ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

2011

working paper series

EMPLOYMENT EFFICIENCY AND PRODUCTION RISK IN THE TUNISIAN MANUFACTURING INDUSTRIES

Almas Heshmati and Ilham Haouas

Working Paper No. 602

EMPLOYMENT EFFICIENCY AND PRODUCTION RISK IN THE TUNISIAN MANUFACTURING INDUSTRIES

Almas Heshmati and Ilham Haouas

Working Paper 602

July 2011

The authors would like to thank Ragui Assaad and other participants at the ERF 17th (2011) Annual Conference at Antalya for their comments and suggestions on an earlier version of this paper.

Send correspondence to:
Almas Heshmati
Korea University
heshmati@korea.ac.kr

First published in 2011 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

This paper specifies a flexible model of labor demand in the manufacturing sector. The model is further extended to incorporate a risk function part which allows identifying the determinants of both level and variations in the employment. The risk function is particularly important when designing public policies that are geared at reducing the variance of employment or those policies that seek to increase employment in manufacturing. Since the variance of the function is both industry- and time-specific, it allows for the identification of industries that are from the perspective of vulnerable employment and design of policies targeting specific segment of the industry. In addition the paper looks at the time variant efficiency of the manufacturing industry in the choice of the level of employment that is technically necessary to produce a given level of output to satisfy the market demand. In applying this model to Tunisian manufacturing sector we add another dimension to the development of the literature on the estimation of a labor demand relationship.

ملخص

تحدد هذه الورقة نموذجا مرنا من الطلب على العمالة في قطاع الصناعة التحويلية. ويمتد كذلك إلى نموذج لدمج جزء من دالة المخاطر التي تتيح التعرف على محددات كل من المستوى والاختلافات في العمل. لوظيفة المخاطر أهمية خاصة عند وضع السياسات العامة التي تهدف إلى الحد من التباين في العمل أو تلك السياسات التي تسعى إلى زيادة العمالة في الصناعة التحويلية. وبما ان الفرق في الوظيفة سواء على مستوى الصناعة والوقت ، فإنه يسمح لتحديد الصناعات التي هي من وجهة نظر العمالة ضعيفة وتصميم السياسات التي تستهدف شريحة معينة من الصناعة. بالإضافة إلى ان الورقة تبحث في كفاءة الوقت في قطاع الصناعة التحويلية في اختيار مستوى العمالة التي يتم من الناحية الفنية اللازمة لتحقيق مستوى معين من الإنتاج لتلبية الطلب في السوق. وفي تطبيق هذا النموذج على القطاع الصناعي التونسي نضيف بعدا آخر لأدب تقدير علاقة الطلب واليد العاملة.

1. Introduction

The Tunisian manufacturing sector has been the subject of various shocks and public policy-related changes. During the import substitution period (1971–1986), the manufacturing sector evolved through a highly regulated economic environment. These controls had both a direct and indirect bearing on how the manufacturing sector used its available developmental resources. The resulting low degree of competition has caused the quality of Tunisian products aimed for the domestic market to remain, as a rule, below international standards . Consequently, firms are often not equipped or managed so as to compete on quality, but rely on occupying market niches with short term perspectives, low growth potential and high market risks. In the labour market, for example, the government introduced minimum wages and adopted a rigid wage structure, both of which prevent a close linkage between base wages and performance-based bonuses. Additionally, the dismissal of employees as a measure to cut costs, or to change the skill mix of the firm's workforce, requires authorization which is not easily obtained, and entails substantial severance payments. The effect is that laziness and absenteeism have become difficult to punish, resulting in lower labour productivity and growth and deteriorated national and international competiveness.

Nabli (1981), Morrison (1987), Abdennadher et al. (1994), Sekkat (1996) and Boughzala (1997) are among previous important studies which provide detailed information about the Tunisian manufacturing sector and its evolution over time. Until 1986, the government's regulations fostered very satisfactory results. However, the context became less favourable, notably between 1984 and 1986, because of several factors such as the fall in oil prices, the return of 30,000 workers who had emigrated to Libya, and conflicts between the government and trade unions in 1978, 1980, and 1984. The state proceeded with a comprehensive public investment policy based on borrowing so massively that Tunisia was threatened by the emergence of a financial crisis. In 1987, in exchange for financial assistance from the World Bank and the International Monetary Fund (IMF), the government accepted conditions which led to the adoption of a structural adjustment program. Thus, the Tunisian government turned towards liberalization of the economy and redirected its development strategy in order to place more emphasis on the private sector. Additionally, in parallel to its accession to the General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) and its membership of the Maghreb Customs Union on July 17, 1995, Tunisia became the first country in the Middle East and North Africa (MENA) to sign a Free Trade Agreement with the European Union (EU). The benefits to Tunisia from this trade liberalization should be substantial and pass through various channels (see Papi and Zazzaro, 2000). In addition, trade liberalization has the disadvantage that it can lead to lower prices for imported goods.

Tunisia is an importer of capital equipment, and given complementarities between capital and labour, employment is expected to rise. According to the standard theory of international trade, following integration, employment and total factor productivity should increase for a number of reasons. First, the increases are a result of the better allocation of existing resources (the static effect) and the greater competitiveness of markets, goods, and factors, as well as the expansion of potential markets and the full exploitation of scale and scope economies (the dynamic effect). Secondly, the employment and efficient allocation of labour will increase as a result of foreign and domestic investments stimulated by policies of trade liberalization. Thus, the advantages of foreign investments in addition to an immediate increase in aggregate demand, is that it contributes to knowledge transfers, opportunities to gain professional expertise, and commercial contacts. However, employment benefits will pass through to new investment. This will cause re-allocation of production factors to sectors with greater competitive advantages and, consequently, a general strategy for reform and modernization will develop.

A striking example of the abovementioned process is the plan for industrial restructuring and modernization (labelled locally as 'mise a` niveau program'). The aim of this plan is to prepare the

Tunisian manufacturing firms for the liberalization of markets and for the greater competition that will arise. This program has been accompanied by generous tax breaks for investment in the exporting sector, progressive rationalization of the regulatory framework, and infrastructure development. To increase the flexibility of labour regulations, the national labour code was revised in 1994, and again in 1996, to clarify the conditions under which workers can be laid off for cost-saving reasons and to establish guidelines for financial compensation.

The intent of this paper is to model labour demand in the manufacturing sector[1]. We go further than other studies as we not only seek to explain what determines the level of employment but also to identify the factors that affect the variance of employment in the manufacturing sector that has not only expended sluggishly, but it has also exhibited great variation other time. This is important when designing policies that are geared at reducing the variance of employment or those policies that seek to increase employment. Since the variance of function is both industry- and time-specific, it allows for the identification of industries that are vulnerable and policies can target specific segment of the manufacturing industry. In addition the paper looks at the efficiency of the manufacturing industry in the choice of the level of employment that is technically necessary to produce a given level of output. In applying this model to the manufacturing sector we add another dimension to the literature on the estimation of a labour demand relationship.

In sum, the objectives of this paper are threefold. First, it is concerned with estimating an employment relationship. Second, in estimating the employment relationship we seek to account for the different dimensional variations in employment. Finally, the paper addresses the issue of employment efficiency. The focus is on Tunisian's manufacturing industry. This is an important area of research considering that the sector has evolved through a series of economic regimes and policies mostly of an experimental nature and with a priori unknown expected outcomes of the public interventions.

Labour demand is modelled in the traditional manner as a function of wage, output, quasi- fixed capital and a time trend variable (see Layard and Nickell, 1986; and Symons, 1985). The variance function can be incorporated in the model both additively and multiplicatively to the employment relationship, which may include the above variables plus other factors that influence variations in employment. This is similar to a labour demand model that exhibits heteroscedasticity of known from[2]. In modelling the level and variance of employment we generalize some techniques that have been used earlier in the studies of labour demand, labour use, production risk and efficiency.

Just and Pope (1978)[3] championed the issue of incorporating the variance function and its specification. Since the Just and Pope study is on production, the variance function is appropriately referred to as the production risk function. Kumbhakar (1993) extended the production risk model to incorporate production efficiency. Kumbhakar and Hjalmarsson (1995) studied labour use efficiency in the public insurance industry. The labour use model is a special case of the labour demand model. The labour use approach is found to be appropriate in the analysis of service industries where labour is the dominant factor of production.

The labour demand model and labour use efficiency combined with employment variance is applied to Swedish Savings banks data. by Heshmati (2001). Heshmati and Ncube (2004) applied

[1] Employment is equivalently defined as the labour demand. The use of labour demand is perhaps more appropriate in relation with firm level data. Since we use an aggregate data at manufacturing level throughout the paper we use the term employment as well.

[2] For a detailed discussion of heteroscedasticity of known and unknown forms, see Kmenta (1986, Chapter 8) and an application in Heshmati (1994).

[3] For a comprehensive discussion of the issue of the risk/variance in production, a survey in variance estimation method and their properties with an application to the Norwegian salmon aquiculture, see Tveterâs (1997). For a discussion on firm's response to risk, see Robinson and Barry (1987).

a similar approach to employment in Zimbabwe. Our study is the first attempt to apply this methodology in extended form to the manufacturing industry and to a developing country.

The rest of the paper is organized as follows. The employment model is presented in section 2. Section 3 contains the description of the data. Section 4 presents the model specification and the estimation procedures. The results are discussed in section 5 and the main findings of the study are summarized in section 6.

2. The Model

Let the labour demand or employment relationship for Tunisian's manufacturing industry be represented by:

$$L= f\ (Y, W, K, t; \alpha) \qquad (1)$$

where f is the production technology, L is the level of employment (measured as number of persons) used in the production of a given level of output, Y, and α is a vector of unknown parameters to be estimated. The variables W, K and t are wages, capital inputs and time trend representing technology, respectively[4]. This relationship is similar to an inverted function or input requirement function introduced by Diewert (1974) and Pindyck and Rotenberg (1983).

The employment function above defines the amount of labour that is required to produce a given level of output. Thus the level of employment depends on productions technology $f\,(.)$, technical inefficiency (μ) and other random factors that have both positive and negative impacts on the industry's demand for the labour (v), but they are beyond the control of the industry. Examples of the factors contained in this random component (v) are the external or internal shocks like oil crises, labour market conflicts, unanticipated government policies, etc.

The labour demand model after appending a random error term capturing efficiency differences in use of labour across industry sectors and random shocks is rewritten as:

$$L = f\,(Y, W, K, t; \alpha)\ exp(\varepsilon) \qquad (2)$$

where $\boldsymbol{\varepsilon} = \mu + v$. The random component ($v$) can be either positive or negative, i.e. $-\infty \leq v \leq \infty$. Following Aigner, Lovell and Schmidt (1977), μ is one-sided, $\mu \geq 0$. For the industry that is 100% efficient in the usage of labour, i.e. $\mu=0$, the relation in (2) becomes the conventional average labour demand function. Here the fully efficient unit is used as a reference unit in minimizing the use of labour in producing a given level of output and for a given technology.

The relation above ignores the issues of production risk or heteroscedasticity denoted earlier as the variance of employment. However, in some industries where risk is important, a labour demand function that ignores production risk is restrictive. The inclusion of production risk improves the stochastic component of the labour demand function. In addition, the incorporation of risk is important in cases where knowledge about the variance of employment can play a major role in the design and evaluation of labour market policies that seek to improve employment conditions or labour productivity that is crucial for determination of wage and competitiveness.

To derive the implications of the presence of risk following Kumbhakar (1993), the labour demand accounting for risk is written as:

$$L=f(X; \alpha)\ exp\ (g(X, Z; \beta)\varepsilon) \qquad (3)$$

where $X=(Y, W, K, t)$, and $f(X; \alpha)$ is the deterministic part of the labour demand function and $g(X, Z; \beta)$ represents the variance function of the labour demand. In the variance function the Z vector represents industry characteristics and regulatory regimes such as export, money supply, exchange

[4] The capital variable (K) is considered as the stock of capital and treated a quasi-fixed and introduced to capture variation in the production structures between industries.

rate, government expenditure, saving, credit, foreign direct investment, industry value added, and GDP growth variables, that may influence the variation of labour demand, other than the variables that explain the demand for labour; i.e. the *X-variables*. This is an attempt to relate risk/variance with output and/or input decisions made by the industries. A failure to capture risk in the model reduces the problem to that of simple heteroscedasticity and the degree of which is related to output, inputs and other exogenous variable. The objective is to analyse how riskiness affects input use and production and its outcome. Industries should care about risk in making output and employment decisions. It is desirable to have a model that incorporates risk aspects of production.

Transforming the combined labour demand and risk function to logarithmic form reduces the model to a linear relation in parameters written as:

$$\ln l = \ln f(x; \alpha) + g(X, Z; \beta)\varepsilon \quad (4)$$

This specification has three attractive features. First, $\ln f(.)$ can be expressed in a flexible functional form such as a translog. Second, the expected value of the labour demand function $E(l)$ and its variance $V(l)$ are both affected by risk. Third, the specification accommodates both positive and negative marginal risks even if $g(.)$ is a linear function of input variables.

The expected value and variance of the model (3) is:

$$E(l)=f(x; \alpha)\exp(g^2(.)/2) \text{ and} \quad (5)$$

$$V(l)=f^2(.)\exp(g^2(.)/2[\exp(g^2(.)/2)-1] \quad (6)$$

If $E(l) \geq f(x; \alpha)$ then the marginal risk function is:

$$MR_j=\frac{\partial V(l)}{\partial xj}=2f(.)\exp(g^2(.)/2)\,[f_j(.)\{\exp(g^2(.))-1\}+f(.)g(.)g_j(.)\{2\exp(g^2(.))-1\}] \quad (7)$$

where $f_j(.)$ and $g_j(.)$ are respectively partial derivative of the $f(.)$ and $g(.)$ functions with respect to x_j. From equation (7), it can be seen that the marginal risk with respect to x_j can be either positive or negative depending on the sign of the $g(.)g_j(.)$ term that varies with x_j across industry and overtime. If $g(.)g_j(.)>0$, the marginal risk with respect to x_j is unambiguously positive and the other hand, it is unambiguously negative if $g(.)g_j(.)<0$ and the second term under [.] is greater (in absolute value) than the first term.

3. Data

The data used in this study have been assembled using a diversity of sources, such as the national accounts of the Tunisian National Statistics Institute (INS), statistics coming from the Quantitative Economy Institute (IEQ) and indicators from the World Bank Indicators Database (2009). This was to allow the construction of an integrated database of national, industrial, labour market, and trade statistics. The industries included are: (i) food processing industry, textiles, clothing and leather industry, (ii) chemical industry, (iii) construction material, (iv) ceramics and glass industry, (v) mechanical electric industry, and (vi) and other manufacturing industry (including paper and pulp, plastics, etc.). Thus, the data consists of a balanced panel data of six Tunisian manufacturing industries observed from 1971 to 2009.

The depended variable (*L*) is total employment, and the vector of independent variables (X) in the labour demand part of the model, in addition to wages (*W*), capital (*K*), and output (*Y*), include a number of determinants of employment such as export (*EXP*), money supply (*MON*), government expenditure (*GOV*), gross savings (*SAV*), domestic credit to private sector (*CRE*), foreign direct investment (*FDI*), industry value added (*VAL*), and *GDP* growth (*GDP*)[5]. The employment

[5] The justification for the including, the determinant variables in the variance function is that this function has to capture policy and the environmental variables that may affect the variation of employment. Take for example sales, where one would expect fluctuations in sales to cause same fluctuations in employment. The same applies to these

variable is the total number of employees in each industry. Wages are defined as annual wages obtained from the ratio of total wages in each industry divided by the total number of employees in that industry. Thus, the wage variable is industry-specific. The average wages are then deflated by the consumer price index. Capital is considered as the stock of capital. It is measured as value of capital equipment. Output is measured by the output index of each industry. The output variable defined as value-added is measured as value of production less material and energy expenses.

Export is measured as constant total value of export in 1971 prices. Money supply is represented by *M2*. The output, export, money supply, and capital stock are deflated by the GDP deflator. Government expenditure is measured in Tunisian Dinars and is deflated by the consumer price index. Gross savings are calculated as gross national income less total consumption, plus net transfers. Domestic credit to private sector refers to financial resources provided to the private sector, such as those through loans, purchases of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment. For some countries these claims include credit to public enterprises. Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise.

This study utilizes industry level data. One main reason for using industry level data is lack of data availability at the firm level. Industry level data has the disadvantage that difficulties in the aggregation of data may distort the data and within industry variations are not captured. Employment is internally determined at the firm level, while employment policy and overall market situation determine it at the industry level. It should be mentioned that, employment growth is also affected by a number of other factors such as regional industrial policy and conditions like specialization, diversity, competition, agglomeration, wage level, quality of workforce, and policy measures such as designation of industrial zones to mention a few. Thus using industry level data we are able to control for industry effects but neglect firm heterogeneity in responses to production environment changes. If firm level data is available, one will be able to account for within sector firm heterogeneity by size, location, ownership, export orientation and R&D activities.

Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. GDP growth is annual percentage growth rate of GDP at market prices based on constant local currency. A vector of *T-1* time dummies are used to represent the exogenous rate of technical change in the labour demand function and a time trend is used to capture possible shifts in the variance function over time. In addition, N-1 industry dummies are used to capture industry-specific effects. Summary statistics of the data is found in Table 1.

4. Estimation Procedure

Since model (3) assumes no priori functional form, a less restrictive (translog) specification is used to approximate $f(x; \alpha)$ and a linear form for $g(X, Z; \beta)$. Assuming panel data (see Baltagi, 2008) are available, the model in (4) is expressed as:

$$\begin{aligned} \ln l_{it} &= \alpha_0+\alpha_y \ln y_{it}+\alpha_w \ln w_{it}+\alpha_k \ln k_{it}+\lambda_t+1/2\{\alpha_{yy}\ln y^2_{it}+\alpha_{ww}\ln w^2_{it}+\alpha_{kk}\ln k^2_{it}\} \\ &+\alpha_{yw}\ln y_{it}\ln w_{it}+\alpha_{yk}\ln y_{it}\ln k_{it}+\alpha_{wk}\ln w_{it}\ln k_{it}+\alpha_{yt}\ln y_{it}t++\alpha_{wt}\ln w_{it}t+\alpha_{kt}\ln k_{it}t \qquad (8) \\ &+ \{\beta_y Y_{it}+\beta_w W_{it}+\beta_k K_{it}+\textstyle\sum_j \beta_j Z_{jit}+\beta_t t\}\ [\mu_i+v_{it}] \end{aligned}$$

determinants of levels and variations in employment. Some of these variables have previously been added in employment functions, e, g. Leard and Nickel (1986), and Symons, (1985).

where l, w, y and k are in log form and as previously defined and i indexes industries $(i=l,2,\ldots,N)$, t indexes time periods $(t=1,2,\ldots,T)$, and λ_t represents a vector of yearly time dummies. In order to reduce the number of parameter estimates, for the interactions between the right hand explanatory variable with the time effect a simple time trend is used.

Flowing Just and Pope (1978) and Griffiths and Anderson (1982), a four-step generalized least squares estimation procedure is used to estimate the model (8).[6] The steps are as follows:

<u>*Step 1.*</u> The $g(.)$ function is ignored and model (8) is estimated by least squares dummy variable method. Besides the α coefficients, the μ and λ are respectively estimated from $N-1$ and $T-1$ industry and time dummies. Since $E(v)=0$,the ordinary least squares estimate are consistent but inefficient because the error term is heteroscedastic.[7]

<u>*Step 2*</u>. The estimates of the α, λ and μ from step 1 are used to obtain the residuals:

$$e_{it}= \ln l_{it} - (\alpha_0+\alpha_y lny_{it}+\alpha_w lnw_{it}+\alpha_k lnk_{it}+\lambda_t+1/2\{\alpha_{yy} lny^2_{it}+\alpha_{ww} lnw^2_{it}+\alpha_{kk} lnk^2_{it}\}$$

$$+\alpha_{yw} lny_{it} lnw_{it}+\alpha_{yk} lny_{it} lnk_{it}+\alpha_{wk} lnw_{it} lnk_{it}+\alpha_{yt} lny_{it}t+\alpha_{wt} lnw_{it}t+\alpha_{kt} lnk_{it}t+\mu_i). \quad (9)$$

The estimates of the residuals in (9) are then used to estimate the variance part of the labour demand by non-linear estimation techniques as:

$$lne^2_{it}=-1.2704+ \ln \{\beta_y Y_{it}+ \beta_w W_{it}+ \beta_k K_{it}+\textstyle\sum_j \beta_j Z_{jit}+\beta_t t\}^2+lnv^2_{it}. \quad (10)$$

<u>*Step 3*</u>. Asymptotic efficient estimates of α and β are obtained by estimating models (8) and (9). This is similar to estimating models (8) and (9) by ordinary least squares after dividing both sides of it by the estimate of $g(.)$.

<u>*Step 4*</u>. Steps 1-3 are repeated until convergence is obtained.

The fixed effects obtained from the N-1 industry dummies are used to calculate employment efficiency. Employment efficiency is measured relative to the industry with the best performance in the sample, namely minimum of labour used to produce a given level of output. The best industry is taken to be 100% efficient or $\mu=0$. However, over time different industries can emerge as the best of the sample. Thus, time variant employment inefficiency (*EINEFF*) is obtained using Schmidt and Sickles (1984) approach.

As mentioned previously, employment inefficiency is relative to the most efficient industry in each year and is obtained as:

$$EINEFF_{it}= g(X_{it},Z_{jit}; \beta)\ (\alpha_0+\mu_i)-min_t[g(X_{it},Z_{jit}; \beta)\ (\alpha_0+\mu_i)]$$

$$=\{\beta_y Y_{it}+\beta_w W_{it}+\beta_k K_{it}+\textstyle\sum_j \beta_j Z_{jit}+\beta_t t\}(\alpha_0+\mu_i) \quad (11)$$

$$-min_t\ [\{\beta_y Y_{it}+\beta_w W_{it}+\beta_k K_{it}+\textstyle\sum_j \beta_j Z_{jit}+\beta_t t\}(\alpha_0+\mu_i)]$$

The rate of employment efficiency (*EEFF*) which is both industry and time variant is given by:

$$EEFF_{it}=exp(-EINEFF_{it}) \quad (12)$$

Since the estimated coefficients of the translog labour demand function employed are not directly interpretable, elasticities of the labour demand with respect to output, wages and quasi-fixed capital input are calculated as:

$$E_y=\partial lnl_{it} / \partial lny_{it}=\alpha_y+\alpha_{yy} lny_{it}+\alpha_{yw} lnw_{it}+\alpha_{yk} lnk_{it}+\alpha_{yt} t$$

---

[6] See Just and Pope (1978) and Griffiths and Anderson (1982) for details and properties of the estimates.

[7] For discussion on the issues of heteroscedasticity of unspecified form in standard production function framework, see Heshmati (1994). For estimation of efficiency in production assuming heteroscedasticity, see Caudill, Ford and Gropper (1995) and Kumbhakar (1997).

$E_w=\partial lnl_{it} /\partial lnw_{it}=\alpha_w+\alpha_{ww}lnw_{it}+\alpha_{yw}lny_{it}+\alpha_{wk}lnk_{it}+\alpha_{wt}t$ (13)

$E_k=\partial lnl_{it} /\partial lnk_{it}=\alpha_k+\alpha_{kk}lnk_{it}+\alpha_{yk}lny_{it}+\alpha_{wk}lnw_{it}+\alpha_{kt}t$

We expect a positive relationship between labour demand and increase in output, and a negative relationship between demand for labour and wages. A positive capital elasticity will indicate complementary relationship between labour and capital, while a negative substitutability. The elasticity of labour demand with respect to time, interpreted as the exogenous rate of technical change or shift in the labour demand over time are obtained in similar way as:

$E_t=\partial ln\ l_{it}/\partial_t=(\lambda_t-\lambda_{t-1})+\alpha_{yt}\ ln\ y_{it}+\alpha_{wt}\ ln\ w_{it}+\alpha_{kt}\ ln\ k_{it}$ (14)

Positive and negative signs of the interaction terms indicate the technological bias or labour-using or labour-saving technological change. All elasticities are calculated at each data point, thus the elasticities are both industry- and time-specific.

5. Empirical Results

The parameter estimates of the traditional simple labour demand functions (Model 1), where *f (x; α)* is specified assuming a time trend representation of technology and the combined labour demand and risk model, where in formulation of both of *f(x; α)* and risk function *g(X,Z; β)* technology is represented by a time trend (Model 2), and a alternative specification where technology in the labour demand is represented by a vector of annual time dummies, but a trend in the risk function (Model 3) are reported in Tables 2. In term of parameters signs, root mean square errors (RMSE), goodness of fit (R^2) criteria, the more restrictive Cobb-Douglas functional from were outperformed by the flexible translog specifications.

In the time trend model (Model 2), at least 77% of the coefficients are statistically significant in at least at 10% level of significance and all the X variables have the right sign. The R^2 is very high (0.972 for Model 1, 0.989 for the time trend Model 2, and 0.998 for the time dummy Model 3) suggesting a good fit for the data. All, (but two) industry dummies (compared with the reference industry which is the food industry) are statistically significant. In the Model 2, all but four coefficients are statistically significant in at least at 10% levels of significance. For the Model 3 all but nine coefficients are statistically significant at the 10% levels of significance. All industry dummies are statistically significantly different from zero.

The variance functions *g(X, Z; β)* were estimated using non-linear least square methods as described previously in relation with the steps of the estimation procedure. Convergence was obtained after 36 iterations for the time trend Model 2 and after 18 iterations for the time dummy Model 3. A trend was included in the variance functions to capture neutral shifts in the variance function over time. In the Model 2, the coefficients associated with output, capital, government expenditure, credit and industry value added are statistically significant at the 10% level of significance, while wages, output, government expenditure and GDP growth are significant in the Model 3. The R^2 for the variance functions is lower than those of the labour demand functions. It is 0.31 for the risk Model 2, and 0.17 for the alternative risk Model 3 specification.

For the labour demand functions, elasticities with respect to w, k, y, and time were calculated (as in equations 13, 14) and are reported in Tables 3.a, 3.b and 3.c corresponding to the traditional labour demand Model 1, time trend and time dummy risk models (Model 2 and Model 3) specifications. In order to conserve space these elasticities are evaluated at the mean values for each year and industry. In addition, in the same tables we report the mean values of the exogenous rate of technical change. The mean marginal elasticities of labour demand with respect to each risk factor are also reported in Tables 3.b and 3.c together with the total variance.[8] The mean

[8] Total variance is calculated as the sum of the marginal risk elasticities (excluding the time effects).

efficiency values by industry and over time are reported in the last column of Tables 3.b and 3.c. The overall sample mean and standard deviations of elasticities, marginal variance and efficiencies are also reported at the bottom of these tables. In Tables 4.a and 4.b, the correlation coefficients of the mean elasticities of the labour demand and marginal risk elasticities and rate of technical change for the Model 2 and 3 are presented.

5.1 Labour Demand Elasticities

The elasticities of labour demand with respect to wages, output and capital for all three models are reported in Tables 3.a, 3.b and 3.c. The signs of the elasticities are as expected. The time dummy Model 3 has larger overall wage elasticities, compared to the other models, i.e. -0.771 versus -0.389 and -0.362. The corresponding standard deviation is bigger compared with the Model 2. Looking at the individual industries there is much industry variation in labour demand responsiveness to wage changes. In the Model 1 labour demand responds greatest in the construction material and ceramic (-0.452) and food (-0.403) industries. In the time trend risk Model 2, labour demand responsiveness is greatest to wages in the following industries; food (-0.449), mechanic and electric (-0.400), textile and clothing (-0.399) and construction material and ceramic (-0.397). In the time dummy risk Model 3, labour demand responsiveness is greatest to wages in the chemical (-0.930), construction material and ceramic (-0.888), mechanic and electric (-0.821) and food (-0.789).

Concerning the temporal patterns of elasticities, in Model 1 wage elasticity increased sharply till 1989 and remained high during 1980s. It remained at somewhat lower level remaining study period. In the case of Model 2 there was decrease until 1974 but it increased during 1975-1980, then fluctuated along a constant path up to 2009 with certain stagnation during specific years. For the time dummy Model 3 wage elasticities decreased sharply until 1974, fluctuated until 1994 and then started to increase continuously until 2009. The deregulation of prices under structural adjustment triggered unprecedented inflationary pressures that saw real wages to reduce to their pre-1980 levels.

The sample mean elasticity of labour demand with respect to output for the basic Model 1 is 0.004 with a relatively large standard deviation of 0.139. The corresponding figures for the time trend risk model is 0.099 (0.097), and for the time dummy risk Model 3 is 0.088 (0.123) respectively. Responsiveness of labour demand with respect to output is greatest in the chemicals industry for the Model 2, construction material and ceramic, chemical and other manufacturing for the risk model, and food, chemical, mechanic electric, and construction material for the Model 3. Over time, responsiveness of labour demand to changes in output is negative and starts to increase from 1993 in the time trend Model 2 and continuously rises until 2009. The development of the output elasticity, given minor level difference, is somewhat similar for the time dummy risk Model 3.

On the basis of the sample mean values, the results show that a 1% increase in capital stock leads to a 0.021% increase in labour demand in the risk Model 2, while the corresponding figure for the time dummy Model 3 is 0.122% decrease in the labour demand. Responsiveness is greatest in the textile and construction material industries in all models. Overtime, the labour demand elasticities with respect to capital stock exhibits a less similar pattern for the two models (2 and 3). The responsiveness was greatest between 1977-1982, probably because of the opening up of the economy and the deregulation of the labour market. In addition to these results, the correlation coefficients in Table 4.a support the view that an increase in wages is associated with a fall in capital accumulation.

We now turn to the exogenous rate of technical change. The sample average rate of technical change for the basic time trend Model 1 is 0.048 and with standard deviation of 0.036. For the risk Models 2 it is approximately about the same level, 0.042 (0.025), but in the time dummy Model 3 the sample average rate of technical change is only 0.014 with a large standard deviation 0.156.

There is technical progress (labour saving) in the chemical industry in all the models. Out of this industry, the rate of technical progress is fastest. The industry with the largest regress is textile, followed by food in Model 2 and Model 3. The years in which there was labour saving technical progress are from 2005-2009 for Model 1, 2009 for t Model 2 and 1971-1974, 1984, 1987, 1994, 2008 and 2009 for Model 3. Technical progress was fastest between 1988 and 2009. This is the period when the economy was liberalized and many companies began to replenish their obsolete equipment. The deregulation of the labour market made it possible and easier to replace labour with machinery.

The results show large differences between employment elasticity with respect to wages between the two models. On the average the two models should produce similar responsiveness. The difference can be attributed to the fact that the time dummy model uses 36 parameters more for the neutral parts while for the interactions in both cases a trend is used to reduce the degree of over parameterization. Allocation of different weights to these two components may explain the differences in the elasticity. In absolute numbers the responsiveness is increasing indicating increasing negative relationship between employment and wages in recent years.

The negative capital elasticities reflect substitution between capital and labour and are a reflection of economic policies of the government in general and active capital-labour substitution policies in particular. The size of elasticity differs over time and across industries as a result of targeted incentives provided and heterogeneous technology development among the industries concerning substitution possibilities and labour requirements.

To summarise, the results suggest that labour demand responds most to wages, followed by capital stock changes, and lastly, to level of output. Larger variations in the pattern of the elasticities are found within industries than over time. The rate of technical regress was fastest during the reforms (averaging about 13.3% for the risk Model 2, and 19.5% for the risk Model 3).

5.2 Marginal Elasticities

The β coefficients (variance function) are reported in the lower panel of Table 2. In the time trend risk Model 2, five of the twelve coefficients are statistically significant and four of the twelve are statistical significant in the time dummy risk Model 3. The variance function coefficients for wages, output, exports, money supply, government expenditure, credit and FDI are positive in Model 2. For Model 3, the variance function coefficients are positive for wages, capital, output, exports, money supply, FDI, industry value added and GDP growth. The coefficients for capital stock, saving, industry value added, GDP growth are negative in Model 2. The negative coefficients in Model 3 are government expenditure and saving. The trend variable is negative in both models. The following variables are statistically significant; capital, output, government expenditure, credit and industry value added in the case of Model 2. In the case of Model 3, wages, output, government expenditure and GDP growth are negative. The RMSE and R^2 of Model 2 are respectively 1.925 and 0.309, but for Model 3 are 2.054 and 0.168 (the R^2 is high in the first model compared the second one). The estimate of the variance (σ^2_v) in Model 2 is 3.706, which is lower than that of Model 3, 4.222.

In Model 3, the coefficient associated with the variance function is not directly interpretable. Thus, marginal risk elasticities are calculated as in (7) and are reported in Table 3c. In Model 2 the coefficients are directly interpretable and are reported in Table 3b. An inspection of Table 3b shows that the marginal risk elasticities with respect to wages, with exception of textile, is small and negative in four of the 6 industries. Table 3.c show that this marginal risk elasticities with respect to wage is negative in five of the 6 industries. Over time, they are all negative except 1971, 2005-09 for Model 1 and positive in 1972, 1977, 1982, 1986, 2005, 2007, and 2009 for Model 2.

The overall risk elasticity with respect to output in the risk model is positive and small. The reason for this positive elasticity is because only two of six industries are negative: construction and chemical. It means that changes in this variable increase the variance in labour demand. Development of employment variance over time and for different industries is shown in Figure 1 and 2, respectively. Over time, in all but twelve years in the sample, is the mean marginal risk elasticity with respect to output negative but very close to zero. The overall mean risk elasticity with respect to capital is negative in the dummy model. The industries responsible for the negative output risk elasticities are food, mechanic, chemical, and textile.

The rate of technical change decreases the variation in labour demand in the two risk models. The overall mean marginal risk with respect to technical change is negative but relatively large (-1.548), and with a large standard deviation of 1.824. This decreasing effect is more pronounced in all the industries. Development of mean rate technical change over time and its variations across different industries is shown in Figure 3 and 4, respectively. Over time, the mean marginal risk with respect to technical changes decreases continuously.

In Table 3b and 3.c we report the mean total variance. The overall mean is positive for the two risk models 0.100 (0.313), and 0.043 (0.043). The figure in parenthesis is the standard deviation. The food and chemical industries have the greatest total variation in Model 2 and construction material and chemical for Model 3.

An extension of the traditional simple employment model to incorporate a risk function allows us to account for heteroscedasticity of known form capturing industrial heterogeneity. The modelling provides the opportunity to identify the determinants of variability in employment across industries and over time and to estimate the extent of these determinants impacts. This information sheds light on possible impacts from certain policies and is useful in the design and fine tuning of growth and employment policies to make them sector specific resulting in reducing negative external cross-industry effects and promoting policies with positive spill over effects.

5.3 Employment Efficiency

We now discuss the efficiency results.[9] The results computed according to equation (12) are reported in Table 3.b and 3.c. This measure captures how technically efficient an industry is in its choice of the optimal size of the labour inputs. It is a relative measure as it relates a particular industry to the most efficient one; in this case, textile and clothing. The sample mean efficiency values are 84% (0.142) for Model 2 and 91.5% (0.064) for Model 3. In brackets are the standard deviations. Thus, industries that are close to the average can be better off if, for given level of output, they reduce their demand for labour by between 16.0% and 7.5%. These are high figures by any standard. They reflect excess labour due to the absence of many years of necessary adjustment in manufacturing employment. Considering the fact that for almost a decade before 1991 adjustment of labour was not possible, then these figures, as they suggest some accumulation of the unadjusted stock of labour of between 7.5% and 16%, make sense.

According to the trend Model 2, the industries closer to the best (textile) are other manufacturing, mechanic and electric and construction material, at 89%, 83% and 82%, respectively. For the dummy Model 3, the industries closer to textile are food, mechanic and electric, other manufacturing and construction material, at 92.9%, 92.8%, 89.5% and 87.7%. The least efficient industry is the chemical at 71.5% for Model 2 and 85.7% in Model 3.

Development of mean efficiency over time and its variations across industries is shown in Figures 5 and 6, respectively. Over time efficiency increased sharply between 1971 and 1972. This was

[9] A word of caution is in order here. Care must be taken when interpreting efficiency considering the level of aggregation of our data.

followed by a fall in 1973 and between 1974 and76, and then fluctuated along a constant path up to 2009 for both models.

The pattern of efficiency across industries and time shows that industries are differently efficient in attaining optimal level of employment or labour requirement. These differences can be attributed to the firm's own responses to exogenous changes in the market or be a result of endogenous but optimal decisions made by firms. It can also be a result of public policies targeting certain industries, while neglecting others concerning, financing investment, capital accumulations, technology transfer, skill upgrading, human capital formation and management issues. A generally high level of inefficiency can also be a result of ineffective institutions and inadequate policies. A sufficient large degree of inefficiency between industries is an indication of the necessity to introduce incentives and various forms of interventions to enhance employment efficiency.

The correlation coefficients in Table 4.b show positive and significant correlations between wages and efficiency suggesting that increases in wages force industries to achieve a technically optimal size of labour. An increase in output or capital is associated with a fall in technical efficiency. The correlation is significant for capital, implying that more investment in capital drives industries away from having the technically optimal size of the labour-force. The positive (negative) marginal risks imply increases (decreases) in the level of technical efficiency. The correlation between the mean marginal risk with respect to wage and trend is also negative.

6. Summary and Conclusions

The purpose of this paper has been to estimate a labour demand function incorporating the variance function. This is an extension of previous labour demand models found in literature. The inclusion of the variance function in the specification of a labour demand model is aimed at identifying and estimating the effects of factors that cause fluctuations in labour demand. The variance function is incorporated both additively and multiplicatively to the ordinary labour demand function. Labour demand is a function of wages, output, capital and time variables. In addition to these variables, the variance function is specified as a function of exports, money supply, government expenditure, saving, credit, foreign direct investment, industry value added, and GDP growth. The model is non-linear and is estimated using a multi-step generalized least squares method.

The final model is specified as a translog form to represent the underlying functional form. Restricted versions such as the Cobb-Douglas and the traditional translog form with a time trend to represent the exogenous rate of shift in the demand function were rejected in favour of a translog form with annual time variant intercepts. The goodness of fit statistic, R^2 , for the labour demand models corrected for heteroscedasticity, indicates a good fit.

The elasticity with respect to wages was as expected, negative. The sample mean wage elasticity is between -0.389 and -0.771, depending on the model specification. The size of the wage elasticities vary more among industries than it does over time. Elasticities with respect to output are relatively small with means of 0.099 and 0.088 for the respective risk models. The output elasticity is increasing over time, from being negative in 1970s and highest in recent decades.

This pattern of development of output elasticity holds, when adjustment in the demand for labour in response to changes in output has been a slow process. Expansions in the level of output could be achieved using excess capital without equal increases in the labour force. The responsiveness of labour demand to changes in capital is also small with a sample mean value of between 0.021 and -0.122. The responsiveness was greatest during the period before the structural adjustment period than the period after.

Thus, briefly, labour demand results suggest that labour demand is more responsive to wage changes than it is with respect to the remaining variables, i.e. capital and output. This implies that increases in real wages have a negative impact on labour retention in the manufacturing sector, while investment and economic growth are essential for employment creation. Emphasis should be placed on policies that encourage capital accumulation and overall economic growth.

The results also suggest that during the sample period, for a given level of wages and output there has been some technical progress (labour saving) in the chemical industry in all the models. The overall mean rate of technical regress is estimated to be 4.2% for the time trend model and 1.4% for the time dummy model. This implies that new technologies that are adopted result in additional jobs. The mean rate of increase in employment by industry is within 4.1% in the time trend model and 2.1% in time dummy model. However, over time the rate fluctuates very much. The flexible time dummy model specification allowed us to capture the complex patterns of technical change quite well. We observed periodic switches from technical progress to regress and back to progress. Technical progress was fastest during the economic structural adjustment and liberalization phases.

Marginal variance elasticities with respect to wages, output, capital and trend and other indicators of risk were calculated for the risk function. The sample mean marginal risk elasticities with respect to the wages and time trend are negative whereas capital and output term gives us positive elasticities. Thus, for those industries close to the sample mean, wages and time trend decrease the variation, whereas capital and output increase the variation. Total variation has a sample mean value of 0.100 for the trend model. This is an indication that all the variables taken together increase the variance of labour demand.

The sample mean efficiency was found to be 84% for the trend model and 91.5% for the dummy model. In both models the textile industry is found to be more efficient in all years and thus, it is used as a reference for efficiency comparisons. The results indicate that the current or given level of output can be produced by between 7.5 % and 16% employment and using best technology. The industries closest to textile in terms of having the optimal size of the labour-force were other manufacturing, mechanic and electric and construction material for trend model and food, mechanic and electric, other manufacturing and construction material for dummy model. We find a positive association between increases in wages and improved efficiency. This means that as wage increases it forces employers to use their labour resources more efficiently. Large fluctuation in efficiency over time is an indication of the absence of the expected positive correlation between efficiency and time.

References

Abdennadher C., Karaa A. and J.M. Plassars (1994). Tester la Dualite´ du Marche du Travail: L'exemple de la Tunisie. *Revue d'Economie du De´veloppement* 2, 39–63.

Aigner D.J., Lovell C.A.K. and P. Schmidt (1977). Formulation and Estimation of Stochastic Production Function Models. *Journal of Econometrics* 6, 21-37

Baltagi B.H. (2008), Econometric Analysis of Panel Data, Third Edition, Chichester: John Wiley & Sons

Boughzala M. (1997). Impact on Workers Reduced Trade Barriers: The Case of Tunisia and Morocco. *International Labor Review* 136(3), 379–399.

Caudill S.B., Ford J.M. and D.M. Gropper (1995). Frontier Estimation and Firm-Specific Inefficiency Measures in the Presence of Heteroscedasticity. *Journal of Business & Economic Statistics* 13, 1-7.

Diewert W.E. (1974). Functional Forms for Revenue and Factor Requirements Functions. *International Economic Review* 15, 529-536.

Griffiths W.E. and J.R. Anderson (1982). Using Time-Series and Cross-Section Data to Estimate a Production Function with Positive and Negative Marginal Risks. *Journal of the Royal Statistical Association* 77, 529-536.

Hamermesh D. (1986), The Demand for Labor in the Long Run, in Handbook of Labor Economics, Volume 1, Chapter 8, eds. O. Ashenfelter and R. Layard, Amsterdam: Elsevier.

Hamermesh D. (1993), Labor Demand, Princeton, New Jersey: Princeton University Press.

Heshmati A. (1994). Estimating Random Effects Production Function Models with Selectivity Bias: An Application to Swedish Crop Producers. *Agricultural Economics* 11, 171-189

Heshmati A. (2001). Labor Demand, Labor-Use, Efficiency and Risk in Swedish saving banks. *Applied Financial Economics* 11, 423-433.

Heshmati A. and M. Ncube (2004). An Econometric Model of Employment in Zimbabwe's Manufacturing Industries**.** *Journal of Economic Development* 29(2), 107-130

Just R.E. and R.D. Pope (1978). Stochastic Specification of Production Functions and Economic Implications. *Journal of Econometrics* 7, 67-86.

Kmenta J. (1986), Elements of Econometrics, MacMillan: New York.

Kumbhakar S.C. (1993). Production Risk, Technical Efficiency and Panel Data. *Economics Letters* 41, 11-16.

Kumbhakar S.C. (1997). Efficiency Estimation with Heteroscedasticity in a Panel Data Model. *Applied Economics* 29, 379-386.

Kumbhakar S.C. and L. Hjalmarsson (1995). Labour-Use Efficiency in Swedish Social Insurance Offices. *Journal of Applied Econometrics* 10, 33-47.

Layard P.R.G and S. Nickell (1986). Unemployment in Britain. *Economica* 53, S89-S121.

Morrison C. (1987). Evolution of the Tunisian labor market. Discussion Paper No. 279 (Washington D.C.: Development Research Department, World Bank).

Nabli M. (1981). Alternative Trade Policies and Employment in Tunisia. In: Trade and Employment in Developing Countries, Edited by A. Kreuger (NBER and University of Chicago Press: Chicago).

Nickell S.J. (1986). Dynamic Models of Labour Demand, in Handbook of Labor Economics, Volume 1, Chapter 9, Eds. O. Ashenfelter and R. Layard, Elsevier: Amsterdam.

Papi L. and A. Zazzaro (2000). How Does the EU Agenda Influence Economies Outside the EU? The Case of Tunisia. Centro Studi Luca D'Agliano. Development Studies Working Papers, 148, 1–28.

Pindyck R.S. and J.J. Rotemberg (1983). Dynamic Factor Demands under Rational Expectations, *Scandinavian Journal of Economics* 85(2), 223-238.

Robinson L.J. and P.J. Barry (1978). The Competitive Firm's Response to Risk. Macmillan, New York.

Sekkat K. (1996). Regional Integration Among the Maghreb Countries and Free Trade with the European Union: A Challenge for both sides of the Mediterranean. *Journal of Economic Integration* 11(4), 421–452.

Schmidt P. and R.C. Sickles (1984). Production Frontiers and Panel Data. *Journal of Business and Statistics* 4, 367-374.

Symons J. (1985). Relative Prices and the Demand for Labour in British Manufacturing. *Economica* 52, 37-49

Tverteras R. (1997). Econometric Modelling of Production Technology under Risk: The Case of the Norwegian Salmon Aquaculture Industry. Unpublished Ph.D. Thesis, Department of Economics, University of Bergen.

Appendix

Figure 1: Development of employment variance over time, 1971-2009

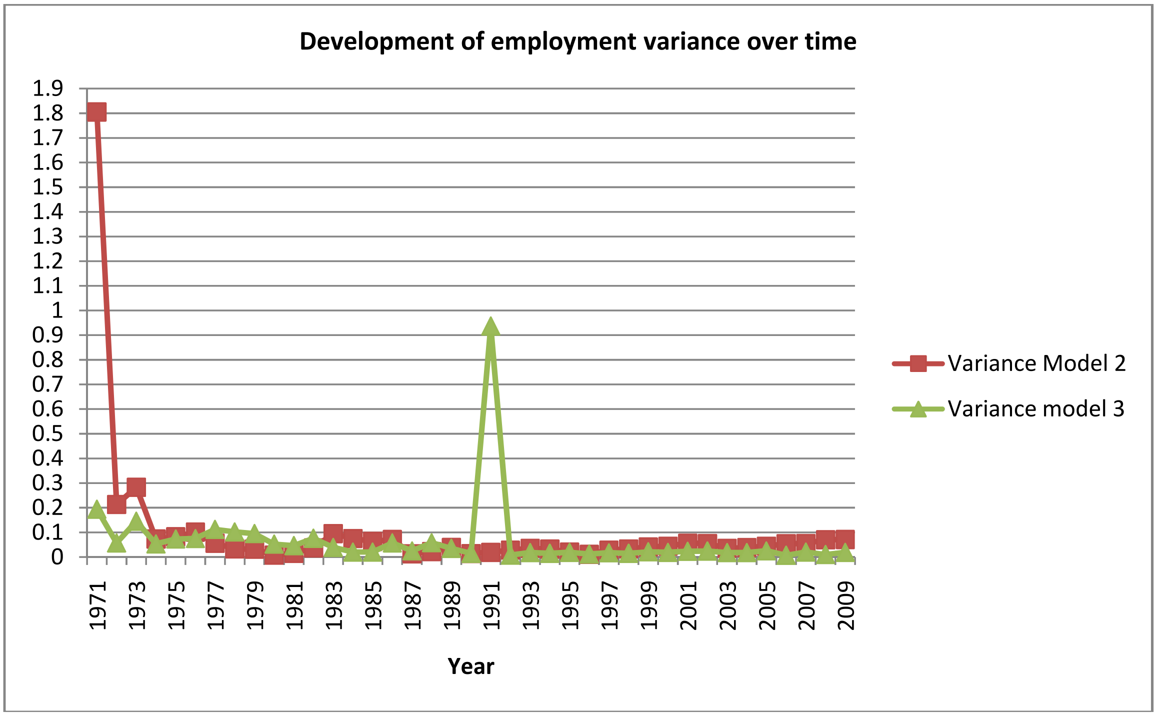

Figure 2: Industry level mean employment variance, 1971-2009.

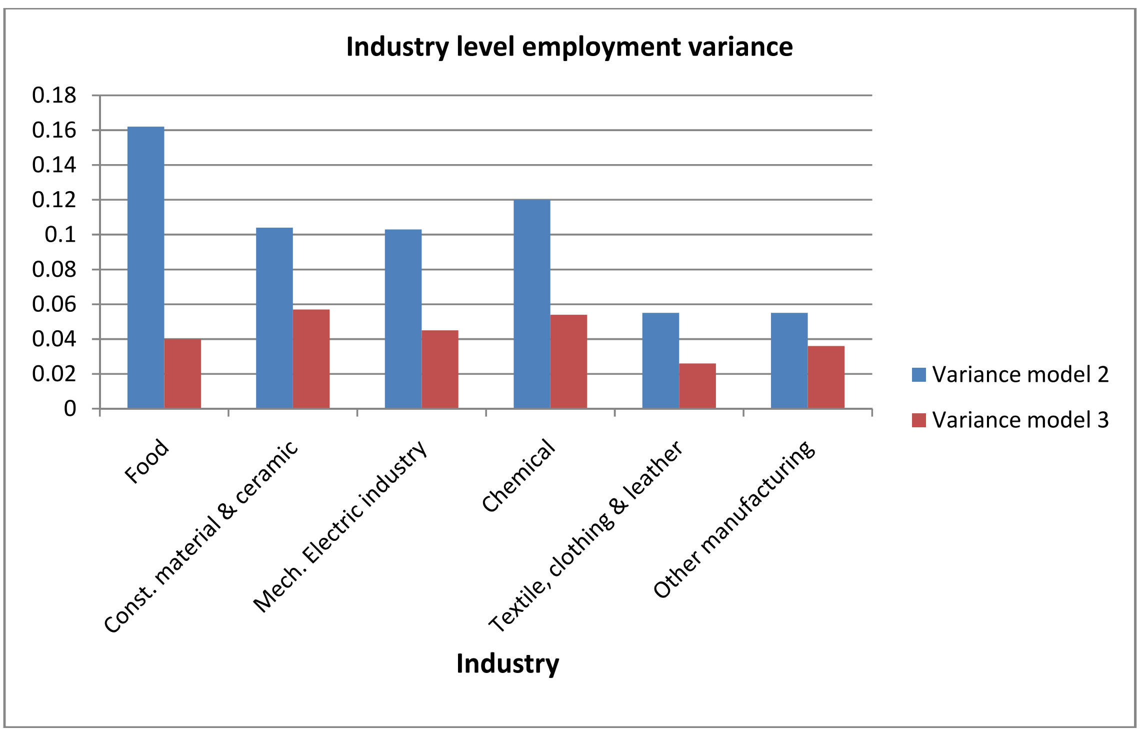

Figure 3: Development of technological change over time, 1971-2009

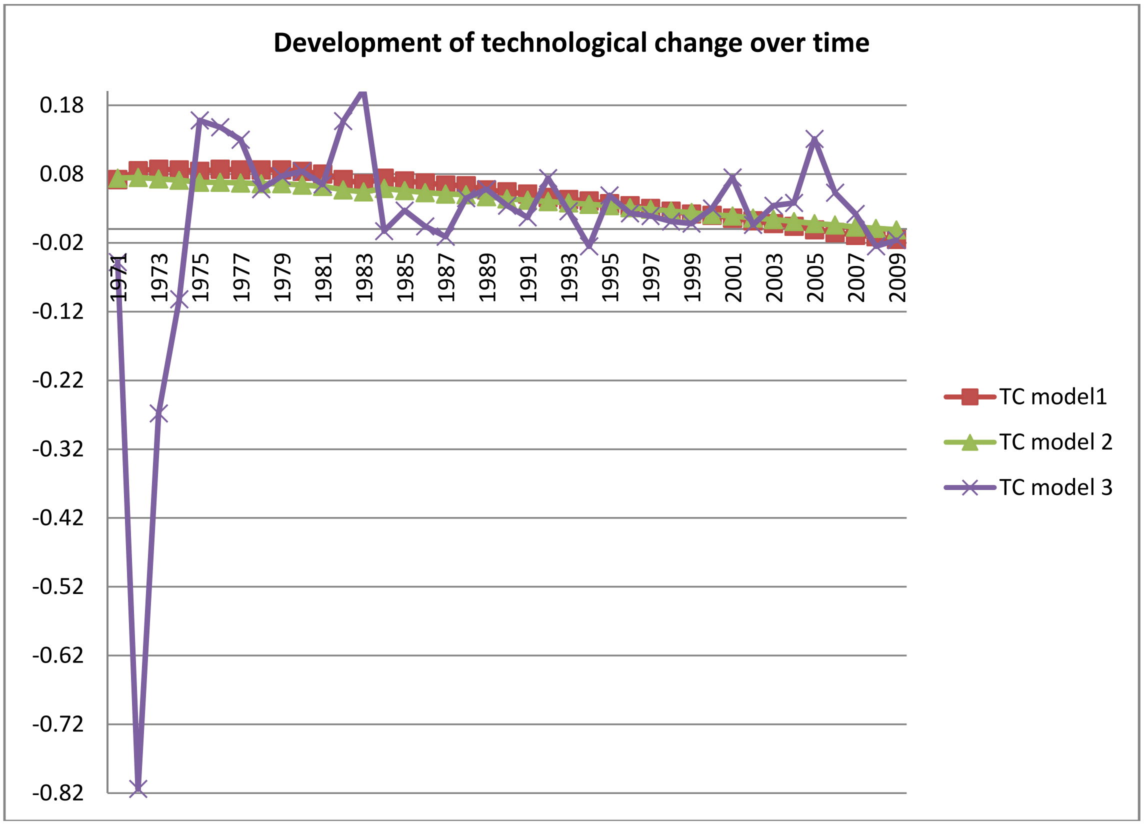

Figure 4: Industry level mean rate of technological change, 1971-2009.

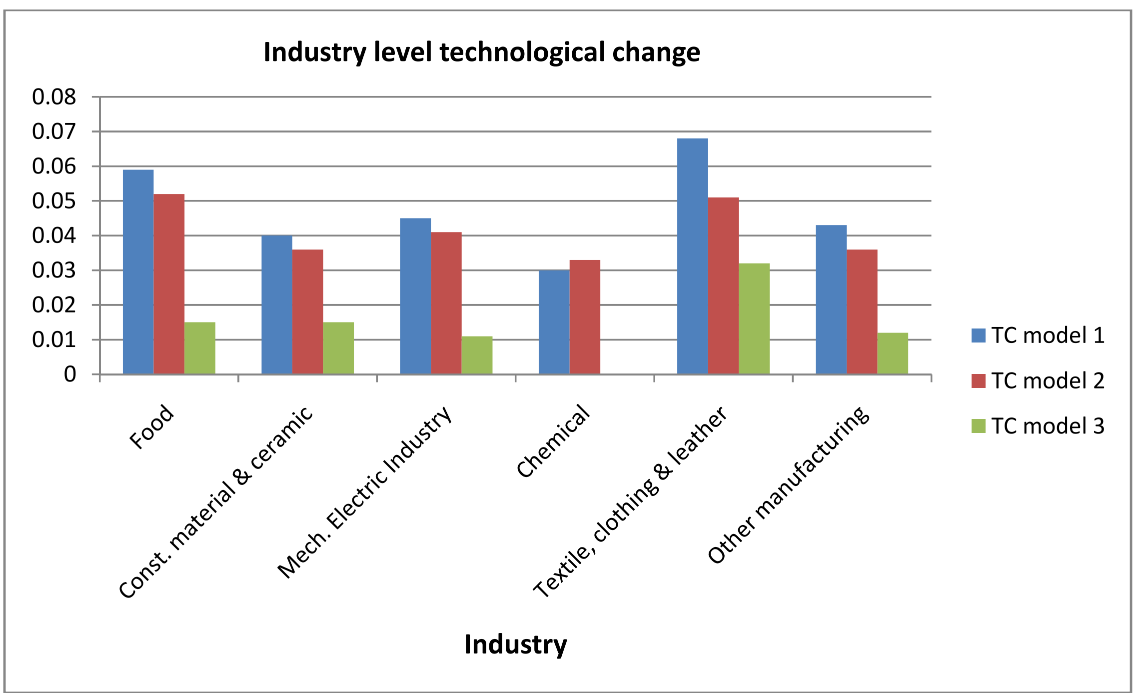

Figure 5: Development of efficiency over time, 1971-2009

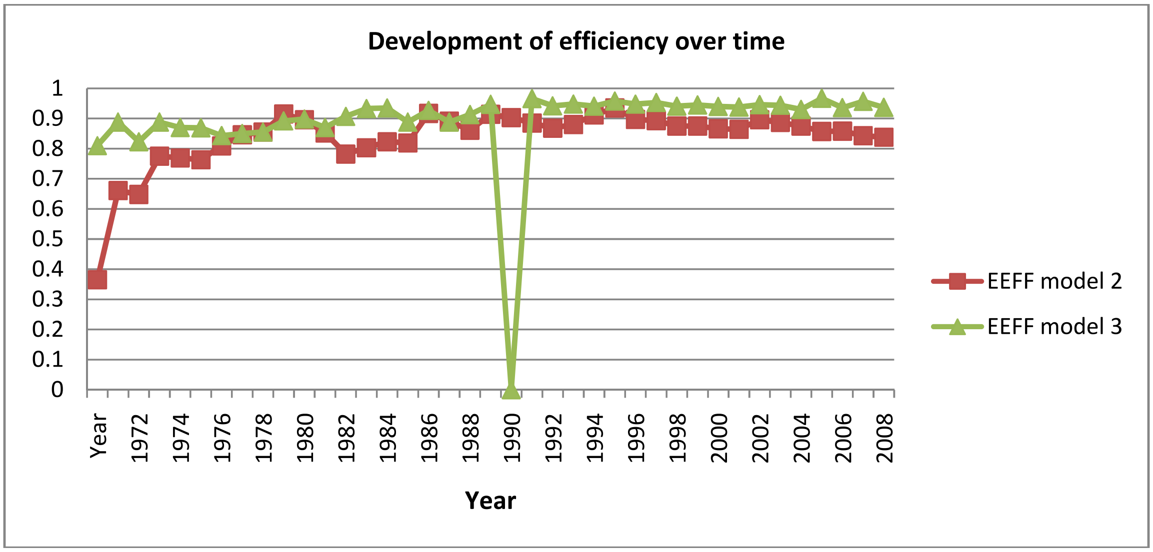

Figure 6: Industry level mean efficiency, 1971-2009

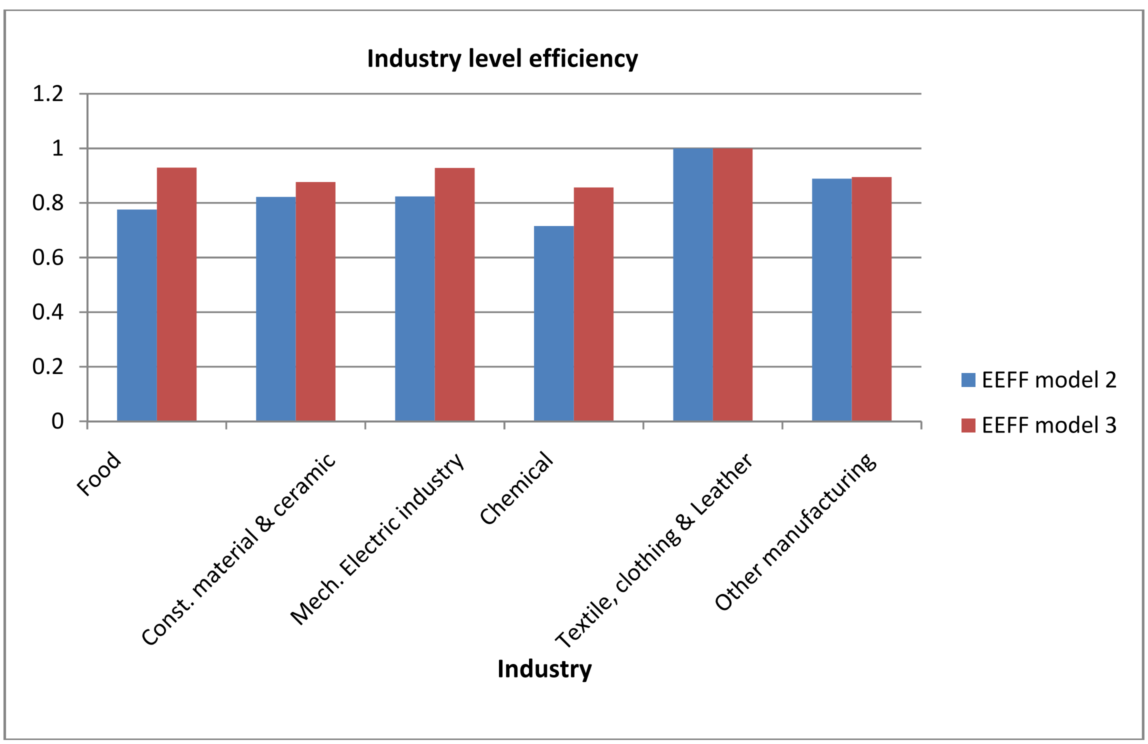

Table 1: Summary statistics of the Tunisian's manufacturing industry, 1971-2009

Variables		Mean	Std Dev	Minimum	Maximum
Labour demand variables					
e	Employment	61.97	65.66	4.83	276.27
w	Average Age	6455.05	6299.98	1060.81	60137.82
y	Output	685.66	580.09	47.98	2365.91
k	Capital	2019.53	860.49	779.46	5090.65
Other variance function variables					
g	Government Expenditure	3770.65	1569.13	1893.48	8846.15
m	Money Supply	11408.66	7487.07	2514.19	30957.28
x	Exports	2.12	0.71	1.23	4.22
s	Saving	22.74	1.80	19.29	27.42
cr	Credit	57.77	10.71	33.70	71.19
fdi	Foreign Direct Investment	2.42	1.85	0.60	10.56
Idva	Industry value added	28.74	3.08	20.06	33.85
gdpg	GDP growth	5.16	3.32	-1.45	17.74
t	Time trend	20.00	11.28	1.00	39.00

Notes: The number of observation is 234

Table 2: Labor Demand and Risk Functions Parameter Estimates

	Basic Time Trend Model 1		Time Trend and Risk Model 2		Time Dummy and Risk Model 3	
Parameter	**Estimate**	**Std. Errors**	**Estimate**	**Std. Errors**	**Estimate**	**Std. Errors**
2.a Labor Demand Function						
α_0	-2.405***	0.256	-2.087***	0.259	-0.470*	0.256
α_w	-0.191*	0.113	-0.432***	0.162	-0.389***	0.092
α_y	-0.536**	0.237	-0.282	0.231	0.003	0.151
α_k	-0.243	0.321	0.048	0.228	-0.569***	0.226
α_t	0.142***	0.024	0.112***	0.023		
α_{ww}	-0.004	0.023	-0.019	0.035	-0.099***	0.027
α_{yy}	-0.093*	0.059	-0.054	0.056	0.023	0.038
α_{kk}	0.521***	0.129	0.419***	0.083	0.463***	0.099
α_{tt}	-0.002***	0.001	-0.002***	0.001		
α_{wy}	0.015	0.058	-0.059	0.076	0.128**	0.050
α_{wk}	-0.329***	0.105	-0.088	0.096	-0.130*	0.079
α_{wt}	-0.009*	0.005	0.001	0.006	-0.019***	0.004
α_{yk}	0.059	0.124	0.114	0.091	0.037	0.078
α_{yt}	0.024***	0.009	0.017**	0.008	0.007	0.006
α_{kt}	0.011	0.014	0.003	0.009	0.025**	0.011
μ_{const}	-0.431***	0.082	-0.374***	0.060	-0.371***	0.052
μ_{mecha}	-0.067	0.059	0.035	0.047	0.048*	0.027
μ_{chemi}	-0.790***	0.077	-0.700***	0.065	-0.592***	0.039
μ_{texti}	1.293***	0.071	1.217***	0.065	0.977***	0.034
μ_{other}	0.099	0.092	-0.050	0.072	-0.390***	0.058
λ_{1972}					-0.790***	0.148
λ_{1973}					-1.046***	0.181
λ_{1974}					-1.138***	0.187
λ_{1975}					-0.975***	0.191
λ_{1976}					-0.829***	0.197
λ_{1977}					-0.704***	0.206
λ_{1978}					-0.654***	0.213
λ_{1979}					-0.588***	0.222
λ_{1980}					-0.516**	0.225
λ_{1981}					-0.463**	0.231
λ_{1982}					-0.313	0.241
λ_{1983}					-0.113	0.240
λ_{1984}					-0.123	0.248
λ_{1985}					-0.106	0.255
λ_{1986}					-0.112	0.264
λ_{1987}					-0.134	0.264
λ_{1988}					-0.098	0.267
λ_{1989}					-0.047	0.266
λ_{1990}					-0.018	0.266
λ_{1991}					-0.006	0.266
λ_{1992}					0.064	0.264
λ_{1993}					0.089	0.263

Table 2: Continued

	Basic Time Trend Model 1	Time Trend and Risk Model 2		Time Dummy and Risk Model 3		
Parameter	Estimate	Std. Errors	Estimate	Std. Errors	Estimate	Std. Errors
λ_{1994}					0.062	0.262
λ_{1995}					0.109	0.261
λ_{1996}					0.131	0.258
λ_{1997}					0.149	0.255
λ_{1998}					0.161	0.251
λ_{1999}					0.169	0.247
λ_{2000}					0.200	0.242
λ_{2001}					0.277	0.239
λ_{2002}					0.286	0.234
λ_{2003}					0.322	0.229
λ_{2004}					0.364*	0.225
λ_{2005}					0.502**	0.222
λ_{2006}					0.562***	0.215
λ_{2007}					0.593***	0.213
λ_{2008}					0.576***	0.209
λ_{2009}					0.571***	0.208
Ra^2	0.972		0.989		0.998	
2.b Risk Function						
β_W			0.087	0.402	4.517***	1.549
β_K			-6.014***	1.599	3.334	2.277
β_Y			0.976*	0.612	6.851***	1.893
β_T			-0.274	0.239	-0.425	0.333
β_X			2.860	2.179	1.561	3.138
β_M			1.481	3.019	7.292	4.842
β_G			3.004**	1.603	-11.855***	2.205
β_S			-0.241	0.265	-0.271	0.436
β_{Cr}			0.413***	0.139	-0.002	0.164
β_{fdi}			0.175	0.209	0.661	0.570
β_{ind}			-0.829***	0.323	0.375	0.407
β_{gdpg}			-0.146	0.166	0.704**	0.305
RMSE	0.159		1.925		2.055	
R^2	0.974		0.309		0.168	
σ^2_v	0.025		3.706		4.222	

Table 3.a: Mean Demand elasticities, Time Trend Model

	Demand Elasticities			
	E_W		E_K	E_T
Mean Elasticities by Industry				
Food	-0.403	-0.087	0.013	0.059
Const. material & ceramic	-0.452	0.091	0.129	0.040
Mech. Electric Industry	-0.378	0.014	-0.076	0.045
Chemical	-0.362	0.104	-0.282	0.030
Textile, clothing & leather	-0.360	-0.108	0.239	0.068
Other manufacturing	-0.215	0.008	-0.344	0.043
Mean Elasticities by Year				
1971	-0.216	-0.111	-0.995	0.072
1972	-0.238	-0.144	-0.530	0.085
1973	-0.251	-0.134	-0.318	0.087
1974	-0.221	-0.141	-0.341	0.086
1975	-0.264	-0.111	-0.182	0.084
1976	-0.317	-0.114	0.034	0.087
1977	-0.352	-0.108	0.126	0.086
1978	-0.383	-0.103	0.242	0.086
1979	-0.403	-0.101	0.322	0.086
1980	-0.406	-0.099	0.324	0.084
1981	-0.402	-0.086	0.312	0.080
1982	-0.395	-0.048	0.203	0.072
1983	-0.399	-0.025	0.126	0.066
1984	-0.412	-0.090	0.216	0.074
1985	-0.432	-0.064	0.281	0.070
1986	-0.435	-0.051	0.295	0.067
1987	-0.429	-0.039	0.288	0.064
1988	-0.410	-0.049	0.220	0.063
1989	-0.391	-0.033	0.128	0.057
1990	-0.389	-0.020	0.105	0.054
1991	-0.378	-0.015	0.061	0.051
1992	-0.373	-0.002	0.008	0.046
1993	-0.372	0.009	-0.026	0.043
1994	-0.367	0.011	-0.028	0.041
1995	-0.360	0.022	-0.061	0.037
1996	-0.356	0.036	-0.090	0.034
1997	-0.353	0.048	-0.117	0.030
1998	-0.354	0.061	-0.129	0.026
1999	-0.357	0.077	-0.152	0.022
2000	-0.359	0.089	-0.142	0.020
2001	-0.362	0.103	-0.171	0.016
2002	-0.369	0.122	-0.173	0.012
2003	-0.375	0.139	-0.162	0.008
2004	-0.377	0.153	-0.190	0.004
2005	-0.378	0.173	-0.255	-0.001
2006	-0.374	0.188	-0.290	-0.005
2007	-0.370	0.200	-0.321	-0.009
2008	-0.362	0.203	-0.334	-0.011
2009	-0.364	0.215	-0.370	-0.015
Overall Mean and Standard Deviations				
Mean	-0.362	0.004	-0.054	0.048
Std. Dev	0.110	0.139	0.401	0.036

Table 3.b: Mean demand elasticities, marginal risk and technical efficiency, Time Trend and Risk Model

	Demand Elasticities				Marginal Risk Elasticities				Efficiency	
	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
Mean Elasticities by Industry										
Food	-0.449	0.034	0.174	0.052	-0.044	0.091	-0.079	-1.283	0.162	0.776
Const. material & ceramic	-0.397	0.158	0.176	0.036	-0.071	-0.036	0.077	-0.473	0.104	0.822
Mech. Electric industry	-0.400	0.095	0.037	0.041	0.115	0.045	0.062	-1.385	0.103	0.824
Chemical	-0.375	0.121	-0.109	0.033	0.001	-0.104	0.036	-0.222	0.120	0.715
Textile, clothing & Leather	-0.399	0.083	0.175	0.051	-2.510	1.467	-0.181	-4.047	0.055	1.000
Other manufacturing	-0.316	0.105	-0.325	0.036	-0.324	0.024	0.217	-1.881	0.055	0.889
Mean Elasticities by year										
1971	-0.370	-0.154	-0.401	0.074	1.055	-0.106	0.269	0.004	1.805	0.365
1972	-0.346	-0.089	-0.213	0.075	-0.007	-0.034	0.010	-0.021	0.213	0.661
1973	-0.329	-0.042	-0.139	0.073	-0.135	-0.079	0.099	-0.073	0.283	0.648
1974	-0.317	-0.037	-0.194	0.071	-0.202	-0.073	0.027	-0.095	0.073	0.775
1975	-0.321	-0.000	-0.095	0.068	-0.342	-0.092	0.026	-0.168	0.082	0.769
1976	-0.339	0.022	0.061	0.068	-0.471	-0.080	0.063	-0.284	0.101	0.763
1977	-0.354	0.032	0.144	0.067	-0.396	-0.077	0.016	-0.322	0.056	0.809
1978	-0.365	0.048	0.227	0.066	-0.555	-0.089	-0.008	-0.452	0.033	0.846
1979	-0.373	0.060	0.284	0.066	-0.619	-0.091	0.005	-0.570	0.032	0.855
1980	-0.378	0.063	0.287	0.064	-0.642	-0.092	-0.021	-0.673	0.008	0.915
1981	-0.375	0.074	0.266	0.062	-0.699	-0.092	0.002	-0.839	0.015	0.896
1982	-0.371	0.083	0.195	0.057	-0.443	-0.092	0.106	-0.866	0.037	0.852
1983	-0.378	0.084	0.166	0.054	-0.404	-0.103	0.848	-0.993	0.095	0.782
1984	-0.407	0.055	0.255	0.059	-0.250	-0.067	0.852	-1.038	0.075	0.803
1985	-0.408	0.079	0.292	0.056	-0.517	-0.216	0.850	-1.085	0.063	0.823
1986	-0.407	0.092	0.291	0.053	-0.446	0.161	-0.809	-1.157	0.071	0.819
1987	-0.402	0.104	0.269	0.051	-0.653	0.012	-0.030	-1.166	0.013	0.917
1988	-0.405	0.093	0.223	0.050	-0.756	0.033	-0.006	-1.228	0.022	0.891
1989	-0.399	0.096	0.150	0.047	-0.693	0.060	0.026	-1.297	0.039	0.861
1990	-0.399	0.104	0.130	0.044	-0.722	0.092	0.004	-1.334	0.014	0.914
1991	-0.399	0.105	0.094	0.042	-0.769	0.121	0.375	-1.415	0.019	0.903
1992	-0.401	0.107	0.061	0.040	-0.618	0.160	-0.219	-1.486	0.028	0.885
1993	-0.403	0.111	0.040	0.038	-1.024	0.215	-0.332	-1.559	0.035	0.868
1994	-0.404	0.116	0.029	0.036	-0.866	0.288	-0.318	-1.698	0.032	0.880
1995	-0.402	0.122	-0.000	0.034	-0.825	0.298	-0.101	-1.804	0.020	0.912

Table 3.b: Continued

	Demand Elasticities				Marginal Risk Elasticities				Efficiency	
	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
1996	-0.401	0.130	-0.027	0.031	-0.932	0.418	0.010	-1.888	0.011	0.935
1997	-0.401	0.137	-0.049	0.029	-0.867	0.472	-0.070	-2.054	0.028	0.897
1998	-0.401	0.145	-0.061	0.026	-0.893	0.632	-0.129	-2.223	0.033	0.893
1999	-0.404	0.153	-0.074	0.024	-0.751	0.653	-0.176	-2.342	0.041	0.875
2000	-0.403	0.164	-0.076	0.021	-1.220	0.758	-0.266	-2.537	0.044	0.875
2001	-0.407	0.169	-0.090	0.019	-1.496	0.858	-0.402	-2.666	0.056	0.866
2002	-0.409	0.181	-0.091	0.016	-0.962	0.639	-0.500	-2.742	0.055	0.864
2003	-0.409	0.195	-0.090	0.014	-1.057	0.361	-0.213	-2.848	0.035	0.896
2004	-0.412	0.200	-0.104	0.011	-1.397	0.876	-0.117	-2.939	0.038	0.887
2005	-0.416	0.202	-0.137	0.008	0.164	0.712	0.023	-2.944	0.044	0.875
2006	-0.415	0.209	-0.163	0.006	0.617	0.702	0.117	-3.185	0.054	0.857
2007	-0.415	0.215	-0.189	0.003	0.787	0.759	0.201	-3.350	0.055	0.858
2008	-0.414	0.221	-0.210	0.001	0.716	0.879	0.308	-3.530	0.070	0.843
2009	-0.419	0.223	-0.225	-0.001	0.875	0.887	0.337	-3.514	0.071	0.838
Overall Mean and Standard Deviations										
Mean	-0.389	0.099	0.021	0.042	-0.472	0.248	0.022	-1.548	0.100	0.838
Std. Dev	0.054	0.097	0.307	0.025	1.608	0.994	0.918	1.824	0.313	0.142

Table 3.c: Mean demand elasticities, marginal risk and technical efficiency, Time Dummy and Risk Model

	Demand Elasticities				Marginal Risk Elasticities				Efficiency	
	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
Mean Elasticities by Industry										
Food	-0.789	0.163	-0.014	0.015	-0.078	-0.080	-0.053	-0.592	0.040	0.929
Const. material & ceramic	-0.888	0.104	0.076	0.015	-0.060	0.014	0.012	-0.265	0.057	0.877
Mech. Electric industry	-0.821	0.114	-0.109	0.011	0.127	-0.067	-0.042	-0.896	0.045	0.928
Chemical	-0.930	0.127	-0.238	0.000	-0.042	-0.060	-0.001	-0.105	0.054	0.857
Textile, clothing & leather	-0.571	0.028	0.021	0.032	-0.616	-1.629	-0.407	-3.753	0.026	1.000
Other manufacturing	-0.630	-0.010	-0.468	0.012	-0.046	0.035	-0.043	-1.035	0.036	0.895
Mean Elasticities by Year										
1971	-0.993	0.130	-0.920	-0.048	-0.021	0.091	-0.338	-0.010	0.194	0.810
1972	-0.772	0.009	-0.674	-0.814	0.007	0.070	-0.024	-0.020	0.057	0.888
1973	-0.685	-0.049	-0.556	-0.268	-0.017	0.108	0.026	-0.038	0.145	0.823
1974	-0.631	-0.070	-0.599	-0.102	-0.045	0.100	-0.003	-0.043	0.053	0.888
1975	-0.641	-0.075	-0.461	0.158	-0.093	0.141	0.008	-0.081	0.073	0.870
1976	-0.629	-0.073	-0.278	0.148	-0.058	0.113	0.025	-0.116	0.075	0.869
1977	-0.650	-0.053	-0.177	0.130	0.019	0.157	0.055	-0.184	0.112	0.843
1978	-0.649	-0.048	-0.072	0.058	-0.094	0.179	0.087	-0.257	0.102	0.850
1979	-0.646	-0.042	0.003	0.077	-0.167	0.185	0.088	-0.329	0.095	0.855
1980	-0.649	-0.030	0.019	0.084	-0.115	0.181	0.050	-0.402	0.052	0.892
1981	-0.649	-0.030	0.015	0.065	-0.104	0.176	0.046	-0.491	0.046	0.898
1982	-0.703	-0.008	-0.039	0.157	0.070	0.218	-0.069	-0.642	0.076	0.870
1983	-0.760	0.025	-0.058	0.203	-0.079	0.206	-0.789	-0.764	0.039	0.907
1984	-0.711	0.047	0.022	-0.003	-0.057	0.109	-0.184	-0.806	0.020	0.933
1985	-0.725	0.049	0.086	0.027	-0.136	0.073	-0.006	-0.921	0.020	0.935
1986	-0.724	0.049	0.104	0.004	0.095	-0.053	0.249	-1.025	0.057	0.888
1987	-0.717	0.047	0.101	-0.011	-0.121	-0.003	0.026	-1.035	0.025	0.927
1988	-0.710	0.060	0.056	0.045	-0.051	-0.044	0.062	-1.089	0.058	0.888
1989	-0.722	0.068	-0.005	0.058	-0.063	-0.062	-0.001	-1.107	0.035	0.913
1990	-0.733	0.077	-0.010	0.034	-0.141	-0.137	-0.027	-1.130	0.015	0.947
1991	-0.734	0.085	-0.035	0.017	-0.170	-0.053	-1.167	0.019	0.937	-
1992	-0.755	0.101	-0.056	0.074	-0.140	-0.227	-0.033	-1.197	0.008	0.966
1993	-0.771	0.115	-0.065	0.026	-0.434	-0.307	-0.052	-1.217	0.018	0.942
1994	-0.761	0.117	-0.062	-0.025	-0.151	-0.385	-0.053	-1.265	0.015	0.948
1995	-0.766	0.124	-0.077	0.049	-0.114	-0.464	-0.067	-1.369	0.019	0.941

Table 3.c: Continued

	Demand Elasticities					Marginal Risk Elasticities			Efficiency	
	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
1996	-0.775	0.131	-0.088	0.023	-0.168	-0.439	-0.080	-1.404	0.012	0.958
1997	-0.785	0.139	-0.096	0.019	-0.153	-0.576	-0.089	-1.461	0.017	0.948
1998	-0.794	0.147	-0.092	0.011	-0.157	-0.621	-0.136	-1.512	0.015	0.953
1999	-0.816	0.161	-0.090	0.008	-0.086	-0.673	-0.127	-1.515	0.021	0.941
2000	-0.817	0.164	-0.074	0.030	-0.236	-0.819	-0.141	-1.619	0.019	0.945
2001	-0.841	0.181	-0.074	0.075	-0.873	-0.894	-0.152	-1.702	0.023	0.940
2002	-0.860	0.191	-0.057	0.006	-0.088	-1.041	-0.159	-1.702	0.024	0.938
2003	-0.871	0.196	-0.036	0.034	-0.182	-1.302	-0.160	-1.860	0.018	0.946
2004	-0.892	0.212	-0.036	0.038	-0.954	-0.870	-0.175	-1.886	0.018	0.944
2005	-0.932	0.236	-0.057	0.131	0.121	-0.850	-0.212	-2.067	0.025	0.930
2006	-0.946	0.246	-0.069	0.053	-0.064	-0.849	-0.213	-2.231	0.007	0.967
2007	-0.956	0.255	-0.080	0.022	0.149	-0.950	-0.269	-2.409	0.020	0.936
2008	-0.945	0.256	-0.088	-0.025	-0.046	-1.013	-0.293	-2.636	0.010	0.957
2009	-0.971	0.276	-0.091	-0.016	0.228	-0.972	-0.288	-2.486	0.019	0.937
Overall Mean and Standard Deviations										
Mean	-0.771	0.088	-0.122	0.014	-0.119	-0.298	-0.089	-1.108	0.043	0.915
Std. Dev	0.174	0.123	0.336	0.156	0.608	1.120	0.407	1.603	0.043	0.064

Table 4.a: Pearson's Correlation Coefficients/probability values, Time trend and Risk Model

	Year	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
Year	1.0000										
	0.0000										
E_W	-0.4249	1.0000									
	0.0001	0.0000									
E_Y	0.8232	-0.2149	1.0000								
	0.0001	0.0009	0.0000								
E_K	-0.1961	-0.6045	0.0046	1.0000							
	0.0026	0.0001	0.9439	0.0000							
E_T	-0.9381	0.1844	-0.8702	0.3849	1.0000						
	0.0001	0.0047	0.0001	0.0001	0.0000						
MR_W	-0.0163	-0.0048	0.0067	-0.1604	-0.1105	1.0000					
	0.8047	0.9419	0.9193	0.0140	0.0918	0.0000					
MR_Y	0.3313	-0.3477	0.1458	0.0964	-0.1898	-0.2028	1.0000				
	0.0001	0.0001	0.0257	0.1416	0.0036	0.0018	0.0000				
MR_K	-0.0679	0.1874	0.0043	-0.1105	0.0007	0.1964	-0.3728	1.0000			
	0.3009	0.0040	0.9479	0.0917	0.9913	0.0025	0.0001	0.0000			
MR_T	-0.5763	0.2216	-0.3379	0.0901	0.4065	0.4568	-0.5539	0.0458	1.0000		
	0.0001	0.0006	0.0001	0.1694	0.0001	0.0001	0.0001	0.4856	0.0000		
TVAR	-0.3024	0.0399	-0.4991	-0.2509	0.2502	0.2164	-0.0426	-0.0696	0.1638	1.0000	
	0.0001	0.5430	0.0001	0.0001	0.0001	0.0009	0.5170	0.2892	0.0121	0.0000	
EEFF	0.3824	-0.0925	0.4803	0.2854	-0.2325	-0.3968	0.2971	-0.0450	-0.5398	-0.6985	1.0000
	0.0001	0.1586	0.0001	0.0001	0.0003	0.0001	0.0001	0.4931	0.0001	0.0001	0.0000

Table 4 b: Pearson's Correlation Coefficients/probability values, Time Dummy and Risk Model

	Year	E_W	E_Y	E_K	E_T	MR_W	MR_Y	MR_K	MR_T	TVAR	EEFF
Year	1.0000										
	0.0000										
E_W	-0.4338	1.0000									
	0.0001	0.0000									
E_Y	0.7768	-0.7972	1.0000								
	0.0001	0.0001	0.0000								
E_K	0.3259	-0.1065	0.2949	1.0000							
	0.0001	0.1042	0.0001	0.0000							
E_T	0.2218	0.0792	0.0241	0.3691	1.0000						
	0.0006	0.2273	0.7070	0.0001	0.0000						
MR_W	-0.0732	-0.1982	0.0447	-0.0739	-0.0559	1.0000					
	0.2647	0.0023	0.4966	0.2604	0.3948	0.0000					
MR_Y	-0.3780	0.0565	-0.3450	-0.2268	-0.0412	0.1679	1.0000				
	0.0001	0.3892	0.0001	0.0005	0.5301	0.0100	0.0000				
MR_K	-0.1525	-0.0183	-0.1278	-0.0128	-0.0678	0.0744	0.3269	1.0000			
	0.0196	0.7802	0.0508	0.8458	0.3013	0.2568	0.0001	0.0000			
MR_T	-0.4544	-0.2504	-0.1923	-0.2073	-0.1246	0.3281	0.6956	0.3929	1.0000		
	0.0001	0.0001	0.0031	0.0014	0.0570	0.0001	0.0001	0.0001	0.0000		
TVAR	-0.6950	-0.0455	-0.3563	-0.3545	-0.1277	0.1404	0.3066	0.0959	0.4625	1.0000	
	0.0001	0.4889	0.0001	0.0001	0.0511	0.0319	0.0001	0.1435	0.0001	0.0000	
EEFF	0.5187	0.2788	0.2304	0.3758	0.1128	-0.2484	-0.3507	-0.2599	-0.6482	-0.7378	1.0000
	0.0001	0.0001	0.0004	0.0001	0.0851	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000