sum\nolimits_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t\right\}\left[\mu_i + v_{it}\right]
\end{aligned} \tag{10}
$$

where *h, y, w* and *q* variables are defined as previously, *j* and *k* $(j, k = 1, 2, ..., M)$ indexes outputs, *i* indexes bank $(i = 1, 2, ..., N)$, *t* indexes time periods $(t = 1, 2, ..., T)$ and λ_t is a vector of time dummy variables representing the exogenous rate of technical change (Time Dummy Model). An exclusion of the wage variable and its interaction with other explanatory variables from $f(.)$ in (10) will result in the labor-use function of Kumbhakar and Hjalmarsson (1995). The demand model in (10) where the set of time dummies in the demand part, $f(.)$, are replaced with a single time trend, its square and interactions with other explanatory variables (Time Trend Model), is written as

$$
\begin{aligned}
\ln h_{it} = \alpha_0 &+ \sum_j \alpha_j \ln y_{jit} + \alpha_w \ln w_{it} + \alpha_q \ln q_{it} + \alpha_t t \\
&+ 1/2\left\{\sum_j \sum_k \alpha_{jk} \ln y_{jit} \ln y_{kit} + \alpha_{ww} \ln w_{it}^2 + \alpha_{qq} \ln q_{it}^2 + \alpha_{tt} t^2\right\} \\
&+ \sum_j \alpha_{jw} \ln y_{jit} \ln w_{it} + \sum_j \alpha_{jq} \ln y_{jit} \ln q_{it} + \sum_j \alpha_{jt} \ln y_{jit} t \\
&+ \alpha_{wq} \ln w_{it} \ln q_{it} + \alpha_{wt} \ln w_{it} t + \alpha_{qt} \ln q_{it} t \\
&+ \left\{\sum_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t\right\}\left[\mu_i + v_{it}\right].
\end{aligned} \tag{11}
$$

In the time trend demand model it is assumed that technical change is a smooth, continuous and monotonical process, while in the time dummy model, it is assumed to be a discontinuous and non-monotonical process. Thus, the latter is more appropriate in modeling sudden shocks of temporary nature, such as a banking crisis. It is to be noted that disregard of the way technical change is represented, in the demand part any shifts in the risk function over time is represented by a time trend. The presence of risk has implications for services produced, labor demand and the levels of inefficiency. The effect of technical inefficiency on log labor demand following Kumbhakar's (1993) specification is given by $g(x;\beta)\mu_i$. Thus, although μ_i is time-invariant, its effect on labor demand varies over time, unless all x-variables included in the specification of the risk function are time-invariant and no time effects enter the specification. The specification is a one-way error component (see, Baltagi (1995)), where μ_i are treated as fixed and the residuals v_{it} are random, assumed to be independently and identically distributed normally with mean 0 and variance 1. Ignorance of the bank heterogeneity here interpreted as inefficiency, μ_i, might lead to biased estimates of the demand function parameters and an over/under estimation of the importance of risk.

Estimation of the models in (10) and (11) consists of the following steps (see Just and Pope (1978) and Griffiths and Anderson (1982)):

(i) Ignore the presence of the risk function, $g(x;\beta)$, and estimate (10) and (11) using the ordinary least squares (OLS). The μ_i and λ_t are estimated from (N-1) bank and (T-1) time dummies relative to the reference bank and reference year. Since $E(\varepsilon_{it} = 0)$, the OLS estimators are consistent and unbiased but inefficient because the error term which contains the risk function parameters is heteroscedastic.[6]

[6] For heteroscedasticity of the unspecified form, see Caudill, Ford and Gropper (1995) and Kumbhakar (1997).

(ii) Using the estimators of α, μ and λ obtained from step 1, the residuals

$$
\begin{aligned}
e_{it} = \ln h_{it} - (\alpha_0 &+ \sum_j \alpha_j \ln y_{jit} + \alpha_w \ln w_{it} + \alpha_q \ln q_{it} + \lambda_t \\
&+ 1/2\left\{\sum_j \sum_k \alpha_{jk} \ln y_{jit} \ln y_{kit} + \alpha_{ww} \ln w_{it}^2 + \alpha_{qq} \ln q_{it}^2\right\} \\
&+ \sum_j \alpha_{jw} \ln y_{jit} \ln w_{it} + \sum_j \alpha_{jq} \ln y_{jit} \ln q_{it} + \alpha_{wq} \ln w_{it} \ln q_{it} + \mu_i)
\end{aligned} \tag{12}
$$

and

$$
\begin{aligned}
e_{it} = \ln h_{it} - (\alpha_0 &+ \sum_j \alpha_j \ln y_{jit} + \alpha_w \ln w_{it} + \alpha_q \ln q_{it} + \alpha_t t \\
&+ 1/2\left\{\sum_j \sum_k \alpha_{jk} \ln y_{jit} \ln y_{kit} + \alpha_{ww} \ln w_{it}^2 + \alpha_{qq} \ln q_{it}^2 + \alpha_{tt} t^2\right\} \\
&+ \sum_j \alpha_{jw} \ln y_{jit} \ln w_{it} + \sum_j \alpha_{jq} \ln y_{jit} \ln q_{it} + \sum_j \alpha_{jt} \ln y_{jit} t \\
&+ \alpha_{wq} \ln w_{it} \ln q_{it} + \alpha_{wt} \ln w_{it} t + \alpha_{qt} \ln q_{it} t + \mu_i)
\end{aligned} \tag{13}
$$

are calculated. The e_{it} is then used to estimate the risk function by non-linear methods as follows:

$$
\ln e_{it} = -1.2704 + \ln\left[\sum_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t\right] + \ln v_{it}. \tag{14}
$$

Since estimates of the error term converges to v_{it}, which is distributed as χ^2 with one degree of freedom, the mean and variance of $\ln v_{it}$ are -1.2704 and 4.9348, respectively (see Theorem 2 of Just and Pope (1978, pp.77-79), and Griffiths and Anderson (1982, p. 531)).[7]

(iii) For asymptotically efficient estimates of the parameters α and β, the models (10) and (11) are to be estimated using the generalized least squares (GLS) method, which is equivalent to OLS after dividing both sides of the equations (10) and (11) by the estimates of $g(.) = \sum_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t$.

(iv) Steps i-iii are repeated in an iterative procedure until convergence is obtained.

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[7] For a detailed discussion of various approaches to the specification and estimation of production risk and properties of the parameter estimates with application to production of salmon farming in Norway, see Tveterås (1997).

(v) The μ_i are treated as fixed and estimated from the coefficients of *(N-1)* bank dummies and the overall intercept. Thus, technical inefficiency is estimated relative to the bank with the best performance in the sample, which is assumed to be fully efficient $(\mu = 0)$. Since the reference bank may not be the best in all years, time variant technical inefficiency following Schmidt and Sickles (1984) is calculated relative to the banks with best performances in each year as

$$\begin{aligned} TINEFF_{it} &= g(x_{it};\beta)(\alpha_0+\mu_i) - \min_t\left[g(x_{it};\beta)(\alpha_0+\mu_i)\right] \\ \text{(15)} \qquad &= (\textstyle\sum_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t)(\alpha_0+\mu_i) \\ &\quad - \min_t\left[(\textstyle\sum_j \beta_j y_{jit} + \beta_w w_{it} + \beta_q q_{it} + \beta_t t)(\alpha_0+\mu_i)\right] \end{aligned}$$

and technical efficiency as

$$\text{(16)} \quad TEFF_{it} = \exp(-TINEFF_{it})$$

which is both bank- and time-specific.[8]

Since the translog labor demand function employed can be viewed as an approximation of the unknown function at a point, prior to the estimation of the models, the data was normalized at the sample mean. The first order coefficients, α_j *and* α_q are expected to be positive and α_w negative. These coefficients can also be interpreted as the labor demand elasticities with respect to outputs, wages and quasi-fixed inputs at the normalized data point. At the all data points, the corresponding elasticities are computed as

$$\begin{aligned} &E_j = \partial \ln h_{it} / \partial \ln y_{jit} = \alpha_j + \textstyle\sum_k \alpha_{jk} \ln y_{kit} + \alpha_{jw} \ln w_{it} + \alpha_{jq} \ln q_{it} + \alpha_{jt} t \\ \text{(17)} \quad &E_w = \partial \ln h_{it} / \partial \ln w_{it} = \alpha_w + \alpha_{ww} \ln w_{it} + \textstyle\sum_k \alpha_{jw} \ln y_{jit} + \alpha_{wq} \ln q_{it} + \alpha_{wt} t \\ &E_q = \partial \ln h_{it} / \partial \ln q_{it} = \alpha_q + \alpha_{qq} \ln q_{it} + \textstyle\sum_k \alpha_{jq} \ln y_{jit} + \alpha_{wq} \ln w_{it} + \alpha_{qt} t. \end{aligned}$$

The rate of technical change in the time trend model is measured as

---

[8] For a recent survey of the econometric approach to efficiency analysis using panel data and various specifications of time-varying technical efficiency see Heshmati (1994).

(18) $E_t = \partial \ln h_{it} / \partial t = \alpha_t + \alpha_{tt} t + \sum_j \alpha_{jt} \ln y_{jit} + \alpha_{wt} \ln w_{it} + \alpha_{qt} \ln q_{it}$

and the corresponding rate in the time dummy model case is obtained as

(19) $E_t = \partial \ln h_{it} / \partial t = (\lambda_t - \lambda_{t-1})$.

E_t is interpreted as the exogenous rate of technical change, a shift in the labor demand function over time. In the time trend model the overall rate can further be decomposed into pure $(\alpha_t + \alpha_{tt})$, non-neutral $(\alpha_{wt} \ln w_{it} + \alpha_{qt} \ln q_{it})$, and scale augmenting $(\sum_j \alpha_{jt} \ln y_{jit})$, components.

The output elasticities, E_j, the wage elasticity, E_w, the quasi-fixed input elasticity, E_q, and the rate of technical change, E_t, are all both bank and time specific. The latter in the time dummy model is only time-specific.

5. Results

The models outlined in the previous section were used to estimate labor demand functions for a sample of Swedish Savings-banks observed for a five year period, 1990-1994. The parameter estimates of the demand functions, $f(x; \alpha)$, and the risk functions, $g(x; \beta)$, are reported in Appendix A. In both time trend and time dummy models, restricted forms of the functions such as Cobb Douglas and generalized Cobb Douglas as well as pooled models ignoring the bank-specific and time-specific effects were rejected. The bank-specific effects are with the exception of two banks statistically significant. Only two out of four time-specific effects are significantly different from zero. The goodness of fit statistic, R^2, for the demand models corrected for heteroscedasticity, is found to be close to 1.0 indicating a good fit. The time dummy model performed better in terms of R^2 values compared to the time trend model. However, the latter has a higher frequency of significant parameters.

The risk functions, $g(x; \beta)$ were estimated using the weighted non-linear least square method as described in step (iv). The parameter estimates are reported in the second part of Appendix A. The β coefficients associated with the estimation of the risk function (14), are mainly statistically insignificant. In both of the risk functions, a time trend is introduced to capture a neutral shift in the risk function over time. A Chow test statistic indicates that the time trend should be included in the specification of the risk function.

All elasticities evaluated at the mean values in each year, for each size group and at the sample mean values, are reported in Table 2. In analogous to the elasticities mentioned above, the marginal risk elasticities with respect to various risk factors together with the total marginal risk are evaluated at each point of the data. The levels of technical efficiency are estimated as in equation (15) and (16). Again the marginal risk elasticities and the levels of technical efficiency are both bank- and time-specific. The annual and the size group mean values together with the sample mean values are reported in Table 3. Finally, the frequency distribution of technical efficiencies is reported in Table 4 and their correlation coefficients in Table 5.

5.a Labor Demand Elasticities and Productivity Growth

The elasticities of labor demand with respect to different outputs, wages and inventories were calculated at each data point. The means for both time specifications are reported in Table 2, by year and by bank size. At the mean data point all elasticities with the exception of wage elasticities are as expected positive and significant, indicating responsiveness of labor demand to changes in the levels outputs and wages and inventories. In a few cases (very small-sized banks) the point output elasticities are negative violating the regulatory conditions. The analysis of the results in this paper will be based primarily on the time dummy model. For comparison, we will also briefly discuss the results obtained using time trend model.

The sample mean elasticity of labor with respect to public loans and guarantees is very small, 0.012 and 0.016. The former with a large standard deviation, 0.073, is increasing over time, while the latter is decreasing over time. The elasticity with respect to deposits is the largest output elasticity. The sample mean elasticities of deposit and branches are 0.195 (0.169) and 0.079 (0.108), respectively. These are both increasing over time. The numbers in parentheses are standard deviations.

The wage elasticity is on average -0.387 with a relatively small standard deviation, 0.077. The elasticity is increasing over time from -0.433 in 1990 to -0.350 in 1994. The continuous slowly decreasing responsiveness shows that adjustment in labor in response to change in the level of wages is a slow process. The possibilities of changes in the size of labor in response to changes in the wage level is becoming smaller as the size of labor is changing gradually towards an optimal level. Labor-saving technology and the speed of their introduction to the banking market is another factor which constrains a full adjustment of labor to the desired level. The elasticity with respect to inventories is on average 0.048 (0.033). It is decreasing over time. This is interpreted as the need (or cost) of continuous additional education of labor in association with new investments in inventories is decreasing. The decreasing pattern can be explained by the fact that labor with a larger need for additional training are crowded out following wage increase and the subsequent adjustment in the stock of labor.

In order to save degrees of freedom no interaction between the set of time dummy variables and the other explanatory variables is allowed. Thus, the exogenous rate of technical change consists of only a pure component. It is changing only over time. The sample mean value is zero.

It increased by 4% during transition from 1990 to 1991. The outbreak of the banking crisis caused a switch from technical regress to a technical progress of the size 4.2% during the next two years. However, the rate of progress returned to zero level in the final year, 1994. The positive rate of technical change interpreted as technical regress (labor demand increasing) in the period prior to the banking crisis has been offset by the technical progress (labor demand diminishing) in the post crisis period. All bank sizes are subject to the same development of productivity growth.

The size of different output and input elasticities varies much by the size of the savings-banks. The elasticities with respect to public loans, guarantees, branches and wages are increasing by the size of the banks, while those of deposit is decreasing by the size. No differences in the rate of technical change are observed among the size groups.

The sample mean elasticities calculated based on the results from the time trend model differ somewhat from those of the time dummy model. The time and size patterns of elasticities are the same but the magnitude differs due to the time trend representation of technical change and the non-neutrality of technical progress. The overall rate of technical change is on average -0.006. It is continuously decreasing from 0.025 in 1990 to -0,035 in the final year 1994. The sample mean decomposition of the overall rate into pure, non-neutral and scale components is -0.006, 0.004 and -0.004, respectively.

5.b Marginal Risk Elasticities

The β coefficients with respect to public loans and guarantees are negative and significantly different from zero. The coefficients of the remaining outputs namely deposits and branches are both positive but insignificant. The wage coefficient is the largest one, positive and significant. The remaining coefficients of inventories and time trend are found to be insignificant. The latter is significant in the time trend model specification. These two models are identical considering the right hand variables. The estimate of the variance, σ_v^2, is 4.3422, and close to the asymptotic variance of v_{it}, 4.9348. The time dummy model underestimates the asymptotic variance, while the time trend model (5.6570) overestimates it (see Appendix A).

The marginal risk elasticities with respect to different outputs, wages, inventories and time trend together with the total variance of labor demand were obtained for each data point using equation (9). The mean values are reported in Table 3 by year and by bank sizes. Marginal risk evaluated at the mean of the data with respect to public loans and guarantees is positive. Negative marginal risks were observed for deposit, branches, wages and time trend. In all cases the standard deviations are relatively large. Thus, for banks with production levels close to the sample means, the labor demand variance increases if the bank produces more public loans and guarantees. The corresponding variance decreases with the production of more deposit, increases with the number of branches and the levels of inventories and wages. In terms of the size of marginal risks, wages, public loans and branches are the most important risk-related factors contributing to the variance of labor demand. The existence of significant marginal risks associated with changes in the levels of outputs and wages is an indication that the demand function exhibits heteroscedasticity in these factors. A test for heteroscedasticity shows that the null hypothesis of homoscedasticity was rejected.

In general, more variation in the estimated marginal risks over time is observed than across bank sizes. Changes in the sign of marginal risk with respect to wages took place in 1992. Other than this, we do not observe any systematic patterns in the size of marginal risks with respect to different factors over time and over bank sizes. Only small differences in the individual values of marginal risks in comparison among the two labor demand model specifications are observed (see Table 3). The standard deviation of the marginal risk with respect to the wage variable is higher in the time trend model.

5.c Technical Efficiency

The mean values of estimates of technical efficiency obtained from equation (16) are reported in Table 3 by year and by bank size. The overall mean technical efficiency is 96.2% with very small standard deviation, 2.4%. It varies in the interval 88% and 100%. Looking at the sample mean we find that the sample of savings-banks in general is technically very efficient. On average, there exists a potential for reduction in labor demand only by up to 3.8% for a given level of output compared with the most efficient bank. It should be noted that the efficiency measure is a relative efficiency. It is measured relative to the bank with the best practice technology in each year assumed to be 100% efficient. Absolute efficiency can not be obtained because the intercept, α_0, captures the effects of the intercept as well as the omitted bank and time effects. Here it is assumed that the sample data contains the most efficient savings-bank on annual basis.

The mean technical efficiency over time is declining. However, the change is marginal and less than 1% during the period of this study. On the other hand, we observe large variations across bank sizes. We find negative relationship between the level of technical efficiency and the size of banks. Very small banks seem to operate with technically optimal size of labor. Unlike the large banks there exists no potential for labor-saving behavior. The results indicate that the largest savings-banks could reduce their labor demand on average with 6.7%. An interesting question is what the reasons and determinants are for this development of productivity and efficiency in Swedish savings-banks. The results above refer to the time dummy model specification. The overall mean efficiency in the two models is identical. No significant differences in the estimates of mean technical efficiency over time and across size classes due to the time trend representation of technical change are found. A positive (negative) marginal risk increases (decreases) the level of technical efficiency of the banks.

The frequency distribution of technical efficiency is reported in Table 4. Unlike the similarities in the time and size patterns of efficiency, we observe some differences in the frequency distribution of technical efficiency across the models. In the time dummy model a number of banks are found in the lower efficiency intervals. On the other hand, in the time trend model the frequency is more concentrated in higher intervals.

The correlation coefficients of ranking of efficiencies are reported in Table 5. In both cases we find negative correlation between efficiencies and the size (-0.92) of banks and time variable (-0.06 and -0.23). Unlike the input risk we find a positive and significant association between the output risk and the size of banks and the time. The high and positive and significant correlation coefficient between the two models (0.95) indicates that the estimates of technical efficiency of banks are robust to the model specification.

6. Summary and Conclusions

Evaluation of deregulation of different sectors has made studies of productivity, efficiency and risk a developing research area. The Swedish banking industry was deregulated in the mid 1980,s. This deregulation was followed by a severe banking crisis in the fall 1992. This paper is concerned with the estimation of production risk and technical efficiency using panel data. The objective is to analyze the impact of the recent deregulation and banking crisis on the performance of the Swedish Savings-bank industry. Labor is a significant variable in the cost structure and a key variable of interest in a study of the efficiency and productivity of banks. Thus, we seek to measure the efficiency in the use of labor given production of services. Efficiency is defined in terms of the distance from the minimum labor required to produce a given level of services while risk is a measure of dispersion in labor demand related to changes in the level of services. Our focus is on the measurement of risk and labor demand efficiency in a sample Swedish savings-banks observed during the period 1990-1994.

A translog labor demand function is estimated where the demand for labor is a function of wages, services produced, input variables that are fixed in short run, and a time variable. The labor demand is generalized to incorporate production risk. The risk (variance) function appears multiplicatively with the demand function and it accommodates both positive and negative marginal risks. A multi-step procedure is used to estimate the parameters of the model. The time effects representing shift in the labor demand over time are represented by time dummies or a time trend. In the time trend demand model it is assumed that any shift is a smooth, continuous and monotonical process, while in the time dummy model, it is assumed to be a discontinuous and non-monotonical process. The latter is more appropriate in modeling sudden shocks such as a banking crisis.

The goodness of fit statistic, R^2, for the models corrected for heteroscedasticity indicate a good fit. The time dummy model performed better compared to the time trend model. The risk functions were estimated using the weighted non-linear least square method. In the risk function, a time trend is introduced to capture the neutral shift in the risk function over time.

The elasticity of labor demand with respect to different outputs and inputs were calculated at each data point. At the mean data point all output elasticities are positive and the wage elasticity is negative indicating responsiveness of labor demand to changes in the levels of outputs and wages. The sample mean elasticity of labor with respect to public loans and guarantees are very small and that of deposits and branches is relatively large. The wage elasticity is very large and negative and it is slowly increasing over time. It shows that adjustment in labor in response to change in the level of wages is a slow process. The elasticity with respect to inventories is small and is decreasing over time. The sample mean exogenous rate of technical change is zero. It increased prior to the banking crisis. The outbreak of the banking crisis caused a switch from technical regress (labor increasing) to technical progress (labor decreasing). However, the rate of progress returned to zero in 1994.

The size of different output and input elasticities varies much by the size of savings-banks. The elasticities with respect to public loans, guarantees, branches and wages are increasing by the size of banks, while that of deposits is decreasing by size. No difference in the rate of technical change is observed among the size groups. The sample mean elasticities calculated based on the results from the time trend model differ somewhat from those of the time dummy model. The time and size patterns of elasticities are the same as those of the time dummy model. However, the magnitude of these elasticities differs.

The marginal risk evaluated at the mean of the data with respect to public loans and guarantees is positive. Negative marginal risks were observed for deposit, branches, wages and trend. Thus, the labor demand variance increases if the bank produces more public loans and guarantees. The corresponding variance is decreasing with the production of more deposit, the number of branches and the levels of wages. In terms of the size of marginal risks, wages, public loans and branches are the most important risk-related factors. In general more variation in the estimated marginal risks over time is observed then across bank sizes.

The overall mean technical efficiency is 96.2%. We find the sample savings-banks in general technically very efficient. On average, there exists potential for reduction in labor demand only by up to 3.8%. The mean technical efficiency over time is declining slowly. We observe large variations across bank sizes. A negative relationship between the level of technical efficiency and the size of the bank is found. Very small banks seem to operate with the technically optimal size of labor. The results indicate that the largest savings-banks could reduce their labor demand on average with 6.7%. The mean results obtained using different specifications are very similar but some differences in the frequency distribution of technical efficiency across the models are observed.

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Table 1 Summary statistics of the Swedish savings-banks, 1990-1994 (in 1990 prices).

Variable	Definition (Units)	Mean	Std Dev	Minimum	Maximum
Dependent variable:					
h	Labor (Hours)	75085	95516	5303	615930
Explanatory variables:					
y1	Public loans (SEK)	433090336	585423191	18167733	3996596962
y2	Guarantees (SEK)	60795270	114614733	26810	796322609
y3	Deposits (SEK)	596422562	724145727	42601000	4801052632
y4	Branches	4	4	1	25
w	Hourly wage (SEK)	169	14	108	215
q	Inventories (SEK)	3120312	5640549	74295	50197000
t	Time trend	3	1	1	5

Table 2 Mean output/input elasticities by year and by size of bank.

Year/size	Public loans	Guarantee	Deposits	Branches	Wages	Inventories	Time
A. Time Dummy Model:							
1990	0.005	0.023	0.191	0.075	-0.433	0.060	0.000
1991	0.007	0.021	0.187	0.077	-0.402	0.057	0.040
1992	0.013	0.016	0.199	0.076	-0.395	0.048	-0.015
1993	0.017	0.011	0.193	0.082	-0.356	0.041	-0.027
1994	0.017	0.008	0.203	0.082	-0.350	0.036	0.000
Very small	-0.090	-0.015	0.426	-0.059	-0.425	0.047	0.000
Small	-0.024	0.004	0.258	0.036	-0.408	0.045	0.000
Medium	0.004	0.017	0.185	0.076	-0.407	0.061	0.000
Large	0.051	0.029	0.124	0.119	-0.381	0.050	0.000
Very large	0.092	0.037	0.038	0.186	-0.324	0.038	0.000
Sample mean	0.012	0.016	0.195	0.079	-0.387	0.048	0.000
Std deviation	0.073	0.022	0.169	0.108	0.077	0.033	0.023
B. Time Trend Model:							
1990	0.043	0.017	0.141	0.088	-0.584	0.060	0.025
1991	0.032	0.014	0.161	0.089	-0.501	0.048	0.006
1992	0.045	0.013	0.154	0.087	-0.410	0.041	-0.004
1993	0.036	0.007	0.174	0.094	-0.336	0.028	-0.023
1994	0.035	0.008	0.179	0.088	-0.233	0.020	-0.035
Very small	-0.031	-0.025	0.277	-0.031	-0.512	0.066	0.004
Small	0.020	-0.001	0.157	0.073	-0.431	0.045	-0.002
Medium	0.042	0.016	0.126	0.086	-0.404	0.060	-0.002
Large	0.068	0.029	0.137	0.115	-0.377	0.028	-0.011
Very large	0.076	0.032	0.144	0.172	-0.366	0.005	-0.019
Sample mean	0.038	0.012	0.162	0.089	-0.413	0.039	-0.006
Std deviation	0.072	0.029	0.167	0.129	0.155	0.045	0.026

Table 3 Mean marginal risk elasticities by year and by size of bank.

Year/size	Public	Guaran.	Depos.	Brans.	Wages	Inven.	Time	Total	Effic.
A. Time Dummy Model:									
1990	0.013	0.002	-0.010	-0.021	-0.017	-0.004	-0.001	-0.019	0.962
1991	0.012	0.001	-0.011	-0.019	-0.080	-0.003	-0.002	-0.093	0.964
1992	0.009	0.004	-0.005	-0.016	0.043	-0.003	-0.001	0.032	0.963
1993	0.010	0.002	-0.022	-0.022	-0.129	0.012	-0.001	-0.138	0.960
1994	0.016	0.002	-0.017	-0.021	-0.183	-0.004	-0.001	-0.198	0.959
Very small	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	-0.001	0.994
Small	0.000	0.000	0.000	0.000	-0.010	0.000	0.000	-0.010	0.980
Medium	0.002	0.000	0.001	0.000	-0.007	0.000	0.000	-0.006	0.964
Large	0.008	0.001	-0.015	-0.014	-0.137	-0.005	-0.001	-0.161	0.946
Very large	0.046	0.009	-0.048	-0.081	-0.217	0.004	-0.004	-0.251	0.933
Sample mean	0.012	0.002	-0.013	-0.020	-0.073	0.000	-0.001	-0.084	0.962
Std dev	0.048	0.011	0.053	0.073	0.560	0.056	0.004	0.562	0.024
B. Time Trend Model:									
1990	0.000	0.000	0.000	-0.005	-0.242	-0.003	-0.003	-0.251	0.968
1991	0.000	0.000	-0.002	-0.006	0.185	-0.002	-0.003	0.176	0.967
1992	-0.002	0.000	0.003	-0.006	0.037	-0.003	-0.003	0.031	0.963
1993	-0.001	0.000	-0.014	-0.006	-0.087	-0.017	-0.003	-0.123	0.959
1994	0.002	0.001	-0.016	-0.007	-0.239	-0.002	-0.003	-0.260	0.955
Very small	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	-0.001	0.993
Small	0.000	0.000	0.000	0.000	-0.013	0.000	0.000	-0.013	0.977
Medium	0.001	0.000	0.001	0.001	0.003	0.000	0.000	0.005	0.962
Large	-0.001	0.000	-0.019	-0.005	-0.262	-0.002	-0.002	-0.291	0.946
Very large	0.000	0.002	-0.010	-0.024	-0.053	-0.023	-0.013	-0.104	0.939
Sample mean	0.000	0.001	-0.006	-0.006	-0.068	-0.005	-0.003	-0.083	0.962
Std dev	0.014	0.004	0.047	0.025	1.102	0.049	0.010	1.101	0.021

The *total* is the sum of the outputs and inputs marginal risk elasticities (the time effects not included).

Table 4 Frequency distribution of technical efficiency.

	Time Dummy Model		Time Trend Model	
Percent efficiency interval	Frequency	Percent	Frequency	Percent
88-90	3	1.1	-	-
90-92	4	1.5	2	0.8
92-94	39	14.7	39	14.7
94-96	78	29.4	84	31.7
96-98	71	26.8	79	29.8
98-100	70	26.4	61	23.0

Table 5 Correlation coefficients (number of observation = 265).

	Characteristics		Marginal risk			Efficiency	
	Time	Size	Total	Output	Input	TDM	TTM
Time	1.0000						
	0.0000						
Size	0.0000	1.0000					
	1.0000	0.0000					
Total	-0.0465	-0.0623	1.0000				
	0.4571	0.3191	0.0000				
Output	-0.1159	-0.2348	-0.0790	1.0000			
	0.0601	0.0001	0.2058	0.0000			
Input	-0.0392	-0.0515	0.9988	-0.1279	1.0000		
	0.5298	0.4087	0.0001	0.0401	0.0000		
TDM	-0.0646	-0.9171	0.0451	0.2888	0.0327	1.0000	
	0.2946	0.0001	0.4708	0.0001	0.6004	0.0000	
TTM	-0.2272	-0.9152	0.0521	0.3035	0.0381	0.9540	1.0000
	0.0002	0.0001	0.4047	0.0001	0.5415	0.0001	0.0000

Time dummy (TDM) and time trend models (TTM).

Appendix A Labor demand and risk functions parameter estimates. The dependent Variable is labor measured in hours.

	Time Dummy Model		Time Trend Model	
Parameter	estimate	std error	estimate	std error
A. Labor Demand Functions:				
α_0	-1.1420a	0.0952	-1.2018a	0.0990
α_{y1}	0.0639c	0.0339	0.0928c	0.0507
α_{y2}	0.0271a	0.0079	0.0140c	0.0083
α_{y3}	0.1315c	0.0684	0.1033	0.0887
α_{y4}	0.1191a	0.0315	0.1327a	0.0350
α_w	-0.3759a	0.0765	-0.6952a	0.1047
α_q	0.0571a	0.0131	0.0563a	0.0159
α_t	-	-	0.0361a	0.0099
α_{y11}	0.0153	0.0174	0.0399b	0.0191
α_{y22}	0.0021	0.0022	0.0054b	0.0024
α_{y33}	-0.1240	0.0882	-0.0027	0.1230
α_{y44}	-0.0611b	0.0272	-0.1130a	0.0295
α_{ww}	-0.0290	0.2388	0.0431	0.2544
α_{qq}	0.0076	0.0102	-0.0048	0.0124
α_{tt}	-	-	-0.0074a	0.0017
α_{y12}	0.0163	0.0180	0.0447c	0.0240
α_{y13}	0.1040	0.0951	-0.0139	0.1216
α_{y14}	-0.1094	0.0748	-0.1197	0.0792
α_{y1w}	-0.1499	0.2741	-0.0239	0.2930
α_{y1q}	0.0008	0.0334	-0.0202	0.0464
α_{y1t}	-	-	-0.0009	0.0168
α_{y23}	-0.0307	0.0202	-0.0765a	0.0270
α_{y24}	-0.0006	0.0096	-0.0068	0.0101
α_{y2w}	-0.0235	0.0462	0.0386	0.0529
α_{y2q}	0.0164a	0.0062	0.0248a	0.0070
α_{y2t}	-	-	0.0060a	0.0024
α_{y34}	0.2527a	0.0811	0.3179a	0.0928
α_{y3w}	0.3009	0.2901	-0.0683	0.3356
α_{y3q}	-0.0868a	0.0351	-0.0658	0.0496
α_{y3t}	-	-	-0.0058	0.0205
α_{y4w}	0.0384	0.1275	-0.0596	0.1403
α_{y4q}	0.0370b	0.0175	0.0413b	0.0203
α_{y4t}	-	-	-0.0086	0.0059
α_{wq}	-0.0595	0.0815	0.0908	0.0971
α_{wt}	-	-	0.1102a	0.0365
α_{qt}	-	-	-0.0048	0.0058
λ_2	0.0394a	0.0082	-	-
λ_3	0.0217a	0.0087	-	-

Appendix A Continued ...

	Time Dummy Model		Time Trend Model	
Parameter	estimate	std error	estimate	std error
λ_4	-0.0073	0.0120	-	-
λ_5	-0.0058	0.0124	-	-
μ_2	1.3415a	0.1082	1.4055a	0.1124
μ_3	-0.3055a	0.0518	-0.3128a	0.0538
μ_4	0.0426	0.0389	-0.0167	0.0418
μ_5	1.7133a	0.1391	1.7727a	0.1437
μ_6	-0.0518	0.0481	-0.0624	0.0515
μ_7	-0.4223a	0.0635	-0.5223a	0.0708
μ_8	1.3622a	0.1076	1.4106a	0.1133
μ_9	0.3948a	0.0631	0.4458a	0.0659
μ_{10}	0.4365a	0.0584	0.4822a	0.0617
μ_{11}	0.3278a	0.0605	0.3409a	0.0644
μ_{12}	0.4926a	0.0581	0.4839a	0.0650
μ_{13}	0.6931a	0.0715	0.7245a	0.0758
μ_{14}	1.9965a	0.1957	2.0837a	0.2004
μ_{15}	1.5479a	0.1229	1.6046a	0.1270
μ_{16}	1.0305a	0.0968	1.0817a	0.1010
μ_{17}	1.3410a	0.1000	1.3845a	0.1038
μ_{18}	-0.4639a	0.0463	-0.4915a	0.0489
μ_{19}	0.2341a	0.0705	0.2948a	0.0726
μ_{20}	0.8012a	0.0831	0.8407a	0.0871
μ_{21}	0.4211a	0.0777	0.3865a	0.0865
μ_{22}	1.0420a	0.1083	1.0860a	0.1136
μ_{23}	1.6771a	0.1408	1.7275a	0.1462
μ_{24}	1.3087a	0.1103	1.4434a	0.1191
μ_{25}	1.5928a	0.1269	1.6370a	0.1316
μ_{26}	-0.5240a	0.0674	-0.6283a	0.0747
μ_{27}	1.4564a	0.1169	1.5193a	0.1214
μ_{28}	-0.2307a	0.0396	-0.2613a	0.0417
μ_{29}	0.4979a	0.0651	0.4879a	0.0695
μ_{30}	2.2717a	0.2734	2.3455a	0.2792
μ_{31}	1.2132a	0.0937	1.2534a	0.0984
μ_{32}	1.4750a	0.1397	1.5457a	0.1447
μ_{33}	1.6093a	0.1237	1.6911a	0.1284
μ_{34}	-0.3079a	0.0567	-0.3474a	0.0610
μ_{35}	1.5049a	0.1260	1.5692a	0.1303
μ_{36}	1.0932a	0.0779	1.1268a	0.0810
μ_{37}	-0.1323b	0.0606	-0.2121a	0.0633
μ_{38}	0.9125a	0.0757	0.9410a	0.0799
μ_{39}	0.7234a	0.0891	0.7321a	0.0970
μ_{40}	1.5292a	0.1264	1.5451a	0.1316

Appendix A Continued ...

	Time Dummy Model		Time Trend Model	
Parameter	estimate	std error	estimate	std error
μ_{41}	1.2417a	0.1169	1.3254a	0.1234
μ_{42}	0.5549a	0.0583	0.5827a	0.0588
μ_{43}	0.7869a	0.0719	0.8222a	0.0767
μ_{44}	1.6567a	0.1599	1.7013a	0.1651
μ_{45}	0.4476a	0.0740	0.5010a	0.0771
μ_{46}	0.0181	0.0335	-0.0113	0.0343
μ_{47}	1.4561a	0.1159	1.4959a	0.1200
μ_{48}	0.0726c	0.0387	0.0442	0.0397
μ_{49}	0.3498a	0.0622	0.3260a	0.0641
μ_{50}	-0.4387a	0.1156	-0.6216a	0.1273
μ_{51}	0.3902a	0.0753	0.4610a	0.0769
μ_{52}	-0.2697a	0.0467	-0.3107a	0.0487
μ_{53}	0.7927a	0.0845	0.8458a	0.0893
$R^2_{adjusted}$	0.9991	-	0.9989	-

Parameter	estimate	std error	estimate	std error
B. Risk functions:				
β_{y1}	-0.0116a	0.0038	-0.0016	0.0060
β_{y2}	-0.0017c	0.0010	-0.0008	0.0010
β_{y3}	0.0082	0.0068	-0.0015	0.0081
β_{y4}	0.0069	0.0053	0.0006	0.0051
β_{w}	0.0263a	0.0049	0.0213a	0.0049
β_{q}	0.0014	0.0023	0.0019	0.0022
β_{t}	0.0007	0.0015	0.0031c	0.0016
σ^2_v	4.3422	-	5.6570	-

Significant at the less than 1% (a), 1-5% (b), and 5-10%(c) levels of significance.

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