Would cheaper capital replace labour? Evidence from firm-level and household data

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Abstract

Using South African 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. Own-price labour demand elasticities range from −0.56 to −0.8 while capital and all occupation types are substitutes. When aggregating the four occupations into two skill levels, we find more-skilled labour (−0.44) is less elastic than less-skilled labour (−0.64) and find evidence of weak capital-skill-complementarity. These results hold for the vast majority of firms in the sample – not simply on average – and justify concerns that falls in the cost of capital relative to wages could result in capital displacing labour, particularly those with few skills.
1. Introduction

“Cheaper capital without reforms to reduce the relative cost of labour is likely to result in higher investment that displaces labour” – pg 23; African National Congress (ruling party) Discussion Document (2005)

This statement, together with pronouncements that some of the labour legislation introduced by the first South African majority-rule government since 1994 may have driven up the costs of labour and subsequently reduced employment, signals a potentially profound shift in approach. In developing countries across the world, the importance of relative labour costs for employment in the context of trade liberalization, skill-biased technical change and other factors is a debated topic.¹

South Africa is an interesting case because unemployment has historically been “literally ‘off the charts’” compared to other developing countries (Nattrass, 2004:90). Despite a fall from recent highs, the official (narrow definition) unemployment rate is 26% (Statistics South Africa, 2005). South Africa also has strong collective bargaining institutions (Nattrass, 2000) that may be raising the cost of labour and contributing to unemployment, while production is capital intensive (Fedderke et. al, 2001). Policies to reduce the cost of capital, combined with institutions that are potentially conducive to high wages, may result in a further shift into capital away from labour.

A microeconomic contribution can be made by estimating the elasticity of substitution between factors. Under certain assumptions, the sign of the parameter can predict whether a fall in the cost of capital relative to that of labour will lead to a rise or fall in the demand for labour. Estimates of labour demand elasticities would also suggest to what extent higher wages may be reducing labour demand.

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 in South Africa. Such elasticities are measured between capital and labour inputs disaggregated

¹ See for example Katz & Autor (1999) and Wood (1994)
This study divides the workforce into four occupations—managerial/professional, skilled/artisan, semi-skilled, and unskilled. The four occupations are subsequently aggregated into more-skilled and less-skilled labour. Such measures allow one to address the concerns now expressed by the ruling party in South Africa. Furthermore, by differentiating by skill type, we are able to examine the Capital-Skill-Complementarity (CSC) hypothesis due to Griliches (1969) and hence see whether cheaper capital has relatively stronger negative effects on those with fewer skills.

Despite the importance of such measures for policy, few estimates of disaggregated labour demand elasticities exist for the developing world. According to Fajnzylber & Malony (2001), only two of the nearly 200 studies surveyed by Hamermesh (1993) use establishment data for developing countries. These appear to be limited to Latin America, but Teal (2000) studies Ghana.

By using firm-level data that is highly disaggregated by skill and by using a translog cost function and associated factor shares rather than a simpler technology or direct labour demand estimates, this study presents a thus far undocumented combination for a developing country. Furthermore, unlike other published work, we are able to indicate how these elasticities vary across the firms in the sample.

Having a drawback that is common to developing and developed countries alike, the firm-level data 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 disaggregated AES estimates suggest capital and all forms of labour are substitutes. Unskilled workers and skilled/artisanal workers are substitutes but unskilled workers and semi-skilled workers are complements. Own-price elasticities are –0.56 for the managerial/professional and skilled/artisan occupations, –0.65 for unskilled workers and –0.80 for semi-skilled employees. The aggregated data supports the CSC hypothesis, finding capital and less-skilled labour are bigger substitutes than capital and more-skilled labour are. We find demand elasticities of –0.64 and –0.44 for less- and more-skilled labour respectively.
In arriving at these results, this paper explains the elasticity concepts to be calculated in section 2 and motivates why estimating translog cost functions is appropriate for finding the elasticities in section 3. Section 4 discusses the estimation process and inference options. Section 5 discusses the data, in particular the process by which wages are constructed using household data. Section 6 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 7 contains the results and section 8 concludes.

2. Elasticities of Substitution and Factor Demand

The elasticity of substitution measures the link between relative factor prices and relative factor demand. 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:

$$\sigma_{AES,ij} = \frac{q_{ij} \sum_k q_{k,x_k}}{|q|x_i x_j}$$

$x_i$ 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 $j$. $|q|$ is the determinant of the bordered Hessian of equilibrium conditions and $q_{ij}$ is the cofactor of $q_{ij}$ (the cross-partial derivative) in $q$. The AES as expressed in equation 1 imposes a cumbersome calculation, but Uzawa (1962) uses the duality between production and cost functions to show that equation 1 can be replaced by:

$$\sigma_{AES} \equiv \sigma_{AU} = \frac{CC_{ij}}{C_i C_j}$$

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, 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 2 under more general technological settings may be “folk knowledge”, it is instructive to confirm and document
this. Appendix 1 shows the duality result 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:

\[ \lambda_{ij} = s_j \sigma_{AES,ij} \]  

\( \lambda_{ij} \) 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 \( j \). \(^2\)

3. Calculating Elasticities using Translog Cost Functions and Share Equations

For South Africa, 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. 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 imply the AES is unity.

Constant Elasticity of Substitution functions allow the AES to differ from one, but it is the same between all input pairs. For example, Edwards (2003) estimates an equation for the demand for skilled relative to unskilled labour in South Africa’s Gauteng Province. Adding factors requires complex techniques. For example, 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. Considering studies of other developing countries, Fajnzylber & Malony (2001) also estimate labour demand functions directly, as do Roberts & Skoufias (1997).

\(^2\) Equation 3 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 2 shows, the underlying technology is not homothetic.
The transcendental logarithmic (translog) function developed by Christensen, Jorgenson and Lau (1973) does 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. Teal (2000) uses a translog function to estimate elasticities between skilled labour, unskilled labour and capital. This study uses a translog cost function of the form:

\[
\ln C = \ln a_0 + \sum_i a_i \ln w_i + a_y \ln y + \sum_i \sum_j b_{ij} \ln w_i \ln w_j \\
+ b_y \ln^2 y + \sum_i b_{yi} \ln w_i \ln y; (i, j = 1, \ldots, 5)
\]  

(4)

\(C\) 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 \(\ln w_i\):

\[
s_i = a_i + \sum_j b_{yi} \ln w_j + b_{yi} \ln y
\]  

(5)

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

\[
\frac{\partial \ln C}{\partial \ln W} = 1 \text{ (price homogeneity) iff } \sum_j b_{yi} = \sum_i b_{ji} = 0; \sum_i a_i = 1; \sum_i b_{yi} = 0
\]  

(6)

where \(\partial \ln W = \partial \ln w_i \forall i\)

In addition, restrictions can be imposed on the technology. Homotheticity implies \(b_{yi} = 0 \ \forall i\).

If homothetic, the underlying technology is homogeneous of degree \(r\) if \(b_{yi} = 0\), with \(r = \sqrt[1]{a_y}\).

The translog parameter estimates can be used to calculate elasticity values, as shown in Chung (1994) and Binswanger (1973a):

\[
\lambda_{ij} = \frac{\partial \log x_j}{\partial \log w_i} = \frac{b_{ji}}{s_i} + s_j
\]  

(7)

\[
\sigma_{ij} = \frac{b_{ji}}{s_i s_j} + 1
\]  

(8)

\[
\lambda_{ii} = \frac{b_{ii}}{s_i} + s_i - 1
\]  

(9)

\[
\sigma_{ii} = \frac{b_{ii}}{s_i s_i} + 1 - s_i
\]  

(10)
4. Estimation and inference

For the disaggregated measures, the cost share equations (5) are estimated together with the cost function (equation 4) using the Zellner seemingly unrelated regressions (SUR) approach, which exploits cross equation restrictions 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 in this study, 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 blocking these catchments for error would spill the biases throughout the system.

The sums of the \( a_i \) coefficients across the factor share equations equal unity for each observation, which prevents estimation (Berndt, 1991). A common response is to impose price homogeneity on the cost function and across the share equations: Using the second restriction in (6), let \( a_k = 1 - \sum a_i \), where \( k \) refers to capital and \( i \) and \( j \) refer 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:

\[
\ln s_i = a_i + \sum_j b_{ij} \ln \frac{w_j}{w_k} + b_{iy} \ln y; \quad (i, j = 1, \ldots, 4) \tag{11}
\]

The capital equation is dropped but Berndt (1991) shows the choice is arbitrary if the Zellner iterated efficient (IZEF) procedure is used.

Some studies use the estimated coefficients and actual factor shares to calculate elasticities in equations 7 to 10 (Chung, 1994), but it is correct to use the regression’s predicted shares (Berndt, 1991). It is typical for studies to calculate the shares using mean factor prices and factor quantities, presenting a single elasticity based on this point Greene (2003). However,
this approach fails to exploit one of the potential 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. Cross-firm variation is used because significant regression coefficients neither imply nor are necessary for significant elasticities (Anderson and Thursby, 1986). Reviews of empirical work make no mention of significance (Chung, 1994; Hamermesh, 1993). The difficulty lies in the fact that the elasticity estimates are highly non-linear combinations of the coefficients and data (Greene, 2003).

5. Data Description and Construction

This section briefly describes the firm-level data used. Because no factor prices are available, this section focuses on how the data is augmented by costs of capital and wages from other sources. The core dataset is the National Enterprise Manufacturing Survey (NE survey) covering the period of 1998. 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:

\[ c = (r - \pi) + \delta + \tau \]

(12)

\(\Pi\) is the inflation rate. Fedderke et al. calculate industry-level data on depreciation (\(\delta\)) ranging from 11% to 16%.\(^3\) For the nominal interest rate (\(r\)), we 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\(^4\). Fedderke et al. use the nominal corporate tax rate for \(\tau\), which was 35% for the fiscal year starting early in 1998 (RSA, 1998). 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.

\(^3\) I thank Prof Fedderke for providing this data.
\(^4\) Adding 5% is the standard rule of thumb premium added for new small ventures.
The four occupation groups are managerial/professional, skilled/artisan (technicians, welders), semi-skilled (machinery operators) and unskilled (labourers, security guards). While there is information on quantities employed, the NE survey does not have wage data. 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. For each occupation, the characteristics available in both data sources are:

- 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).

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5 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 characteristics and persistent rejection of price homogeneity consistent with cost minimizing behaviour. 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.

6 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.
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.7

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.8

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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7 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 disaggregated estimates to gauge robustness.

8 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.
Table 1: Some of the groups according to which wages are classified

<table>
<thead>
<tr>
<th>Skilled/Artisan</th>
<th>Mean Monthly Salary (R millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
</tr>
<tr>
<td>Food &amp; Beverages</td>
<td>1562</td>
</tr>
<tr>
<td>Wood, Pulp &amp; Paper – Province Grouping 1</td>
<td>1116</td>
</tr>
<tr>
<td>Wood, Pulp &amp; Paper – Province Grouping 2</td>
<td>1993</td>
</tr>
<tr>
<td>Chemicals, Rubber &amp; Plastic - Prov0, not unionised</td>
<td>786</td>
</tr>
<tr>
<td>Chemicals, Rubber &amp; Plastic - Prov0, unionised</td>
<td>2316</td>
</tr>
<tr>
<td>Chemicals, Rubber &amp; Plastic - Prov1</td>
<td>2067</td>
</tr>
</tbody>
</table>

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, to be discussed in section 6, 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 ($\rho$) by turnover ($y$). This works on the perfectly competitive assumption that turnover equals total costs including opportunity costs (the cost of capital). Value added can alternatively be constructed using the predicted factor costs. Total input cost ($C_i$), including raw materials, is calculated as $C_i = C_f / \rho$. 

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: Comparison of value added measures in Rand millions

<table>
<thead>
<tr>
<th>Statistic</th>
<th>(V_1=py)</th>
<th>(V_2=y-rm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>8</td>
<td>8.71</td>
</tr>
<tr>
<td>1st quartile</td>
<td>1.2</td>
<td>0.77</td>
</tr>
<tr>
<td>Median</td>
<td>2.8</td>
<td>3.21</td>
</tr>
<tr>
<td>3rd quartile</td>
<td>8.75</td>
<td>9.63</td>
</tr>
</tbody>
</table>

*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.*

Table 2 compares this value added measure \((V_2)\) with the value added measure calculated by multiplying \(p\) by \(y\) \((V_1)\). 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.

6. Accounting for Firm Size Effects on Wages

Oi and Idson (1999) review the evidence for firm-specific effects on wages, especially firm size effects. There is disagreement over the cause of the correlation, in particular whether it is pure firm characteristics or the characteristics of workers hired by large firms, but the correlation is regularly observed. The following paragraphs analyse what impact ignoring this correlation may have on translog estimates, showing that estimates 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 observed to be correlated with firm size measured according to sales \((y)\) and a vector of those variables available from the household survey \((x)\).
\[ \ln w_i = \beta_{lnx} \ln x + \gamma_i \ln y; \quad \gamma_i > 0 \]

\[ = \ln \hat{w}_i + \gamma_i \ln y \quad (13) \]

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

\[ \ln C = \sum a_i \ln \hat{w}_i + \Gamma \ln y + \sum \sum \frac{1}{2} b_{ij} \ln \hat{w}_i \ln \hat{w}_j + \Phi \ln^2 y + \Omega \ln \hat{w}_i \ln y, \]

where

\[ \Gamma = \sum a_i \gamma_i + a_\gamma; \quad \Phi = \sum \sum \frac{1}{2} b_{ij} \gamma_i \gamma_j + \sum b_{i\gamma} + b_{\gamma\gamma}; \quad \Omega = \sum \sum b_{ij} \gamma_j + \sum b_{i\gamma} \quad (14) \]

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 hold in the true cost function:

\[ \Gamma' = \sum a_i \gamma_i + 1; \Phi' = \sum \sum \frac{1}{2} b_{ij} \gamma_i \gamma_j; \Omega' = \sum \sum b_{ij} \gamma_j \quad (15) \]

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 \( \gamma_i \) 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 \( \gamma \).

If there is an equal firm size effect, price homogeneity implies \( \Phi' \) is zero. If the firm-size effect is not equal for each occupation, there is the possibility of \( \Phi' \) being found significant when it actually is not. This would falsely reject a homogeneous technology. Similar analysis concludes the coefficient on \( \Omega' \) 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:

\[ \left[ \frac{d \ln C}{d \ln y} \right]^{-1} = \left[ \gamma + a_\gamma + b_{\gamma\gamma} \ln y \right]^{-1} \quad (16) \]

Using these assumptions, one can gauge that omitting the firm size variable will underestimate the denominator by \( \gamma \) 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 \( \gamma \) 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 $\gamma_i$ to the wage series. Bhorat and Lundall (2002) estimate the following manufacturing firm-size wage effects for the Gauteng Province.

Table 3: Estimates of $\gamma$ used to infer firm-size effects

<table>
<thead>
<tr>
<th>Managers</th>
<th>Professional &amp; Technical</th>
<th>Craft</th>
<th>Operators</th>
<th>Labourers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.089</td>
<td>0.076</td>
<td>0.096</td>
<td>0.094</td>
<td>0.031</td>
<td>0.065</td>
</tr>
</tbody>
</table>

*Note: All except Labourers were significant. Source: Bhorat & Lundall (2002)*

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.

7. Cost Function and Cost Share Estimations

Regressions run without firm-size adjusted wages produced nonsensical results including estimates inconsistent with cost minimising behaviour such as a rejection of price homogeneity. These estimates led to positive own-price elasticities and poorly fitting equations. Using firm-size adjusted wages, this section first presents the calculated elasticity parameters for capital and four occupation types before presenting estimates of capital and two aggregated skill types and making comparisons with some other relevant studies.

The full regression results with are shown in appendix 2. A Wald test fails to find all the $\beta_{ij}$ jointly significant, suggesting the use of simpler specifications like a Cobb-Douglas function may be sufficient for other applications. However, homotheticity is rejected at 1%. Perhaps 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 in this
study; Söderbom & Teal (2004) have estimates for African firms of up to 0.15. Another explanation is that factor shares are truly a function of output in the sample. For example, bigger firms have cheaper and easier access to capital and therefore employ more capital relative to labour, as observed by Söderbom & Teal (ibid.2004).

The AES are presented in table 4. 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.

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)

<table>
<thead>
<tr>
<th></th>
<th>Capital</th>
<th>Man/Prof</th>
<th>Skil/Art</th>
<th>Semi</th>
<th>Un</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>-1.62*</td>
<td>2.19*</td>
<td>2.91*</td>
<td>2.73*</td>
<td>1.74*</td>
</tr>
<tr>
<td>Man/Prof</td>
<td>2.19*</td>
<td>-5.96</td>
<td>-5.77</td>
<td>-1.46</td>
<td>-2.04</td>
</tr>
<tr>
<td>Skil/Art</td>
<td>2.91*</td>
<td>-5.77</td>
<td>-7.53</td>
<td>-7.28*</td>
<td>1.79*</td>
</tr>
<tr>
<td>Semi</td>
<td>2.73*</td>
<td>-1.46</td>
<td>-7.28*</td>
<td>-5.48*</td>
<td>-2.44*</td>
</tr>
<tr>
<td>Un</td>
<td>1.74*</td>
<td>-2.04</td>
<td>1.79*</td>
<td>-2.44*</td>
<td>-5.94*</td>
</tr>
</tbody>
</table>

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

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 (Hamermesh, 1993). 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. The elasticity estimates produce the following results for at least 95% of firms:

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

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

---

9 This contrasts with *q*-complements and *q*-substitutes, which apply in the context of the effects of exogenous changes in one factor’s quantity on another factor’s price.
skilled/artisan wages will lead to a 1.2% fall in unskilled employment but while the same fall in semi-skilled wages would lead to a 3.4% rise in unskilled employment. This difference demonstrates the potential value of disaggregation.

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

<table>
<thead>
<tr>
<th>$\lambda_{ij}$</th>
<th>Capital</th>
<th>Man/Prof</th>
<th>Skil/Art</th>
<th>Semi</th>
<th>Un</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>-0.96*</td>
<td>0.18*</td>
<td>0.18*</td>
<td>0.40*</td>
<td>0.19*</td>
</tr>
<tr>
<td>Man/Prof</td>
<td>1.28*</td>
<td>-0.56</td>
<td>-0.32*</td>
<td>-0.20</td>
<td>-0.20</td>
</tr>
<tr>
<td>Skil/Art</td>
<td>1.77*</td>
<td>-0.42*</td>
<td>-0.56</td>
<td>-0.99*</td>
<td>0.19*</td>
</tr>
<tr>
<td>Semi</td>
<td>1.60*</td>
<td>-0.12*</td>
<td>-0.43*</td>
<td>-0.80*</td>
<td>-0.26*</td>
</tr>
<tr>
<td>Un</td>
<td>1.03*</td>
<td>-0.16*</td>
<td>0.12*</td>
<td>-0.34*</td>
<td>-0.65*</td>
</tr>
</tbody>
</table>

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

Having examined disaggregated elasticities, we turn to more aggregated versions. Casual inspection of table 4 reveals that all forms of labour seem roughly equally substitutable for capital. This suggests capital is separable from the labour inputs (Berndt & Christensen (1973 a,b)). The implication is that studies of labour/capital substitution would not incur a great cost by aggregating various forms of heterogeneous labour. Berndt & Christensen (ibid.) present formal tests of separability, which are subject to critiques and other difficulties, especially in the multiple-input case. Nonetheless, a strict application of the test, in failing to find all the $\beta_{ij}$ jointly significant, does not reject the hypothesis of weak separability.

We group the Managerial/Professional and Skilled/Artisanal occupations together as more-skilled labour and group Semi-skilled and Unskilled occupations together as less-skilled labour. Capital remains as a third factor. The main advantage of keeping capital is that it allows us to test whether skilled and unskilled labour are complements or substitutes, whereas two-factor estimates would by construction have them as substitutes (Chung, 1994).

We estimate equations of the form of (5) for more-skilled and less-skilled labour, constraining the coefficients on the wages to be equal for the two occupations in each skill group. We do not estimate (4) because, given this procedure, estimating a cost function in addition to cost share equations proves cumbersome. While the elasticities for labour are calculated as before,

we find the elasticities involving capital by using the following result found in Sato & Koizumi (1973)\textsuperscript{11}:

\[ \sum_j \lambda_{ij} = 0 \]  

(17)

Appendix 3 contains the factor share equation estimates. H omogeneity is again rejected, but unlike the disaggregated estimates, the $\beta_{ij}$ are jointly significant. Table 6 presents the aggregated elasticities of substitution.

Table 6: Allen Elasticities of Substitution (percentage change in the ratio of factor quantities in response to exogenous change of 1% in relative factor prices): Aggregated inputs

<table>
<thead>
<tr>
<th>( \sigma_{ij} = \sigma_{ji} )</th>
<th>Capital</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>-0.15*</td>
<td>0.21</td>
<td>0.81*</td>
</tr>
<tr>
<td>More</td>
<td>0.21</td>
<td>-2.55*</td>
<td>1.07*</td>
</tr>
<tr>
<td>Less</td>
<td>0.81*</td>
<td>1.07*</td>
<td>-2.20*</td>
</tr>
</tbody>
</table>

Note: * consistent across 95% of firms; + consistent across 90% of firms; all other values are consistent across at least 75% of firms.

The most striking feature of the elasticities of substitution is their support for the weak form of the CSC hypothesis: Capital and less-skilled labour are bigger substitutes than capital and more-skilled labour are. The absolute values of the elasticities are generally lower than the disaggregated estimates, which is to be expected as more aggregated groupings are likely to be less easily substituted with one another. The elasticity between skill types is greater than the elasticities of approximately 0.41 to 0.47 in Edwards (2003) for Gauteng in South Africa and between the 0.28 (fixed effects) and 2.2 (no fixed effects) found by Teal (2000) for Ghana. The results imply more- and less-skilled labour are p-substitutes. Table 7 presents the aggregated conditional elasticities of factor demand.

Table 7: Elasticities of factor demand (% change in quantity of factor i in response to a 1% change in the price of factor j): Aggregated inputs

<table>
<thead>
<tr>
<th>( \lambda_{ij} )</th>
<th>Capital</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>-0.26*</td>
<td>0.04</td>
<td>0.22*</td>
</tr>
<tr>
<td>More</td>
<td>0.12</td>
<td>-0.44*</td>
<td>0.30*</td>
</tr>
<tr>
<td>Less</td>
<td>0.46*</td>
<td>0.17*</td>
<td>-0.64*</td>
</tr>
</tbody>
</table>

Note: * denotes consistent across 95% of firms; + consistent across 90% of firms; all other values are consistent across at least 75% of firms. All other values are consistent across at least 75% of firms.

\textsuperscript{11} Inspection of table 5 verifies this
For Capital and more-skilled labour, the coefficients are quite close to zero and positive for 75% of firms only, so one cannot conclude that they are complements or substitutes. Capital and less-skilled labour appear to be substitutes. Similar results in Teal (2000) suggest this may be a feature of other developing economies.

The labour demand elasticity for less skilled labour is close to the -0.71 found for black labour by Fallon & Lucas (1998). Own-elasticites are well within the 0.15-0.75 range reported by Hamermesh (1993) for homogeneous labour and consistent with his conclusion that demand is less elastic for occupations with more skills. The own elasticities are consistent in pattern and magnitude with those found by Teal (2000), who reports elasticities of -0.44 and -0.52 for skilled and unskilled labour based on fixed effects estimates.

8. Concluding Comments

While the shortage of establishment-level wage data prevails for developing countries, this study, along with that of Teal (2000), presents an option for supplementing it with data from other sources. Exploiting the opportunity to disaggregate labour into four occupations, we find most occupations share a common substitute – capital – and that unskilled labour is a p-complement with semi-skilled workers but a p-substitute with skilled/artisanal labour.

The results also suggest that, for certain applications, using more aggregated labour types or simpler technologies may be both legitimate and appropriate given the quality of data available, although they should possibly allow for non-homotheticity. Aggregating occupations into two skill groups produces results that support the weak form of the capital-skill-complementarity hypothesis in a developing country and that suggest more-skilled and less-skilled labour are substitutes. We are able to report that these results hold for the vast majority of firms in the sample.

It is hoped that these estimates will provide a fresh source of parameter values for use in computational modeling exercises. Furthermore, the implication of these results is that a fall in the cost of capital relative to labour may increase investment at the expense of employment – a fear recently expressed by policy-makers in South Africa’s governing African National Congress. The results also suggest the negative demand effects would be felt more by those
with few or no skills. It is instructive to note that the ANC’s trade union alliance partner, COSATU, has often called for lower interest rates as an investment and employment creation mechanism.\textsuperscript{12} This implies complementarity between investment and employment creation, which is not supported by the microeconomic evidence.

However, some caveats must be mentioned. The labour demand elasticities are conditional on output as we have not been able to calculate scale effects. For example, cheaper capital could result in expansions in output and labour demand that exceeds the substitution effect calculated.

While some authors prescribe wage restraint as a mechanism for employment creation (Fallon & Lucas, 1998), others question or reject the historical role relative factor prices have played in South Africa’s capital intensity and lack of employment creation (Kaplinsky, 1995; Fedderke et. al, 2001). Nonetheless, it would be hard to argue that relative factor prices have no role to play. The elasticity parameters are the minimum requirement for an informed investigation of legislation that raises the cost of labour, especially unskilled labour, relative to capital.

\textsuperscript{12} Although the Congress of South African Trade Unions traditionally based their calls on the potential macroeconomic link between interest rates and investment (COSATU, 1998), it has recently emphasised the potential role of lower interest rates in weakening the currency and stimulating export demand (COSATU 2005).
References


Katz, L & D Autor (1999); Changes in the wage structure and earnings inequality; in Ashenfelter, O & D Card (eds.). "Handbook of Labour Economics Volume 3A"; Elsevier North Holland, Amsterdam


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

The conditional factor demands are derived from the cost minimisation problem\textsuperscript{13}:

$$\min \sum w_i x_i \text{ subject to } q(x_1,\ldots,x_n) = y$$ \hfill (18)

The first order conditions are, where $\mu$ is the Lagrange multiplier:

$$w_i = \mu \frac{\partial q}{\partial x_i} \quad (i = 1,\ldots,n)$$ \hfill (19)

$$q() = y$$

The cost function is:

$$C(w_1,\ldots,w_n,y) = \sum y$$ \hfill (20)

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

$$0 + q_1 \frac{\partial C}{\partial w_1} + q_2 \frac{\partial C}{\partial w_1} + \ldots + q_n \frac{\partial C}{\partial w_1} = 0$$

$$\frac{1}{\mu} q_1 \frac{\partial C}{\partial w_1} + q_{11} \frac{\partial C}{\partial w_1} + q_{12} \frac{\partial C}{\partial w_1} + \ldots + q_{1n} \frac{\partial C}{\partial w_1} = \frac{1}{\mu}$$

$$\frac{1}{\mu} q_2 \frac{\partial C}{\partial w_1} + q_{21} \frac{\partial C}{\partial w_1} + q_{22} \frac{\partial C}{\partial w_1} + \ldots + q_{2n} \frac{\partial C}{\partial w_1} = 0$$

$$\ldots\ldots\ldots\ldots\ldots\ldots$$

$$\frac{1}{\mu} q_n \frac{\partial C}{\partial w_1} + q_{n1} \frac{\partial C}{\partial w_1} + q_{n2} \frac{\partial C}{\partial w_1} + \ldots + q_{nn} \frac{\partial C}{\partial w_1} = 0$$

By Cramer’s rule:

$$\frac{\partial C}{\partial w_1} = \frac{1}{\mu |q|} \begin{vmatrix} 0 & q_1 & 0 & \ldots & q_n \\ q_1 & q_{11} & q_{12} & \ldots & q_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ q_n & q_{n1} & q_{n2} & \ldots & q_{nn} \end{vmatrix} \hfill (22)$$

Therefore:

$$\frac{\partial C}{\partial w_1} = \frac{1}{\mu |q|} q_{11}$$ \hfill (23)

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

$$\sigma_{x_1,x_2} = \sum q_{ij} x_i x_j \hfill (24)$$

But:

$$\mu \sum x_i q_i = \sum w_i x_i = C$$ \hfill (25)

(by the first order conditions) and

\textsuperscript{13} I am particularly grateful to Dr Margaret Stevens for her role in establishing this result.
\[
\sigma_s = \frac{\partial C}{\partial w_s}
\]  \hspace{1cm} (26)

(by Shephard’s Lemma), so:

\[
\sigma_{s,s} = \frac{C \frac{\partial^2 C}{\partial w_y \partial w_z} - \frac{\partial C}{\partial w_y} \frac{\partial C}{\partial w_z}}{\frac{\partial C}{\partial w_y} \frac{\partial C}{\partial w_z}}
\]  \hspace{1cm} (27)
Appendix 2: Regression used as basis for disaggregated elasticity results

Estimation method: Seemingly Unrelated Regression using Iterated Zellner Efficient Method with cost minimisation restrictions imposed (see equation 6).

<table>
<thead>
<tr>
<th>Summary diagnostics for each equation</th>
<th>Obs</th>
<th>RMSE</th>
<th>&quot;R-sq&quot;</th>
<th>chi²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man/Prof</td>
<td>307</td>
<td>0.06</td>
<td>0.43</td>
<td>232.62</td>
<td>0</td>
</tr>
<tr>
<td>Skilart</td>
<td>307</td>
<td>0.08</td>
<td>0.18</td>
<td>71.78</td>
<td>0</td>
</tr>
<tr>
<td>Semi</td>
<td>307</td>
<td>0.13</td>
<td>0.16</td>
<td>61.78</td>
<td>0</td>
</tr>
<tr>
<td>Un</td>
<td>307</td>
<td>0.11</td>
<td>0.11</td>
<td>38.65</td>
<td>0.02</td>
</tr>
<tr>
<td>Cost</td>
<td>307</td>
<td>0.54</td>
<td>0.85</td>
<td>2021.29</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Wald Test for homotheticity: p=0.02. Wald Test for joint significance of βij: p=0.31.

<table>
<thead>
<tr>
<th>Cost Equation</th>
<th>Coeff</th>
<th>p</th>
<th>ind2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>0.245</td>
<td>0.733</td>
<td>0.196</td>
<td>0.406</td>
</tr>
<tr>
<td>ManProf</td>
<td>0.266</td>
<td>0.442</td>
<td>0.496</td>
<td>0.046</td>
</tr>
<tr>
<td>SkilArt</td>
<td>0.079</td>
<td>0.718</td>
<td>-0.249</td>
<td>0.186</td>
</tr>
<tr>
<td>Semi</td>
<td>0.165</td>
<td>0.727</td>
<td>0.418</td>
<td>0.150</td>
</tr>
<tr>
<td>Un</td>
<td>0.245</td>
<td>0.374</td>
<td>0.110</td>
<td>0.631</td>
</tr>
<tr>
<td>0.5*Capital^2</td>
<td>-0.326</td>
<td>0.070</td>
<td>ind8</td>
<td>0.065</td>
</tr>
<tr>
<td>Capital*ManProf</td>
<td>0.057</td>
<td>0.277</td>
<td>ind9</td>
<td>0.313</td>
</tr>
<tr>
<td>Capital*SkilArt</td>
<td>0.074</td>
<td>0.195</td>
<td>loc2</td>
<td>0.214</td>
</tr>
<tr>
<td>Capital*Semi</td>
<td>0.148</td>
<td>0.171</td>
<td>loc3</td>
<td>0.334</td>
</tr>
<tr>
<td>Capital*Un</td>
<td>0.047</td>
<td>0.479</td>
<td>loc4</td>
<td>0.292</td>
</tr>
<tr>
<td>0.5*ManProf^2</td>
<td>0.029</td>
<td>0.413</td>
<td>loc5</td>
<td>-0.746</td>
</tr>
<tr>
<td>ManProf*SkilArt</td>
<td>-0.032</td>
<td>0.079</td>
<td>loc6</td>
<td>0.740</td>
</tr>
<tr>
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<td>-0.030</td>
<td>0.426</td>
<td>loc7</td>
<td>0.703</td>
</tr>
<tr>
<td>ManProf*Un</td>
<td>-0.025</td>
<td>0.344</td>
<td>loc8</td>
<td>-0.231</td>
</tr>
<tr>
<td>0.5*SkilArt^2</td>
<td>0.024</td>
<td>0.372</td>
<td>loc9</td>
<td>-0.290</td>
</tr>
<tr>
<td>SkilArt*Semi</td>
<td>-0.071</td>
<td>0.049</td>
<td>Exports as % sales</td>
<td>0.235</td>
</tr>
<tr>
<td>SkilArt*Un</td>
<td>0.005</td>
<td>0.844</td>
<td>Raw materials as % costs</td>
<td>0.006</td>
</tr>
<tr>
<td>0.5*Semi^2</td>
<td>0.007</td>
<td>0.940</td>
<td>imports as % raw materials</td>
<td>-0.001</td>
</tr>
<tr>
<td>Semi*Un</td>
<td>-0.054</td>
<td>0.255</td>
<td>equipment age</td>
<td>0.008</td>
</tr>
<tr>
<td>Un^2</td>
<td>0.027</td>
<td>0.575</td>
<td>Recruitment ease ManProf</td>
<td>0.100</td>
</tr>
<tr>
<td>Value Added</td>
<td>0.294</td>
<td>0.000</td>
<td>Recruitment ease SaleCle</td>
<td>-0.054</td>
</tr>
<tr>
<td>0.5*(Value Added)^2</td>
<td>0.129</td>
<td>0.000</td>
<td>Recruitment ease Skilart</td>
<td>-0.066</td>
</tr>
<tr>
<td>(Value Added)*Cap</td>
<td>0.005</td>
<td>0.778</td>
<td>Recruitment ease Semi</td>
<td>0.010</td>
</tr>
<tr>
<td>(Value Added)*ManProf</td>
<td>-0.018</td>
<td>0.002</td>
<td>Recruitment ease Un</td>
<td>0.015</td>
</tr>
<tr>
<td>(Value Added)*SkilArt</td>
<td>0.000</td>
<td>0.960</td>
<td>Productivity dissatisfaction</td>
<td>0.052</td>
</tr>
<tr>
<td>(Value Added)*Semi</td>
<td>0.010</td>
<td>0.433</td>
<td>Training expenditure</td>
<td>0.000</td>
</tr>
<tr>
<td>(Value Added)*Un</td>
<td>0.002</td>
<td>0.760</td>
<td>Market conditions</td>
<td>-0.010</td>
</tr>
</tbody>
</table>

- Firm size > 50 employees | 0.371| 0.000|
- ownermanaged             | -0.613| 0.000|
- CollectiveBargaining      | 0.003| 0.962|
- Firm age                 | 0.044| 0.090|
- klratio                  | 1.404| 0.000|
- Computer Investment as % Assets | -3.334| 0.000|
- cons                     | 4.107| 0.044|
Appendix 3: Share equation used as basis for aggregated elasticity results

Estimation method: Seemingly Unrelated Regression using Iterated Zellner Efficient Method with cost minimisation restrictions imposed (see equation 6).

<table>
<thead>
<tr>
<th>Summary diagnostics for each equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation</td>
</tr>
<tr>
<td>shmore</td>
</tr>
<tr>
<td>shless</td>
</tr>
</tbody>
</table>

Note: Wald Test for homotheticity: p=0.00. Wald Test for joint significance of $\beta_{ij}$: p=0.00.

<table>
<thead>
<tr>
<th>Equation: Share of more-skilled labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff</td>
</tr>
<tr>
<td>ManProf</td>
</tr>
<tr>
<td>SkilArt</td>
</tr>
<tr>
<td>Semi</td>
</tr>
<tr>
<td>Un</td>
</tr>
<tr>
<td>Value Added</td>
</tr>
<tr>
<td>Raw materials as % costs</td>
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<tr>
<td>Productivity dissatisfaction</td>
</tr>
<tr>
<td>Computer Investment as % Assets</td>
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<td>Ownermanaged</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation: Share of less-skilled labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff</td>
</tr>
<tr>
<td>ManProf</td>
</tr>
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<td>SkilArt</td>
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<tr>
<td>Semi</td>
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<td>Un</td>
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<tr>
<td>Value Added</td>
</tr>
<tr>
<td>Productivity dissatisfaction</td>
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<tr>
<td>Market conditions</td>
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<td>Ownermanaged</td>
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<tr>
<td>Firm age</td>
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<td>_cons</td>
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</table>