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ESTIMATES OF LABOUR DEMAND ELASTICITIES AND ELASTICITIES OF SUBSTITUTION USING FIRM-LEVEL MANUFACTURING DATA

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Alberto Behar completed an MPhil in Economics, Oxford University (Nuffield College) in 2004 and is proceeding to a DPhil.

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Estimates of Labour Demand Elasticities and Elasticities of Substitution using Firm-Level Manufacturing Data

Abstract

Using firm-level manufacturing data supplemented with wages from household survey data, this paper estimates translog cost functions to calculate labour demand elasticities and Allen Elasticities of Substitution between capital and four occupation types. It finds that own-price labour demand elasticities range from –0.56 to –0.8, that capital and all occupation types are substitutes and that most occupation types are themselves complements.

1. Introduction

The purpose of this paper is to estimate the Allen Elasticities of Substitution (AES) between various labour inputs as well as cross- and own-price elasticities of labour demand. Such elasticities are measured between capital and labour inputs disaggregated according to skill. While skill can be defined by education level, this study divides the workforce into four occupations – managerial/professional, skilled/artisan, semi-skilled and unskilled.

For South Africa, no documented empirical measures exist at this level of disaggregation, using firm-level data, and/or using an appropriate technological representation. There are, however, studies of somewhat disaggregated labour elasticities. Moolman (2003) attempts industry-level demand estimations for skilled and unskilled labour, but the equations are rudimentary and the wage variables are aggregated across skill/occupation types. Du Toit and Koekemoer (2003) estimate macroeconomic models for skilled and unskilled labour demand and supply based on a Cobb Douglas technology. Edwards (2003, 2002) uses firm-level manufacturing data from Gauteng to estimate relative demand functions for two occupations using Constant Elasticity of Substitution (CES) production technologies.

Cobb Douglas technologies are inappropriate because they assume the AES is unity, while CES functions are not easily conducive to multiple factors and also impose various technological restrictions on the technology and elasticities (Heathfield and Wibe, 1987). Translog functions can overcome these disadvantages. This paper therefore estimates a translog cost function to derive the AES and factor demand elasticities.

It employs national firm-level manufacturing data, which unfortunately does not contain wages. Therefore, household data are used to predict wages for each firm according to characteristics that are common to both the firm and household surveys, after which the wages are adjusted for firm-size effects.

The AES estimates suggest capital and all forms of labour are substitutes and offer no evidence of capital-skill complementarity. Managerial/Professional labour and other occupations are complements. Unskilled workers and skilled/artisan workers are substitutes but unskilled workers and semi-skilled workers are complements. Unlike other studies, this paper can indicate to what extent these results hold across the entire sample. Own-price elasticities are –0.56 for managerial/professional and skilled/artisan occupations, –0.65 for unskilled workers and –0.8 for semi-skilled employees.

In arriving at these results, this paper motivates why estimating translog cost functions is the most appropriate for deriving substitution elasticities in section 2. Section 3 discusses the estimation process and inference options. Section 4 discusses the data, in particular the process by which wages are constructed using household data. Section 5 shows analytically the potential pitfalls of not accounting for firm-size in wage construction before adjusting wages using an existing estimate of firm-size effects on wages. Section 6 contains the results and section 7 provides some brief concluding commentary.

2. Elasticities of Substitution and Factor Demand

Robinson (1933) proposed the Elasticity of Substitution between two factors:

$$\sigma = \frac{\partial \log x_i / \partial \log x_j}{\partial \log q_i / \partial \log q_j} \qquad (1)$$

x_i and x_j are factors i and j while q_i and q_j are the first derivatives of output with respect to factors i and j. On the assumption that the factor price equals marginal product, this can be interpreted as the percentage change in the ratio of factor quantities in response to a one percent change in the ratio of factor prices.

In a multiple factor setting, Allen (1938) proposes the (partial) Elasticity of Substitution (AES) between 2 factors, holding output and other factor prices constant. Using a production function and the system of first order conditions for the cost-minimising factor demands, he defines the AES between factors *i* and *j* as:

$$\sigma_{AES,ij} = \frac{\mathbf{q_{ij}} \sum_k q_k x_k}{|\mathbf{q}| x_i x_j} \tag{2}$$

$|\mathbf{q}|$ is the determinant of the bordered Hessian of equilibrium conditions and $\mathbf{q}_{ij}$ is the cofactor of q_{ij} in $\mathbf{q}$. By Euler's theorem, the summation term equals q under constant returns to scale.

The AES as expressed in equation 2 imposes a cumbersome calculation, but Uzawa (1962) uses the duality between production and cost functions to show that equation 2 can be replaced by:

$$\sigma_{AES} \equiv \sigma_{AU} = \frac{C.C_{ij}}{C_i C_j} \tag{3}$$

Uzawa's proof employs a unit cost function, which only uniquely represents the underlying production function under constant returns to scale (Varian, 1992). His result thus appears strictly applicable to constant returns to scale only. However, countless studies use this result in more general settings. For example, of the twelve listed in Chung (1994), only five have a linearly homogenous production technology. While the validity of equation 3 under more general technological settings may be "folk knowledge", it is instructive to confirm and document this. Appendix 1 shows the duality result indeed holds without the requirement of constant returns to scale.

Based on Marshall's (1920) rules of labour demand, the relationship between the AES and the constant output elasticity of factor demand is:

$$\lambda_{ij} = s_j \sigma_{AES,ij} \tag{4}$$

λ_{ij} is the partial elasticity of the quantity of factor *i* with respect to the price of factor *j* and s_j is the cost share of factor *j*. Heathfield and Wibe (1987) assert the relationship between λ_{ij} and σ_{ij} holds only under conditions of constant returns to scale. Indeed, they refer to Allen (1938), who in his exposition uses linear homogeneity. However, constant returns to scale is *not* a requirement for this result to hold, as shown in appendix 2.

Equation 4 refers to the constant output elasticity of factor demand. Provided the technology is homothetic, one can endogenise profit-maximising output to factor prices and allow for so-called scale effects as shown in Fallon and Verry (1988) and Mosak (1938). However, because this study uses firm-level data to infer industry-level effects, constant returns to scale is required and, as the regression in appendix 3 shows, the underlying technology is not homothetic.

3. Estimating Elasticities using Translog Cost Functions

Binswanger (1974a) lists why cost functions are more popular than production functions for estimation purposes. First, as a consequence of optimising behaviour, cost functions exhibit homogeneity of degree one in prices, which can be imposed to improve estimation efficiency without recourse to technological assumptions. Also, cost functions are more consistent with the view that wages are exogenous. The main reason, however, for using a cost function in this study is that, as shown in section 2, the AES and elasticity of factor demand can be far more tractably arrived at than by using production functions.

There are various options for the choice of technological approximation. In a macroeconomic model of skilled and unskilled labour demand and supply, Du Toit and Koekemoer (2003) use a Cobb Douglas production function. Although they claim it was "*estimated and validated as representative of the South African production structure*" (*ibid:* 7), the homogeneity and separability assumptions it carries are too restrictive to go untested in a new study. More importantly, the implication that the Elasticity of Substitution is unity completely circumvents one of the aims of this work.

Constant Elasticity of Substitution functions allow the Elasticity of Substitution to differ from one, but the Elasticity of Substitution is the same between all input pairs. This is still a major restriction, but the resulting factor demand equations yield easily estimable elasticities between two factors. For example, Edwards (2003) estimates an equation for the demand for skilled relative to unskilled labour (S/U) as a function of relative wages (W_s/W_u), import penetration variables (M), export orientation (X), and technology variables (Φ).

$$\ln\left(\frac{S}{U}\right)_i = \theta_{0i} + \theta_1\Phi_i + \theta_2 M_i + \theta_3 X_i - \sigma \ln\left(\frac{w_s}{w_u}\right)_i + \varepsilon_i \qquad (5)$$

Edwards estimates σ to be –0.47 between skilled and unskilled labour and –0.41 between less-skilled and unskilled labour. The values are quite close, suggesting the CES restriction is not seriously inaccurate.

Adding factors requires complex techniques. Fallon and Lucas (1998) include capital in their CES function to estimate, with non-linear 3 stage least squares and calibration techniques, demand for black and white labour as proxies for unskilled and skilled labour. They produce industry-level long run elasticities of demand for unskilled labour of about –0.7 in manufacturing.

More flexible functional forms do not impose *a priori* technological assumptions like separability of factor inputs or homotheticity. Besides allowing for a potentially more accurate representation of the underlying technology, elasticities can vary across the sample. Two functions in this class are the Generalised Leontief function due to Diewert (1971, in Berndt, 1991) and the transcendental logarithmic (translog) function developed by Christensen, Jorgenson and Lau (1973).

There appears to be no relevant application of either of these to heterogeneous labour in the South African literature. This study uses a translog cost function, which can be interpreted as second order Taylor Approximations to an unknown underlying technology[1]:

$$\begin{aligned}\ln C &= \ln a_0 + \sum_i a_i \ln w_i + a_y \ln y + \sum_i \sum_j b_{ij} \ln w_i \ln w_j \\ &+ b_y \ln^2 y + \sum_i b_y \ln w_i \ln y; (i, j = 1, \ldots, 5)\end{aligned} \qquad (6)$$

C is cost, w_i is the price of factor i, y is output or value added. The cost share equation for factor i is derived by differentiating the cost function with respect to $\ln w_i$. Following Chung (1994):

$$\frac{d \ln C}{d \ln w_i} = a_i + \sum_j b_{ij} \ln w_j + b_{iy} \ln y \qquad (7)$$

But, where x_i is the quantity of factor i and using Shephard's Lemma for the second equality:

[1] In a rare comparison of both technologies, Humphrey and Wolkowitz (1976) obtain somewhat different elasticity estimates, so there certainly is merit in comparing this study's results with those using a Generalised Leontief technology.

$$\frac{\partial \ln C}{\partial \ln w_i} = \frac{w_i \partial C}{C \partial w_i} = \frac{w_i x_i}{C} = s_i \tag{8}$$

Therefore:

$$s_i = a_i + \sum_j b_{ij} \ln w_j + b_{iy} \ln y \tag{9}$$

Berndt and Khaled (1979) show that, for consistency with cost minimising behaviour:

$$\begin{aligned} & b_{ij} = b_{ji} \text{ (Slutsky symmetry)} \\ & \frac{\partial \ln C}{\partial \ln W} = 1 \text{ (price homogeneity) iff } \sum_j b_{ij} = \sum_i b_{ij} = 0; \sum_i a_i = 1; \sum_i b_{iy} = 0 \\ & \text{where } \partial \ln W = \partial \ln w_i \forall i \end{aligned} \tag{10}$$

In addition, restrictions can be imposed on the technology. This is easily seen by observing that returns to scale are calculated as the inverse of:

$$\frac{d \ln C}{d \ln y} = h = \frac{1}{r} = a_y + b_y \ln y + \frac{1}{2} \sum_i b_{iy} \ln w_i \tag{11}$$

To get a measure of returns to scale that is independent of the factor prices, as implied by homotheticity, requires $b_{iy} = 0 \ \forall i$. If homothetic, the underlying technology is homogeneous of degree *r* if $b_y = 0$, with $r = 1/a_y$.

To derive the elasticity of factor demand (λ_{ij}), observe that:

$$\begin{aligned} x_i &= \frac{C}{w_i} s_i \\ \lambda_{ij} &= \frac{\partial \log x_i}{\partial \log w_j} = \frac{w_j}{x_i} \frac{\partial}{\partial w_j} (\frac{C}{w_i} s_i) \\ &= \frac{w_j}{x_i} \left(\frac{C b_{ij}}{w_i w_j} + \frac{x_j s_i}{w_i} \right) \text{ (using Shephard's Lemma)} \\ &= \frac{b_{ij}}{s_i} + s_i \left(\frac{w_j x_j}{C} \right) \left(\frac{C}{w_i x_i} \right) \end{aligned} \tag{12}$$

Therefore:

$$\lambda_{ij} = \frac{\partial \log x_i}{\partial \log w_j} = \frac{b_{ij}}{s_i} + s_j \tag{13}$$

Using equation 4, the AES is:

$$\sigma_{ij} = \frac{b_{ij}}{s_i s_j} + 1 \tag{14}$$

$b_{ij}=0$ would yield the Cobb Douglas AES of unity. The own elasticity of factor demand in Binswanger (1974a) is:

$$\lambda_{ii} = \frac{b_{ii}}{s_i} + s_i - 1 \tag{15}$$

while the AES is:

$$\sigma_{ii} = \frac{b_{ii}}{s_i s_i} + 1 - s_i \tag{16}$$

Humphrey and Wolkowitz (1976) suggest the own AES can be interpreted as a change in a factor's demand responsiveness to a change in its own price.

The cost share equations (9) will be estimated together with the cost function (equation 6) using the Zellner seemingly unrelated regressions (SUR) model, which exploits correlations between the errors in each of the share equations to improve efficiency. Scope for such gains is limited by the fact that the explanatory variables in each factor share equation are identical or at least highly correlated. However, cross equation restrictions do allow for efficiency improvements (Greene, 2003). Restrictions exist because the cost shares are derivatives of the cost function, so some coefficients are the same. Slutsky symmetry also implies cross equation restrictions.

However, the restrictions that a_i in the cost equation equal the constant for each share equation i is *not* imposed, even if it is supposed to be the same by definition This is because the equations may still suffer from measurement error and other specification issues. Wooldridge (2002) demonstrates that much of the bias of these imperfections is deposited on the constant, so restricting these catchments for error would spill the biases throughout the system.

By construction, the sums of the a_i coefficients across the factor share equations equal unity for each observation. Therefore, the residual cross product and disturbance covariance matrices are singular and prevent estimation (Berndt, 1991). A common response is to impose price homogeneity on the cost function and hence across the share equations. Using the second restriction in (10), let $a_k = 1 - \sum a_l$, where k refers to capital and l refers to the four labour inputs. This allows the share equation for capital to be dropped and the remaining four factor share equations to be estimated as[2]:

$$s_i = a_i + \sum_j b_{ij} \ln \frac{w_j}{w_k} + b_{iy} \ln y; \; (i, j = 1, ..., 4) \qquad (17)$$

The capital equation is dropped but Berndt (1991) shows the choice is arbitrary if the Zellner iterated efficient (IZEF) procedure is used. The IZEF procedure is the dominant method in the literature and is the one employed by this study: instead of one or two-step feasible generalised least squares estimates, the procedure iterates over the disturbance covariance matrix and parameter estimates until they converge (see Statacorp (2003)).

Some studies use the estimated coefficients and actual factor shares to calculate elasticities in equations 13 to 16 (Chung, 1994), but it is correct to use the regression's predicted shares (Berndt, 1991). Greene (2003) finds it is typical for studies to calculate the shares using mean factor prices and factor quantities, presenting a single elasticity based on this point.

However, this approach fails to exploit one of the advantages of translog estimates over other functional forms, namely the variation of elasticity estimates across the sample. This paper uses the parameter estimates and the attributes of each firm to calculate elasticities for every observation. In addition to the median of these elasticity estimates, indications of how elasticities vary across the sample are also presented. As an informal method of inference, information is provided on whether elasticity estimates have the same sign for 95% of firms.

Such an informal method is necessary because significant regression coefficients neither imply nor are necessary for significant elasticities (Anderson and Thursby, 1986) [3]. The difficulty lies in the fact that the elasticity estimates are highly non-linear combinations of the coefficients and data (Greene, 2003). Reviews of empirical work make no mention of significance (Chung, 1994; Hamermesh, 1993). Some studies do not report confidence intervals for the estimators at all (eg Bergström and Panas (1992); Chung (1987); Teal (2000)). Others (eg Binswanger (1974b); Mak (2000)) regard the factor shares as fixed

[2] For convenience, the subscripts *i,j* are retained but now refer to the four labour inputs. w_k is the cost of capital.

[3] "Significant" can refer to rejecting a null hypothesis of the elasticity being zero, in which case we can be confident the factors are complements or substitutes or can refer to the Cobb-Douglas elasticity of unity.

and treat the b_{ij} coefficient as the only one with a confidence interval, incorrectly inferring the elasticity significance from a t-statistic.

Anderson and Thursby (1986) find Allen Elasticities of Substitution asymptotically follow the normal or ratio-of-normals distribution only if the means of the actual factor shares are used, but this study does not have the option to make use of the result as no actual shares are available.

4. Data Description and Construction

The core dataset is from the National Enterprise Manufacturing Survey (NE survey) covering the period of 1998. After adjusting for non-response and outliers, there are about 300 firms with the appropriate variables. Unlike the Greater Johannesburg Metropolitan Council Survey (GJMC survey), the NE survey is national in coverage. For a thorough description of the data, see Bhorat and Lundall (2002).

Capital is the first input. In an industry-level study of capital in South Africa, Fedderke *et. al*. (2001) use the following expression:

$$c = (r - \pi) + \delta + \tau \tag{18}$$

Π is the inflation rate and τ is the corporate tax rate. Fedderke *et. al*. calculate industry-level data on depreciation (δ) ranging from 11% to 16%[4]. For the nominal interest rate (r), they use yields on 10-year government bonds, but I use the average prime lending rate.

Furthermore, the interest rate is adjusted to account for risk. Adjustments range from –2% for large firms older than 5 years to + 5% for new small firms[5]. Fedderke *et. al*. use the nominal corporate tax rate for τ, which was 35% for the fiscal year starting early in 1998 (RSA, 1998), but state it would be ideal to have the effective rates of taxation by industry as this is another source of divergence in costs of capital. Negash (1999) calculates effective tax rates to be about 15% below nominal rates for the 1990s, so a 20% average effective rate is applied to all firms.

The four occupation groups are managerial/professional, skilled/artisan (technicians, welders), semi-skilled (machinery operators) and unskilled

[4] I thank Prof Fedderke for providing this data.

[5] Adding 5% is the standard rule of thumb premium added for new small ventures.

(labourers, security guards) [6]. The NE survey does not have wage data. Edwards (2003) instruments for wages and other industry specific factors by including industry dummies in his labour demand equations, which is inappropriate in a study where wages form an integral part.

However, average wages by industry and occupation can be a good approximation to those faced by firms in South Africa. Nattrass (2000) reports that the main wage setting institutions are industrial level bargaining councils (BC), noting that 65% of manufacturing workers are covered by a BC and concluding that extension by the Minister of Labour is at the core of wage setting in an industry. Also, Moll (1996) shows how extensions of bargaining council agreements leads to convergence in technologies and wages in the industry.

The NE survey shows over 70% of firms are subject to a BC agreement. There is therefore support for convergence of wages in industries and justification for wages being calculated at a supra-firm level for use in firm-level studies.

The use of predicted wages for firm-level cost function estimates has precedence. Teal (2000) predicts values from earnings functions using a matching panel. Classifying workers as skilled or unskilled, he generates firm-level wages using the human capital characteristics observed in those workers sampled for each firm. Adopting a similar approach, this paper uses features common to the NE dataset and the 1997 October Household Survey,[7] which has 3 500 people formally working for somebody else in manufacturing, to estimate wages.

For each occupation, the characteristics available in both data sources are:

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[6] The sales/clerical occupation is dropped on the assumption of separability. Of all the factors, this is the one that one should be most comfortable assuming separability for. It is hard to believe that the number of salespeople or clerks a company employs will have any impact on the relationship between other factors, especially the production workers on the factory floor. The motivation behind dropping sales/clerical is poor specification and misleading results. The sales/clerical own-price elasticity is persistently positive in systems estimations, which show evidence of a poorly specified sales/clerical equation. Part of the reason for the bad specification is that this is quite a diverse group in terms of skill-level, so wages are more likely to be inaccurate in this occupation. Also, the responsibilities of this diverse group vary more than usual across firms, so the control variables are less able to refine this role. Furthermore, in systems estimation, errors in one equation can transmit themselves to other parts of the system. Therefore, the damage to other results from including the sales/clerical occupation is most likely greater than any damage from excluding it.

[7] The 1998 survey was much smaller due to funding problems. This and an allowance for adjustment lags make the 1997 survey the preferred edition. Inflationary increases are easily dealt with.

- economic activity (broken down into nine industries);
- province group (the nine provinces were *ex post* broken down into two groups with similar wages);
- individual trade union membership (household data); collective bargaining and bargaining council membership (firm data).

Wage construction entails calculating the survey-adjusted means for selected groupings of people for each occupation. This paper accounts for probability weights and clustering but only partially adjusts for stratification. The reason for this is that many magisterial districts (strata) have only one cluster – many have only one observation – and at least two are needed for variance estimates. Therefore, compromise stratification by province, which sometimes has close to 100 magisterial districts, is carried out. A variety of wage series were initially constructed, differing in the degree of disaggregation[8].

Estimating the most highly disaggregated wage is not optimal, as many estimates would come from as few as one observation. The variance on these estimates would be very wide (or undefined). Recognising the trade-off between heterogeneity and precision, there is therefore a need to aggregate certain groups. The aim is to produce a set of estimates with better precision characteristics but sufficient variation to represent the firm-level wages. To do this, various combinations are carefully inspected. Factors considered are differences in log wages, the number of observations, and comparisons of the confidence intervals of the separate and combined groups.

Comparing the confidence intervals of two groups is naturally akin to performing a two-sample t-test. However, visual inspection is quicker for all the combinations and allows for analysis in conjunction with the other criteria. The choice of confidence interval is a matter of taste in this application, so 85% bands are used. As a control against this judgement-based procedure, standard t-tests, regressions and non-parametric procedures are performed on certain groups[9].

It is perhaps easiest to elaborate with an example. Table 1 presents six of the fifteen groups the skilled/artisan wages are divided into and the associated estimates.

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[8] Data on wages classified only by industry are available at http://www.nuff.ox.ac.uk/users/Behar/data/wage1data.xls. All wage series were used in estimates to gauge robustness.

[9] These include tests of median equality, Anova and Scheffe's method of comparing the means of each group to those of all the others, but there is no readily available way to adjust for survey design. The results do not suggest material differences in classification.

EXAMPLE OF WAGE CLASSIFICATIONS

Table 1: Example of Wage Classifications

Skilled/Artisan	*Mean Monthly Salary*	
	Estimate	*Std Error*
Food & Beverages	1562	161
Wood, Pulp & Paper - Prov0	1116	229
Wood, Pulp & Paper - Prov1	1993	169
Chemicals, Rubber & Plastic - Prov0, not unionised	786	152
Chemicals, Rubber & Plastic - Prov0, unionised	2316	264
Chemicals, Rubber & Plastic - Prov1	2067	284

The first row contains wages for all skilled/artisans in the Food and Beverages industry, regardless of location or union membership. The Wood Pulp and Paper industry is subdivided by province group but not union membership (rows 2 and 3). Wages in the Chemicals, Rubber and Plastic industries are subdivided by province group. One group of provinces is further divided into unionised and non-unionised workers (rows 4 and 5) while the other group is not (row 6).

After adjusting for firm size, as discussed in section 5, wages are also used to determine cost shares and total costs. The vast majority of studies, including but not restricted to Berndt and Christensen (1973), Teal (2000) and Bergström and Panas (1992), derive total cost and/or factor cost shares using factor price and quantity data. Similarly, labour costs are obtained by multiplying labour quantities by the constructed wage. Capital costs are the cost of capital percentage multiplied by the capacity-adjusted capital stock. Total factor cost (C_f) is the sum of factor costs and is the dependent variable in the cost function.

Two other variables found in cost functions are raw materials and value added. Although the NE survey does not contain total costs and does not contain raw materials costs, it does contain information on raw materials as a percentage of total costs. It also does not have information on value added but does have turnover.

It is possible to build an adequate proxy for value added by multiplying raw materials as a percentage of total costs (p) by turnover (y). This works on the perfectly competitive assumption that turnover equals total costs including opportunity costs.

Value added can alternatively be constructed using the predicted factor costs. Total input cost (C_i), including raw materials, is calculated as $C_i = {}^{c_f}\!/_{1-p}$. Raw materials costs (*rm*) are easily calculated using C_i and C_f and subtracted from output to get a measure of value added. Table 2 considers this value added measure (V_2) and compares it with the value added measure calculated by multiplying p by turnover (V_1).

Table 2: Comparison of value added measures in R million

Statistic	$V_1=py$	$V_2=y-rm$
mean	8	8.71
1st quartile	1.2	0.77
Median	2.8	3.21
3rd quartile	8.75	9.63

Note: The first column uses data on raw material cost percentages and turnover. The second uses data on raw material cost percentages, factor prices and quantities.

The measures of central tendency are close but there is moderate dispersion at the 25th and 75th percentiles. The correlation between the first measure and the wage-based measures is 0.9. The similarities are considerable in spite of the completely different calculations, so there are grounds for confidence in the constructed data.

In cost estimations, V_2 would introduce very serious correlation with the dependent variable, which was constructed using the exact same factor prices and quantities. V_2 would also be highly correlated with the other inputs. Therefore, while useful for comparison with V_1, V_2 is not used in regressions. V_1 is used in the cost function.

The dataset is a single cross section, so variables are required to control for firm-specific effects and avoid omitted variable bias. Fortunately, the NE dataset has a rich set of variables for the purpose.

5. Accounting for Firm Size Effects on Wages

Oi and Idson (1999) review the evidence for firm-specific effects on wages, especially firm size effects. Possible reasons are that workers are more productive because of their education, abilities or the higher capital:labour ratio or that they receive compensating differentials for a less-pleasant environment. The cost of capital a firm gets tends to fall as it gets bigger, certainly up to a point, because small and/or young firms incur risk premia.

The following paragraphs analyse what impact ignoring this effect may have on translog estimates, showing that the estimations are more likely to (falsely) reject homothetic technology and linear price homogeneity and overstate returns to scale. Abstracting from individuals' characteristics, wages for occupation *i* can be seen as a simple function of firm size measured according to sales (y) and a vector of those variables available from the household survey ($\mathbf{x}$).

$$\begin{aligned} \ln w_i &= \boldsymbol{\beta}_i \mathbf{lnx} + \gamma_i \ln y; \quad \gamma_\mathrm{i} > 0 \\ &= \ln \hat{\mathrm{w}}_\mathrm{i} + \gamma_i \ln y \end{aligned} \tag{19}$$

Estimating a translog cost function without accounting for firm size is the same as estimating:

$$\begin{aligned} &\ln C = \sum_i a_i \ln \hat{w}_i + \Gamma \ln y + \sum_i \sum_j \frac{1}{2} b_{ij} \ln \hat{w}_i \ln \hat{w}_j + \Phi \ln^2 y + \Omega \ln \hat{w}_i \ln y, \text{ where} \\ &\Gamma = \sum_i a_i \gamma_i + a_y; \;\; \Phi = \sum_i \sum_j \frac{1}{2} b_{ij} \gamma_i \gamma_j + \sum_i b_{iy} \gamma_i + b_{yy}; \;\; \Omega = \sum_i \sum_j b_{ij} \gamma_j + \sum_i b_{iy} \end{aligned} \tag{20}$$

The coefficients containing value added may be vastly different to what they are supposed to be. Furthermore, on the assumption that linear price homogeneity and constant returns to scale $\left(\sum_i a_i = 1; \sum_i b_{ij} = \sum_j b_{ij} = 0; b_{iy} = b_{yy} = 0; a_y = 1 \right)$ are valid for the true cost function:

$$\Gamma' = \sum_i a_i \gamma_i + 1; \Phi' = \sum_i \sum_j \frac{1}{2} b_{ij} \gamma_i \gamma_j ; \Omega' = \sum_i \sum_j b_{ij} \gamma_j \tag{21}$$

We can't be sure $\Gamma' > 1$, Varian (1992) shows it is *not* necessarily the case that all $a_i > 0$ in translog functions. However, linearly homogeneous prices imply that, if all the values of γ_i for each occupation are close enough to the average across occupations, the result will tend to be an upward bias on the value added coefficient. If the firm size effect is equal for all occupations, the bias is γ.

If there is an equal firm size effect, price homogeneity implies Φ' is zero. If the firm-size effect is not equal for each occupation, there is the possibility of Φ' being found significant when it actually is not. This would falsely reject a homogeneous technology. Similar analysis concludes the coefficient on Ω' may be found significant and therefore falsely reject homotheticity or that linear price homogeneity is rejected by distorted coefficient values.

To understand the likely effects on returns to scale, assume for simplicity a common firm-size effect across all occupations. The assumption of a homogeneous technology is relaxed but homotheticity and price homogeneity are maintained. Returns to scale are given by:

$$\left[\frac{\partial C}{\partial y}\right]^{-1} = \left[\gamma + a_y + b_{yy} \ln y\right]^{-1} \qquad (22)$$

Using these assumptions, one can gauge that omitting the firm size variable will underestimate the denominator by γ on average, so returns to scale will be overestimated. This is intuitive: if wages rise for bigger firms, the returns to scale are less than otherwise. Therefore, including a measure of γ will reduce the estimated returns to scale.

Given the possibly severe problems with ignoring firm-size effects, ways of capturing them must be found. There is unfortunately no information on the size of the firms that individuals in the household survey work for. One way to proceed is to attach previously estimated values of γ_i to the wage series. Bhorat and Lundall (2002) estimate the following manufacturing firm-size wage effects for the Gauteng Province.

Table 3: Estimates used to infer firm-size effects

Managers	*Professional & Technical*	*Clerks*	*Sales & Clerical*	*Craft*	*Operators*	*Labourers*	*Total*
0.089	0.076	0.09	0.066	0.096	0.094	0.031	0.065

Note: All except Labourers were significant.

Their estimates are parsimonious, using only average firm wages and annual firm sales, but they are similar to the US study of Doms, Dunne and Troske (1997). Assuming the unadjusted wages represent those for an average-sized firm, the wage series is inflated/deflated accordingly after adjusting the estimates to match the NE survey occupations.

6. Cost Function and Cost Share Estimations

Because they are not of direct interest, the full regression results are shown in appendix 3. A Wald Test rejects homotheticity at 1%. There are two possible explanations for this. One is that the wage data are still not accurate enough and poor data are causing false rejections of homotheticity. For example, the firm size effect could be bigger than allowed for[10]. Another explanation is that factor shares are truly a function of output. For example, bigger firms have cheaper and easier access to capital and therefore employ more capital relative to labour. It could also be a genuine technological feature, driven by the relationship between firm size and manufacturing industry type. If the technology as implied by the cost function is heterothetic, this vindicates the use of translog functions instead of more restricted functional forms.

The AES are presented in table 4. Values marked with an asterisk are consistently signed across at least 95% of the sample; the other values are consistent across at least 75% of the sample.

Table 4: Allen Elasticities of Substitution (percentage change in the ratio of factor quantities in response to exogenous change of 1% in relative factor prices)

$\sigma_{ij} = \sigma_{ji}$		j				
		Capital	Man/Prof	Skil/Art	Semi	Un
	Capital	-1.62*	2.19*	2.91*	2.73*	1.74*
	Man/Prof	2.19*	-5.96	-5.77	-1.46	-2.04
i	Skil/Art	2.91*	-5.77	-7.53	-7.28*	1.79*
	Semi	2.73*	-1.46	-7.28*	-5.48*	-2.44*
	Un	1.74*	-2.04	1.79*	-2.44*	-5.94*

Note: *denotes consistent across 5th and 95th percentiles; all others are consistent across both quartiles.

For example, a 1% rise in unskilled wages relative to semi-skilled wages will lead to a 2.44% fall in the ratio of unskilled to semi-skilled employment. Adopting the terminology in Hamermesh (1993), if a rise in the price of one factor leads to a fall in the quantity of another, as measured by the elasticity of factor demand, the pair are said to be *p-complements*. If a rise in the price of one factor leads to rise in the quantity of another, the pair are said to be *p-substitutes*[11]. The elasticity estimates produce the following results:

- Capital and all occupations are p-substitutes.
- Managerial/professional labour and all other occupations are p-complements.

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[10] Regressions run without firm-size adjusted wages are available on request. These produced nonsensical results including estimates inconsistent with cost minimising behaviour, leading to positive own-price elasticities and poorly fitting equations.

[11] This contrasts with *q-complements* and *q-substitutes*, which he applies in the context of the effects of exogenous changes in one factor's quantity on another factor's price.

- Skilled/artisan occupations are p-complements with managers/professionals and semi-skilled workers but they are p-substitutes with unskilled labour.
- Semi-skilled workers and all other occupations are p-complements.
- Unskilled workers are p-complements with managers/professionals and semi-skilled workers but p-substitutes with skilled/artisan labour.

Table 5 presents the own- and cross-price elasticities of factor demand.

Table 5: Elasticities of factor demand (% change in quantity of factor i in response to a 1% change in the price of factor j)

λ_{ij}		j				
		Capital	Man/Prof	Skil/Art	Semi	Un
	Capital	-0.96*	0.18*	0.18*	0.40*	0.19*
	Man/Prof	1.28*	-0.56	-0.32*	-0.20	-0.20
i	Skil/Art	1.77*	-0.42*	-0.56	-0.99*	0.19*
	Semi	1.60*	-0.12*	-0.43*	-0.80*	-0.26*
	Un	1.03*	-0.16*	0.12*	-0.34*	-0.65*

Note: * denotes consistent across 95% of firms; all other values are consistent across 75% of firms.

All own-price elasticities are close to the –0.66 to –0.85 range found in most South African studies (see Nattrass (2004)). In particular, we can say that, based on firm-level manufacturing evidence, a 10% fall in unskilled wages should lead to a 6.5% rise in unskilled employment, holding output constant. A 10% fall in skilled/artisan wages will lead to a 1.2% fall in unskilled employment while the same fall in semi-skilled wages would lead to a 3.4% rise in unskilled employment. This demonstrates the value of disaggregation.

7. Concluding Comments

The survey year was a year of recession, which perhaps distorts the production relations between the factors. Moreover, much restructuring took place in the early 1990s and has continued since the sample period, meaning the nature of technological relationships may already have changed since then.

Nonetheless, the AES involving capital offer no support for the capital skill complementarity (CSC) hypothesis. Due to Griliches (1969), the CSC hypothesis is that capital is relatively more complementary to skilled labour than to unskilled labour. The weak form requires that capital and unskilled labour are more substitutable than capital and more skilled labour, but this is clearly not the case.

The fact that all forms of labour seem roughly equally substitutable for capital suggests capital is separable from the labour inputs (see Sato (1975)). This has two methodological implications. First, studies of labour/capital substitution would not incur a great cost by aggregating various forms of heterogeneous labour. Second, should data constraints prevent the use of costs of capital in studies of intra-labour elasticities, omitting capital would not affect the estimates badly.

Most occupations share a common substitute – capital – but are themselves p-complements. This result is important, and differs from two-factor studies, which by construction will find skilled and unskilled labour to be substitutes. While the previous paragraph suggested simplifications to the model need not be damaging in some applications, only using two factors can be very misleading in others.

Furthermore, the values imply that wage restraint in one occupation, by allowing relative wages to fall relative to the cost of capital, would increase employment of that occupation and the other occupations. There are therefore gains from co-ordination in wage setting between occupation groups (as opposed to co-ordination between industries). This may be a reason why unions within an industry tend to represent more than one occupation on the skill spectrum and tend to bargain for wages at all levels simultaneously. Given the complementarity between occupation types and the apparent opportunities for co-ordination, there are clear grounds for research into the interactions between different occupations through their unions.

References

Allen, R.(1938) *Mathematical Analysis for Economists*. London: Macmillian & Co Ltd.

Anderson, G., and J. Thursby (1986). "Confidence Intervals for Elasticity Estimators in Translog Models." *Review of Economics and Statistics* 68, no. 4.

Bergström, V., and E. Panas (1992). "How robust is the capital-skill complementarity hypothesis?" *Review of Economics and Statistics* 74, no. 3.

Berndt, E.(1991) *The Practice of Econometrics, Classic and Contemporary*. Reading: Addison-Wesley.

Berndt, E., and L. Christensen (1973). "The Translog Function and the Substitution of Equipment, Structures and Labour in U.S. Manufacturing 1929-68." *Journal of Econometrics* 1

Berndt, E., and M. Khaled (1979). "Parametric Productivity Measurement and Choice Among Flexible Functional Forms." *Journal of Political Economy* 87, no. 6.

Bhorat, H., and P. Lundall (2002). "Employment, wages and skills development: firm specific effects - evidence from two firm surveys in South Africa." *Development Policy Research Unit Working Paper* 68.

Binswanger, H. (1974a). "A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution." *American Journal of Agricultural Economics* 56, no. 2.

Binswanger, H. (1974b). "The Measurement of Technical Change Biases with Many Factors of Production." *American Economic Review* 64, no. 6.

Christensen, L., D. Jorgenson, and L. Lau (1973). "Transcendental Logarithmic Production Frontiers." *Review of Economics and Statistics* 55, no. 1.

Chung, J. (1987). "On The Estimation of Factor Substitution in the Translog Model." *Review of Economics and Statistics* 69, no. 3.

Chung, J.(1994) *Utility and Production Functions*. Oxford: Blackwell.

Doms, M., T. Dunne, and K. Troske (1997). "Workers, Wages and Technology." *Quarterly Journal of Economics* 112, no. 1.

Du Toit, C., and R. Koekemoer (2003). "A labour model for South Africa." *South African Journal of Economics* 71, no. 1.

Edwards, L. (2003). "A Firm Level Analysis of Trade Technology and Employment in South Africa." *Journal of International Development* 15

Edwards, L. (2002). "A Firm Level Analysis of Trade, Technology and Employment in South Africa." *TIPS Annual Forum Paper* 2002

Fallon, P., and R. Lucas (1998). "South Africa: Labor Markets: Adjustment and Inequalities." *World Bank Southern Africa Department Discussion Paper*, no. 12.

Fallon, P., and D. Verry.(1988) *The Economics of Labour Markets*. Oxford: Philip Alan Publishers Limited.

Fedderke, J., *et al*. (2001). "Changing factor market conditions in South Africa: the capital market - a sectoral description." *Development Southern Africa* 18, no. 4.

Greene, W. H.(2003) *Econometric Analysis*. 5th ed. Upper Saddle River: Pearson Education International.

Griliches, Z. (1969). "Capital-skill complementarity." *Review of Economics and Statistics* 51, no. 4.

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

Heathfield, D., and S. Wibe.(1987) *An Introduction to Cost and production Functions*. Hong Kong: Macmillan Education Ltd.

Humphrey, D., and B. Wolkowitz (1976). "Substituting intermediates for capital and labour with alternate functional forms: an aggregate study." *Applied Economics* 8

Mak, K. (2000). "The contribution of Canadian education to industrial production." *Education Economics* 8, no. 3.

Marshall, A.(1920) *Principles of Economics*. 8th ed. London: Macmillan & Co Ltd.

Moll, P. (1996). "Compulsory Centralisation of Collective Bargaining in South Africa." *American Economic Review: Papers and Proceedings* 86, no. 2.

Moolman, E. (2003). "An Econometric Analysis of Labour Demand at an Industry Level in South Africa." *TIPS Working Paper*, no. 5.

Mosak, J. (1938). "Interrelations of Production, Price and Derived Demand." *Journal of Political Economy* 46, no. 6.

Nattrass, N. (2000). "Inequality, Unemployment and Wage-setting in South Africa." *Studies in Economics and Econometrics* 24, no. 3.

Nattrass, N. (2004). "Unemployment and AIDS, the Social-democratic challenge for South Africa." *Development Southern Africa* 21, no. 1.

Negash, M. (1999). "Corporate tax and capital structure: some evidence and implications." *The Investment Analysts Journal* 56, no. 2.

Oi, W., and T. Idson (1999) *Firm size and wages*, ed. O. Ashenfelter, and D. Card, vol. 3C, Elsevier North Holland.

Robinson, J.(1933) *The Economics of Imperfect Competition*. London: Macmillan & Co Ltd.

Republic of South Africa (1998) *Budget Review 1998*. Pretoria

Sato, K.(1975) *Production Functions and Aggregation*. North Holland Publishing Company: Oxford.

Statacorp.(2003) *Stata: Reference Manual: Release 8*. Texas: Statacorp.

Teal, F. (2000). "Real wages and the demand for skilled and unskilled male labour in Ghana's manufacturing sector: 1991-1995." *Journal of Development Economics* 61

Uzawa, H. (1962). "Production Functions with Constant Elasticities of Substitution." *Review of Economic Studies* 29, no. 4.

Varian, H.(1992) *Microeconomic Analysis*. Third ed. London: WW Norton & Company.

Wooldridge, J.(2002) *Econometric Analysis of Cross Sectional and Survey Data*. London: MIT Press.

Appendix 1: Proof that Uzawa result holds under general technological conditions

The conditional factor demands are derived from the cost minimisation problem[12]:

$$\min \sum_i w_i x_i \text{ subject to } q(x_1,...,x_n) = y \tag{23}$$

The first order conditions are, where μ is the Lagrange multiplier:

$$\begin{aligned} & w_i = \mu \frac{\partial q}{\partial x_i} \quad (i = 1,...,n) \\ & q(\cdot) = y \end{aligned} \tag{24}$$

The cost function is:

$$C(w_1,...,w_n, y) = \sum_i w_i x_i (w_1,...,w_n, y) \tag{25}$$

Following Allen (1938), but without assuming constant returns to scale, differentiate the first-order conditions with respect to wi , divide each equation by μ and define $q_i \equiv \frac{\partial q}{\partial x_i}$ and $q_{ij} \equiv \frac{\partial^2 q}{\partial x_i \partial x_j}$:

$$\begin{array}{cccccc} 0 & +q_1 \frac{\partial x_1}{\partial w_1} & +q_2 \frac{\partial x_2}{\partial w_1} & +... & +q_3 \frac{\partial x_n}{\partial w_1} & = 0 \\ \frac{1}{\mu} q_1 \frac{\partial \mu}{\partial w_1} & +q_{11} \frac{\partial x_1}{\partial w_1} & +q_{12} \frac{\partial x_2}{\partial w_1} & +... & +q_{1n} \frac{\partial x_n}{\partial w_1} & = \frac{1}{\mu} \\ \frac{1}{\mu} q_2 \frac{\partial \mu}{\partial w_1} & +q_{21} \frac{\partial x_1}{\partial w_1} & +q_{22} \frac{\partial x_2}{\partial w_1} & +... & +q_{2n} \frac{\partial x_n}{\partial w_1} & = 0 \\ . & . & . & . & . & . \\ \frac{1}{\mu} q_n \frac{\partial \mu}{\partial w_1} & +q_{n1} \frac{\partial x_1}{\partial w_1} & +q_{n2} \frac{\partial x_2}{\partial w_1} & +... & +q_{nn} \frac{\partial x_n}{\partial w_1} & = 0 \end{array} \tag{26}$$

[12] I am particularly grateful to Dr Margaret Stevens for her role in establishing this result.

By Cramer's rule:

$$\frac{\partial x_2}{\partial w_1} = \begin{vmatrix} 0 & q_1 & 0 & \dots & q_n \\ q_1 & q_{11} & 1/\mu & \dots & q_{1n} \\ q_2 & q_{12} & 0 & \dots & q_{2n} \\ . & . & . & \dots & . \\ q_n & q_{1n} & 0 & \dots & q_{nn} \end{vmatrix} \div \begin{vmatrix} 0 & q_1 & q_2 & \dots & q_n \\ q_1 & q_{11} & q_{12} & \dots & q_{1n} \\ . & . & . & \dots & . \\ . & . & . & \dots & . \\ q_n & q_{n1} & q_{n2} & \dots & q_{nn} \end{vmatrix} \tag{27}$$

Therefore:

$$\frac{\partial x_2}{\partial w_1} = \frac{1}{\mu} \frac{\mathbf{q_{12}}}{|\mathbf{q}|} \tag{28}$$

where, as in equation 2, $|\mathbf{q}|$ is the determinant of the bordered Hessian of equilibrium conditions and $\mathbf{q}_{ij}$ is the cofactor of q_{ij} in $\mathbf{q}$. Using equation 2:

$$\sigma_{AES,12} = \frac{\sum_k q_k x_k}{x_1 x_2} \mu \frac{\partial x_1}{\partial x_2} \tag{29}$$

But:

$$\mu \sum_k x_k q_k = \sum_k w_k x_k = C \tag{30}$$

(by the first order conditions) and

$$x_k = \frac{\partial C}{\partial w_k} \tag{31}$$

(by Shephard's Lemma), so:

$$\sigma_{AES} = \frac{C \dfrac{\partial^2 C}{\partial w_1 \partial w_2}}{\dfrac{\partial C}{\partial w_1} \dfrac{\partial C}{\partial w_1}} \tag{32}$$

Appendix 2: Proof that the link between AES and demand elasticities hold under general technological conditions:

Using (29) to (31):

$$\sigma_{AES,12} = \frac{C}{x_1 x_2}\frac{\partial \mathrm{x}_1}{\partial w_2} = \frac{C}{w_2 x_2}\frac{\partial \log \mathrm{x}_1}{\partial \log w_2} \tag{33}$$

But:

$$s_i = \frac{w_i x_i}{C} \tag{34}$$

Therefore:

$$\sigma_{AES,12} = \frac{\lambda_{12}}{s_2} \tag{35}$$

Appendix 3: Regression used as basis for final cost function elasticity results

Estimation method: Seemingly Unrelated Regression using Iterated Zellner Efficient Method with cost minimisation restrictions imposed (see equation 10).

Summary diagnostics for each equation					
Equation	*Obs*	*RMSE*	*"R-sq"*	*chi2*	*P*
Man/Prof	307	0.06	0.43	232.62	0
Skilart	307	0.08	0.18	71.78	0
Semi	307	0.13	0.16	61.78	0
Un	307	0.11	0.11	38.65	0.02
Cost	307	0.54	0.85	2021.29	0

Note: Wald Test for homotheticity: $Chi^2_5 = 16.01$; p=0.0068.

Cost Equation	*Coeff*	*p*			
Capital	0.245	0.733	ind2	0.196	0.406
ManProf	0.266	0.442	ind3	0.496	0.046
SkilArt	0.079	0.718	ind4	-0.249	0.186
Semi	0.165	0.727	ind5	-0.053	0.793
Un	0.245	0.374	ind6	0.418	0.15
0.5*Capital^2	-0.326	0.07	ind7	0.110	0.631
Capital*ManProf	0.057	0.277	ind8	0.065	0.81
Capital*SkilArt	0.074	0.195	ind9	-0.313	0.048
Capital*Semi	0.148	0.171	loc2	0.214	0.428
Capital*Un	0.047	0.479	loc3	-0.334	0.08
0.5*ManProf^2	0.029	0.413	loc4	-0.292	0.122
ManProf*SkilArt	-0.032	0.079	loc5	-0.746	0.003
ManProf*Semi	-0.030	0.426	loc6	0.740	0.079
ManProf*Un	-0.025	0.344	loc7	0.703	0.043
0.5*Skilart^2	0.024	0.372	loc8	-0.231	0.578
SkilArt*Semi	-0.071	0.049	loc9	-0.290	0.113
SkilArt*Un	0.005	0.844	exports as % sales	0.235	0.246
0.5*Semi^2	0.007	0.94	raw materials as % costs	0.006	0
Semi*Un	-0.054	0.255	imports as % raw materials	-0.001	0.466
Un^2	0.027	0.575	equipment age	0.008	0.106
Value Added	0.294	0	Recruitment ease ManProf	0.100	0.05
0.5*(Value Added)^2	0.129	0	Recruitment ease SaleCle	-0.054	0.232
(Value Added)*Cap	0.005	0.778	Recruitment ease Skilart	-0.066	0.106
(Value Added)*ManProf	-0.018	0.002	Recruitment ease Semi	0.010	0.817
(Value Added)*Skilart	0.000	0.96	Recruitment ease Un	0.015	0.807
(Value Added)*Semi	0.010	0.433	Productivity dissatisfaction	0.052	0.023
(Value Added)*Un	0.002	0.76	Training expenditure	0.000	0.013
			Market conditions	-0.010	0.173
			Firm size > 50 employees	0.371	0
			ownermanaged	-0.613	0
			CollectiveBargaining	0.003	0.962
			Firm age	0.044	0.09
			klratio	1.404	0
			Computer Investment as % Assets	-3.334	0
			_cons	4.107	0.044

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