THE RELATIVE LABOUR PRODUCTIVITY CONTRIBUTION OF DIFFERENT AGE-SKILL CATEGORIES FOR A DEVELOPING ECONOMY

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ABSTRACT

Orientation: The article deals with the estimation, computation and interpretation of the relative productivity contributions of different age-skill categories.

Research purpose: The aim of the article is to estimate and compute i) relative productivity contributions and ii) relative productivity contribution–employee remuneration cost levels for different age-skill categories.

Motivation for the study: The research is deemed necessary given the current debate on relative productivity levels and possible changes to the retirement age in the South African labour market. No real research in this regard has been published regarding the South African labour market situation.

Research design, approach and method: A less restrictive production function was used, allowing for the simultaneous estimation and final computation of relative labour contribution levels of different age-skill categories.

Main findings: The lower-skilled segment produced significantly smaller productivity contributions and the relative productivity contribution–employee remuneration cost ratios of the 55 years and older age group were superior in the higher-skilled segment but at the same time the lowest in the lower-skilled segment.

Practical or managerial implications: It is recommended that human resource practitioners (given the perceived rigidity of labour legislation) implement and maintain structures that promote higher productivity levels for all age-skill categories in the workplace.

Contribution or value-add: An estimation procedure, which can be applied to the measurement of the relative productivity contribution of different age-skill categories, has been established.

Keywords: Productivity contribution ratio, age-skill category, productivity contribution-employee remuneration cost ratio, production function, estimation

JEL classification: J24

INTRODUCTION

Problem statement

The article adds new insight into the age-real productivity debate in South Africa as no estimation, computation, quantification and interpretation of this magnitude on the age-relative labour productivity and employee remuneration cost ratios (when different skill levels are taken into consideration) has previously been done. The manufacturing, construction and the trade and accommodation industries of the Gauteng province are used as case studies. There is a general debate on i) relative productivity levels and ii) the retirement age in the South African economy and the possible impact (if any) that a change in the retirement age might have on labour productivity benefits, the potential loss of valuable expertise and the possible creation of a further loss of skilled employees. This particular research focuses on the age-real productivity aspect of this debate.

Over the past two decades renewed research interest has focussed on the relationship between the different employee age groups and labour productivity in the workplace. The increasing ageing profile of populations in developed economies (especially in Europe) and its impact on those economies has prompted more research (Dostie, 2006; Roger & Wasmer, 2009; Guest & Shacklock, 2005; Daveri & Maliranta, 2006; Malmberg, Lindh & Halvarsson, 2005; Skirbekk, 2003, Remery, Henkins, Schippers & Ekamper, 2003; Colonia-Willner, 1998; Vandenberghe & Waltenberg, 2010) on the age-productivity relationship. No real research has been conducted in this regards for developing economies where the realities are i) real positive population growth rates, ii) a greater number of younger people entering the job market, and iii) a growing component of active employees at the higher end of the age groups.

Literature review

Remery, *et al*. (2003), Guest, *et al*. (2005), Van Ours & Stoeldraijer (2010) and Daveri, *et al*. (2006) indicated very low and even negative productivity differentials for older employees. These studies concluded that i) lower productivity differentials for older employees are due to higher employee remuneration costs and at the same time an inability to adapt to new technology and structural changes in the labour market, ii) a general preference exists for younger employees (simply as a result of relative lower employee remuneration costs), iii) greater discrepancies exists between the productivity contribution levels of ‘older’ employees and remuneration levels (the argument is that marginal productivity levels are growing slower than employee remuneration levels), and iv) firms tend to follow rigid employee remuneration schemes (based on qualifications, experience and tenure) and would then be inclined to adjust their employment structures and not necessarily nominal employee remuneration levels. Colonia-Willner (1998), Dostie (2006); Vandenberghe *et al*. (2010) and Roger *et al*. (2009) concluded that, in certain circumstances the real productivity contribution levels for 'older' employees can be significantly positive due to certain job categories requiring a longer timeframe for the accumulation of job-specific skills and experience. The Roger *et al*. (2009) study specifically indicated that older, higher-skilled employees were the most productive while older, lower-skilled employees were the least productive when compared to the other age groups.

General aspects on the age-labour productivity relationship that all the abovementioned studies are in agreement with are that i) employee remuneration differentials reflect actual differences in relative productivity contribution levels for the different age groups, ii) employee remuneration levels tend to vary far less than relative productivity levels, iii) a definite inequality exists between relative productivity contributions and employee remuneration levels for all the different age groups (the argument is that employee remuneration differentials do reflect actual differences in employee productivity), iv) relative productivity contribution-levels tend to reach a maximum and then decline as employees become older, and v) employers are constantly trying to achieve an employee-age mix that would yield the highest possible relative productivity contribution levels.

In terms of the measurement of the productivity contribution of the different age-skill categories the majority of the studies (Dostie, 2006; Guest & Shacklock, 2005; Daveri & Maliranta, 2006; Vandenberghe & Waltenberg, 2010) used a restrictive production function methodology. A less restrictive measurement methodology was developed by Roger *et al*. (2009) in their extensive study on the actual profile of relative productivity contributions across the different age groups in the manufacturing, services and trade sectors of the French economy. The authors developed a unique and less restrictive production function in which the labour input was treated as a nested Constant Elasticity Substitution (CES) model. In this particular model i) a smaller number of constraints were imposed on production technology and ii) the imperfect substitution between the different categories of employees was allowed for. The model also i) enabled the differentiation of employees simultaneously by age and skill level and ii) estimated the differences in the age-productivity and age-employee remuneration (in relative terms) separately within each skill level.

RESEARCH DESIGN

Research approach and method

The research design comprises the i) specification of an econometric model that would capture the relative labour productivity contributions for the different age groups (in accordance with the different skill levels), ii) identification of the different industries that would serve as proxies for the estimation and computation of the different relative productivity contribution and relative productivity contribution–employee remuneration ratios, iii) statistical validation of the required sample of businesses and the data collected in the proxy industries, and iv) estimation and computation process and the interpretation of the estimation and computation results.

Model specification

A simplified version of the Roger *et al*. (2009) model is used for this particular research.

The International Standard Classification of Occupations (ISCO-88) is used for the differentiation of the different skill levels. Category A constitutes the more skilled employee segment, while category B constitutes the less skilled employee segment. In terms of the different age groups, three categories were identified namely employees i) 35 years and younger, ii) older than 35 years but younger than 55 years and iii) 55 years and older. These age categories were specifically chosen in order to allow for comparative analysis with similar research results. In terms of the estimation and computation process the different employee categories are treated heterogeneously across the defined age-skill groups, but homogeneously within the different age-skill groups. This simply means that employees belonging to the same age-skill group are assumed to be perfectly substitutable.

The methodology of the model of Roger *et al*. (2009: 10-12, 19 & 27-35), as it is applied in this particular study, is explained in the following few paragraphs. In the model the aggregate labour input (high and low-skilled employees) takes the form of a nested CES function.

$$\mathbf{L = (\Sigma\ \delta_i L_i^{p_i})^{1/p}{}_i \ldots.\ \ (1)}$$

(where L=labour, i = skill category, δ_i = distribution parameter, p_i = substitution parameter)

In terms of the different age-skill categories each skill category is treated as a CES function by itself:

$$\mathbf{L_i = (\Sigma_i\, \delta_{ij} L_{ij}^{pij})^{1/p}{}_{ij} \ldots. \quad (2)}$$

(where i = skill category, j = age category, δ_{ij} = distribution parameter per age-skill category, p_{ij} = substitution parameter per age-skill category)

In the estimation process i) the distribution as well as the substitution parameters are firstly estimated, followed by ii) the estimation of the productivity differentials per age-skill category. In order to estimate the productivity contribution per employee category the marginal productivity (MP) for each employee category is computed (given the estimated values of the CES parameters). It is important to note that i) constant returns to scale is assumed and ii) that the Euler's theorem is used in order to specify the labour function. This particular function is homogeneous to the degree of 1 and it is presented as a sum of labour inputs times the marginal productivities.

$$\mathbf{f(L, L_2 \ldots. L_n) = L_1 \partial f/\partial L_1 + L_2 \partial f/\partial L_2 + \ldots L_n \partial f/\partial L_n) \ldots\ldots\ldots (3)}$$

(where f = the function of labour; $L_1L_2L_n$ = labour inputs; ∂/L = marginal productivity per labour input)

In order to cater for skill differentiation the marginal product for each skill category is computed.

$$\mathbf{MP_i = \partial Y/\partial L \cdot \partial L/\partial L_i \ldots\ldots (4)}$$

(where Y = output; L= labour input; L_i = different skill levels)

In terms of the nested CES function the marginal productivity per skill category is presented as:

$$\mathbf{MP_i = AK^{\alpha}\beta(\Sigma_i \delta_i L_i^{pi})^{\beta/pi\ -1} \delta_i L_i^{pi-1} \ldots. (5)}$$

(where MP_i = marginal productivity per skill category; K = capital input; α = marginal productivity of capital; δ_i = distribution per skill category; L_i = employee skill category; p_i = substitution parameter per skill category)

The ratio of the different skill levels is computed in order to determine the relative marginal productivity for the different employee skill categories.

$$\mathbf{MP_1/MP_2 = \partial L/\partial L_1 \div \partial L/\partial L_2 = \lambda = \delta_1 / \delta_2 (L_1/L_2)^{pi-1} \quad ......(6)}$$

(where λ = ratio of the marginal productivities of the two skill categories 1 & 2; δ_1 / δ_2 = ratio of the distribution parameters for skill categories 1 & 2)

A comparison of productivity contributions over different skill categories requires the estimation of the ratio between the marginal productivity of a skill category and the average marginal productivity of the total labour input.

$$\mathbf{MP_1/MP_{av} = L/L_1 + \lambda^{-1}L_2 \text{ and } MP_2/MP_{av} = L/\lambda L_1 + L_2 \quad ......(7)}$$

(where MP_{av} = average marginal productivity for the total labour input)

In terms of the impact of age differentiation on labour productivity, the marginal productivity per age-skill category is computed.

$$\mathbf{MP_{ij} = \partial Y/\partial L \cdot \partial L/\partial L_i \cdot \partial L_i/\partial L_{ij} \quad .....(8)}$$

(where MP_{ij} = marginal productivity per age-skill category)

and;

$$\mathbf{MP_i = AK^{\alpha}\beta(\Sigma\delta_i L_i^{pi})^{\beta/pi - 1}\delta_i Li^{pi/pj - 1}\delta_{ij}L_{ij}^{pij - 1} \quad ......(9)}$$

(where δ_{ij} = distribution parameter per age-skill category; p_{ij} = substitution parameter per age-skill category)

The relative marginal productivity of any two age groups of employees in a given skill category is:

$$\mathbf{MP_{i1}/MP_{i2} = \delta_{i1}/\delta_{i2}(L_{i1}/L_{i2})^{pij-1} \quad ......(10)}$$

The relative marginal productivities between the different age categories are:

i) Relative marginal productivity for employees younger than 35 years versus employees older than 35 years but younger than 55 years of age.

$$\mathbf{MP_{i35<}/MP_{i35\text{-}55} = \varphi \ldots\ldots\ldots(11)}$$

ii) Relative marginal productivity for employees younger than 35 years versus employees 55 years and older.

$$\mathbf{MP_{i35<}/MP_{i55+} = \gamma \ldots\ldots\ldots(12)}$$

iii) Relative productivity for employees older than 35 years but younger than 55 years versus employees 55 years and older.

$$\mathbf{MP_{i35\text{-}55}/MP_{i55+} = \eta \ldots\ldots\ldots(13)}$$

The productivity contribution of each age category is then given by the ratio of the marginal productivities of the respective age group over the average marginal productivity of a specific skill category.

$$\mathbf{MP_{i35<}/MP_{av} = L_i/L_{i35<} + \varphi^{-1}L_{i35\text{-}55} + \gamma^{-1}L_{i55+} \ldots\ldots.(14)}$$

$$\mathbf{MP_{i35\text{-}55}/MP_{av} = L_i/\varphi L_{i35<} + L_{i35\text{-}55} + \eta^{-1}L_{i55+} \ldots\ldots..(15)}$$

$$\mathbf{MP_{i55+}/MP_{av} = L_i/\gamma L_{i35<} + \eta L_{i35\text{-}55} + L_{i55+} \ldots\ldots\ \ ..(16)}$$

In order to estimate the distribution and substitution parameters that are necessary to determine the productivity contributions of the different age-skill categories, the production function model (in which labour is differentiated simultaneously by the different age and skill categories) is estimated.

$$\mathbf{Y = AK^{\alpha}(\gamma(\delta_{L35<}L_{l35<}{}^{pl} + \delta_{l35\text{-}55}L_{35\text{-}55l}{}^{pl} + (1 - \delta_{l35<} - \delta_{lm})L_{lo}{}^{pl})^{ps/pl} + (1 - \gamma)\ (\delta_{h35<}L_{h35<}{}^{ph} + \delta_{h35\text{-}55}L_{h35\text{-}55}{}^{ph} + (1 - \delta_{h35<} - \delta_{h35\text{-}55})L_{h55+}{}^{ph})^{ps/ph})^{\beta/ps} \ldots\ldots\ldots\ldots\ldots\ldots(17)}$$

(where γ = the ratio of the marginal productivities of the 35 to 55 years and the 55 years and older age groups; δ_{LY} = distribution parameter of the lower skill-35 years and younger age category; δ_{Lm} = distribution parameter of the lower skill-35 to 55 years age category; δ_{hy} = distribution parameter of the higher skill – 35 years and younger age category; δ_{hm} = distribution parameter of the higher skill-35 to 55 years age category; $L_{l35<}{}^{pl}$ = substitution parameter of the low skill-35 years and younger age category; $L_{l35\text{-}55l}{}^{pl}$ = substitution parameter of the low skill-35 to 55 years age category; $L_{l55+}{}^{pl}$ = substitution parameter of the low skill-55 years and older age category; $L_{h35<}{}^{ph}$ = substitution parameter for the higher skill-35 years and younger age category; $L_{h55+}{}^{ph}$ = substitution parameter for the higher skill-55 years and older age category)

The model also allows for the computation of the total share of the different age-skill categories in terms of the total employee remuneration costs. These computations would give a clear indication of the relative employee remuneration-labour productivity levels per age-skill category.

Data collection

The Gauteng Province of South Africa was identified as a case study for this particular study due to the dominant gross geographical product (GGP) position of this particular province in the South African economy. The manufacturing, construction and the trade and accommodation industries in Gauteng were identified as proxy industries based on i) the important contribution of these industries to the GGP of Gauteng and ii) the availability of applicable real data. Information on firms in the manufacturing, construction and the trade and accommodation industries was supplied by CETA, CATHSSETA, SERVICES SETA, MERSET, W&RSETA, FoodBevSETA, Department of Labour and StastSA. It was also the aim of the data collection process to make sure that the spread of firms throughout the different industries was statistically significant. In the manufacturing and construction industries only firms that have more than eighty employees were included in the sample groups. For the trade and accommodation industry only firms that had more than ten employees were included. Given the aforementioned constraint and statistical validation requirements, the sample response sizes (192 firms in the manufacturing industry, 96 firms in the construction industry and 89 firms in the trade and accommodation industry) were found to be statistically significant.

For each of the individual firms in the sample groups, data had to be collected on value added, value of the capital stock (including material stock), the hours worked per age group, the hours worked per age-skill category and the hourly earnings by age and by age-skill category. Monthly employee remuneration levels were transformed to hourly rates. Data on the different variables had to be standardised (values were divided by 100 000 and logarithms were then computed) in order to enable comparison and application of the data in the estimation process. The summary sample statistics are presented in annexure A.

The data revealed interesting statistics for the different sample categories. Firstly, the individual percentage contribution of the different age groups to the total hours worked is relatively the same for all three industries. The 35 to 55 years age group is the biggest contributor (on average 45%), followed by the 35 years and younger age group (on average 33%) and lastly the 55 years and older age group (on average 21%). Secondly, in terms of the age-skill categories the lower-skilled category contributed approximately 67% of the total hours worked (albeit a smaller contribution of 58% in the trade & accommodation industries) compared to the approximately 33% contribution of the higher-skilled category (except for the trade and accommodation industries where the contribution is higher at 42%). In the lower-skilled segment the 35 to 55 years age group is the biggest contributor to the total hours worked followed by the 35 years and younger age group. In the higher-skilled segment the spread of the total number of hours worked per age group is more evenly in the case of the manufacturing and construction industries. In the trade and accommodation industry the contribution of the 35 to 55 years age group is much higher (47%). Thirdly, for both the lower-skilled and higher-skilled segments the 35 to 55 years age groups have by far the greatest total employee remuneration capacity (in excess of 60%), while the total employee remuneration capacity of the 55 years and older age group exceeds that of the 35 years and younger age group.

RESULTS

The parameter estimates of the non-linear production functions are listed in Table 1.

Table 1: Estimation results for the distribution and substitution parameters when the labour input is differentiated by age and skill level

Parameter		**Parameter estimates**	
	M	**C**	**T & A**
α	0.257 *(0.0021)*	0.197 *(0.0057)*	0.204 *(0.0087)*
β	0.691 *(0.0068)*	0.612 *(0.0104)*	0.649 *(0.0099)*
$\boldsymbol{\delta}_{L35<}$	0.418 *(0.045)*	0.387 *(0.0084)*	0.402 *(0.0097)*
$\boldsymbol{\delta}_{L35\text{-}55}$	0.466 *(0.0062)*	0.471 *(0.0101)*	0.473 *(0.0072)*
$\boldsymbol{\delta}_{L55+}$	0.116	0.142	0.125
$\boldsymbol{\delta}_{H35<}$	0.276 *(0.0098)*	0.224 *(0.0087)*	0.249 *(0.017)*
$\boldsymbol{\delta}_{H35\text{-}55}$	0.376 *(0.0176)*	0.399 *(0.019)*	0.407 *(0.0091)*
$\boldsymbol{\delta}_{H55+}$	0.348	0.377	0.344
ρ_L	0.503 *(0.0087)*	0.699 *(0.0089)*	0.715 *(0.086)*
ρ_H	0.681 *(0.032)*	0.811 *(0.013)*	0.726 *(0.0093)*
$\boldsymbol{\gamma}$	0.301 *(0.0088)*	0.386 *(0.016)*	0.293 *(0.0097)*
$\mathbf{1-\boldsymbol{\gamma}}$	0.699	0.614	0.707

*(M= manufacturing; C = construction; T & A = trade and accommodation; the standard errors are significant at a 10% confidence level and are in parenthesis)

Source: Own estimations

The estimations in Table 1 were used to compute i) the marginal productivity contribution of each age-skill category and ii) a remuneration-productivity profile for the different age-skill categories (equations 4 – 16). This was done for each firm in the sample groups. In order to perform a general comparison of all the productivity contributions of the different age-skill categories i) a marginal productivity contribution mean value for each of the three industries were computed and ii) the ratio of marginal productivity contribution for each age-skill category for the individual firms and the industry marginal productivity contribution mean value were computed. Average ratios for each age-skill category per industry were then computed. If the ratio of the marginal productivity contribution of a specific age-skill category and the mean marginal productivity contribution value equals 1, the marginal productivity contribution of that specific age-skill category was the same as the industry average. If the value of the ratio is greater than 1 the marginal productivity contribution of that particular age-skill category exceeded the industry average, and if the ratio was less than 1 the marginal productivity contribution was less than the industry average. All the computed average marginal productivity contribution ratio values for the different age-skill categories in the different industries are listed in Table 2.

Table 2: Marginal productivity ratios per age-skill category for the three industries

Age-skill category		**Industry**	
	M	**C**	**T & A**
Lower-skilled			
Younger than 35 ($L_{35<}$)	0.82 *(0.36)*	0.71 *(0.28)*	0.92 *(0.26)*
35 and older but younger than 55 ($L_{35\text{-}55}$)	1.07 *(0.12)*	1.01 *(0.08)*	1.02 *(0.10)*
55 and older (L_{55+})	0.86 *(0.04)*	0.61 *(0.06)*	0.81 *(0.02)*
Higher-skilled			
Younger than 35 ($L_{35<}$)	0.95 *(0.18)*	0.86 *(0.15)*	1.02 *(0.16)*
35 and older but younger than 55 ($L_{35\text{-}55}$)	1.09 *(0.08)*	1.08 *(0.11)*	1.04 *(0.10)*
55 and older (L_{55+})	1.24 *(0.12)*	1.17 *(0.06)*	1.14 *(0.09)*

*(M= manufacturing; C = construction; T & A = trade and accommodation; the mean absolute deviations are in parenthesis)

Source: Own estimations

Analysts should not only concern themselves with relative productivity contribution levels but should also consider the applicable employee remuneration cost aspect of a particular productivity contribution level. From a productivity contribution / employee remuneration cost perspective, it was deemed necessary to compute the marginal productivity contribution / marginal employee remuneration cost ratios for each of the age-skill categories in the different industries. It simply meant that the productivity contributions are matched with the employee remuneration costs. If the productivity contribution / employee remuneration cost ratio was greater than 1, the relative productivity contribution of a particular age-skill category exceeded the relative employee remuneration cost of that age-skill group and if the ratio was smaller than 1, the relative productivity contribution of a particular age-skill category was less than the relative employee remuneration cost of that age-skill group.

The computation of the marginal productivity/employee remuneration ratios also required the computation of the marginal employee remuneration cost ratios (average employee remuneration cost per age-skill category / average employee remuneration cost for the industry). If the relative employee remuneration cost ratio was greater than 1, the average employee remuneration cost of that particular age-skill category exceeded the average employee remuneration cost of the employers and if the ratio was less than 1, the average employee remuneration of that particular age-skill category was smaller than the average employee remuneration costs of the employers. The employee remuneration and the productivity contribution / employee remuneration cost ratios off all the different age-skill categories for the three industries are listed in Table 3.

Table 3: Employee remuneration and the productivity contribution / employee remuneration ratios per age-skill category for the three industries

Age-skill category			**Industry**			
	M		**C**		**T & A**	
	R	**P/R**	**R**	**P/R**	**R**	**P/R**
Lower-skilled						
Younger than 35 ($L_{35<}$)	0.98 *(0.11)*	0.83 *(0.08)*	0.91 *(0.13)*	0.78 *(0.09)*	0.99 *(0.09)*	0.92 *(0.15)*
35 and older but younger than 55 (L_{35-55})	1.03 *(0.09)*	1.04 *(0.11)*	0.99 *(0.10)*	1.02 *(0.11)*	0.98 *(0.11)*	1.04 *(0.16)*
55 and older (L_{55+})	1.09 *(0.07)*	0.78 *(0.09)*	1.14 *(0.03)*	0.54 *(0.07)*	1.07 *(0.03)*	0.76 *(0.09)*
Higher-skilled						
Younger than 35 ($L_{35<}$)	0.97 *(0.11)*	0.98 *(0.13)*	0.83 *(0.06)*	0.96 *(0.12)*	0.98 *(0.03)*	1.04 *(0.08)*
35 and older but younger than 55 (L_{35-55})	0.99 *(0.04)*	1.10 *(0.06)*	0.99 *(0.12)*	1.09 *(0.14)*	1.01 *(0.12)*	1.03 *(0.11)*
55 and older (L_{55+})	1.11 *(0.13)*	1.12 *(0.14)*	1.03 *(0.09)*	1.13 *(0.07)*	1.09 *(0.03)*	1.05 *(0.12)*

*(M= manufacturing; C = construction; T & A = trade and accommodation; R = employee remuneration ratios and P/R = productivity/employee remuneration ratios; the mean absolute deviations are in parenthesis)

Source: Own estimations

DISCUSSION

The aim of the article was to estimate, compute, quantify and interpret the real productivity levels for the different employee age groups when different skill levels are taken into consideration.

The estimation results of the marginal ratios per age-skill category indicated that for the lower-skilled category the 55 years and older age group had the lowest productivity contribution while the 35 to 55 years age group had the highest productivity contribution (the relative productivity contribution levels of this particular age group marginally exceeded the average industry productivity contribution levels for the three industries). It was also significant to note that for the 35 years and younger age group the productivity contribution was less than the average industry productivity contribution levels. These results are a confirmation of the general perception of low productivity levels for the lower-skilled employee component of the South African economy. The challenge for human resource practitioners (given the perceived rigidity of current labour legislation) is to i) enhance a greater understanding of the importance of higher productivity levels in the workplace, ii) implement structures that would promote and monitor productivity levels more efficiently and to constantly improve work-based training.

The abovementioned findings is in contrast with the findings of the Roger *et al*. (2009) study which indicated a significant productivity contribution (exceeding the average industry productivity contribution) of the 'younger' age group (in those particular developed economies).

The results derived for the higher-skilled segment are in contrast with the results derived for the lower-skilled segment. The 55 years and older age group generated relative productivity contributions that significantly exceeded the average industry productivity levels. The same applies to the 35 to 55 years age group but at a relative smaller magnitude. These results are similar to the findings of the Colonia-Willner (1998) and Roger *et al*. (2009) studies which indicated high productivity levels for the 'older' age group in the higher-skilled segment. A plausible explanation is that for certain higher-skilled occupations a high level of longer job experience and 'learning by doing' effects are a necessity. Given the significant higher productivity contribution levels of the higher-skilled segment (in comparison with the lower-skilled segment) it is important that i) older highly-skilled employees are kept in the workplace for as long as possible and ii) that structures are put in place that could limit any outflow of high-skilled employees from the South African workplace. It is surprising to note that the relative productivity contribution of the 35 years and younger age group still remained lower than the average industry productivity contribution levels (albeit better than compared to the lower-skilled segment). In this regard it is felt that the productivity levels of this particular age-skill category can be improved by enhancing the quality and speed of learning/training and to rigorously keep track with technological progress.

In terms of the productivity contribution – employee remuneration cost component the results of the study should be of great interest to human resource/remuneration specialists. In the case of the lower-skilled segment the productivity contribution – employee remuneration cost ratio for both the younger than 35 years and older than 55 years age groups were smaller than 1 (for all three industries). This is a clear indication that relative productivity contributions are lower than relative employee remuneration costs. In simplistic terms it reflects a situation where both age groups are paid more than they should be paid when productivity levels are considered. The productivity contribution – employee remuneration levels are especially low for the older than 55 years age group. This particular outcome was also recorded in the Remery *et al*. (2003) and the Rogers *et al*. (2009) studies. In the case of the 35 to 55 years age group the productivity contribution – employee remuneration cost ratios was marginally higher than 1 (for all three industries), thus indicating a situation where the relative productivity contributions matched the relative employee remuneration costs. The abovementioned discussion is again a confirmation of the general perception that the relative remuneration costs of lower-skilled employees in South Africa is too high. Given the unionised nature of this particular skill segment, the challenge for human resource practitioners (as mentioned earlier) is to implement effective strategies that would enhance higher productivity levels (especially for an ever-expanding younger than 35 years age group in the South African labour market).

The situation is totally reversed when the higher-skilled segment is considered. The productivity contribution – employee remuneration cost ratios of the 55 years and older age group (greater than 1) was greater than the other two age groups (in all three industries). This is a clear confirmation of the superior productivity contribution levels of this particular age-skill group. These results have been obtained even when the relative employee remuneration cost ratios were greater than 1 (for all three industries). It simply means that the relative productivity contributions of this particular age group exceeded the relative high employee remuneration costs. The productivity contribution – employee remuneration cost ratio for the 35 to 55 years age group was also greater than 1 (indicating high levels of relative productivity contributions). The younger than 35 years age group also presented better relative productivity contribution–employee remuneration cost ratios (compared to the lower-skilled segment). These ratios were slightly less than 1, indicating a situation where relative productivity contributions nearly match relative employee remuneration costs.

The results of this particular study is again a confirmation of i) relative low productivity levels and relative high employee remuneration costs in the more unionised lower-skilled segment of the South African labour market, ii) the absolute need to improve the productive skill base of the labour market and iii) the need to maintain skilled employees (for all age groups) in the workplace. Further possible extensions of this particular study are i) the relative productivity contribution levels of the two gender groups (for the three age-skill categories) and ii) geographical differences in terms of relative productivity contribution levels (for the three age-skill categories).

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Annexure A: Summary of the sample statistics

Variables		M		C		T & A
	share	**mean**	**share**	**mean**	**share**	**mean**
***Ln* value added**		-3.56 *(0.99)*		-2.79 *(0.76)*		-3.08 *(1.01)*
***Ln* capital stock**		-3.89 *(1.04)*		-3.06 *(0.92)*		-3.67 *(1.12)*
Hours worked per age category						
Total	1	4.93 *(0.83)*	1	4.68 *(1.07)*	1	4.30 *(1.11)*
Younger than 35 ($L_{35<}$)	0.33	1.64 *(0.54)*	0.33	1.56 *(1.02)*	0.33	1.44 *(0.87)*
35 and older but younger than 55 (L_{35-55})	0.48	2.37 *(1.01)*	0.45	2.09 *(0.99)*	0.46	1.97 *(1.02)*
55 and older (L_{55+})	0.19	0.92 *(0.24)*	0.22	1.03 *(0.47)*	0.21	0.89 *(0.38)*
Hours worked per age-skill category						
Lower-skilled (Ll)	0.67	3.30 *(1.23)*	0.67	3.12 *(1.01)*	0.58	2.50 *(1.02)*
Younger than 35 (Lly)	0.32	1.04 *(0.77)*	0.31	0.98 *(0.56)*	0.36	0.89 *(0.43)*
35 and older but younger than 55 (Llm)	0.53	1.75 *(0.94)*	0.48	1.49 *(0.78)*	0.45	1.12 *(0.55)*
55 and older (Llo)	0.15	0.51 *(0.11)*	0.21	0.65 *(0.25)*	0.19	0.49 *(0.24)*
Higher-skilled (Lh)	0.33	1.63 *(0.91)*	0.33	1.56 *(0.88)*	0.42	1.80 *(1.15)*
Younger than 35 (Lhy)	0.37	0.60 *(0.29)*	0.37	0.58 *(0.12)*	0.31	0.55 *(0.21)*
35 and older but younger than 55 (Lhm)	0.38	0.62 *(0.45)*	0.38	0.60 *(0.11)*	0.47	0.85 *(0.37)*
55 and older (Lho)	0.25	0.41 *(0.22)*	0.25	0.38 *(0.14)*	0.22	0.40 *(0.17)*
Hourly remuneration per age-skill category						
Lower-skilled (Ll)	0.42	41.56 *(11.75)*	0.41	39.24 *(16.13)*	0.38	31.29 *(11.98)*
Younger than 35 (Lly)	0.21	35.12 *(9.75)*	0.23	33.78 *(14.28)*	0.26	29.29 *(10.58)*
35 and older but younger than 55 (Llm)	0.60	42.78 *(10.08)*	0.63	40.99 *(9.48)*	0.59	38.98 *(9.98)*
55 and older (Llo)	0.19	44.12 *(8.37)*	0.14	42.12 *(8.77)*	0.15	40.07 *(9.05)*
Higher-skilled (Lh)	0.58	57.34 *(14.11)*	0.59	55.74 *(11.52)*	0.62	52.01 *(10.71)*
Younger than 35 (Lhy)	0.17	42.08 *(11.65)*	0.15	41.12 *(10.03)*	0.14	34.06 *(8.66)*
35 and older but younger than 55 (Lhm)	0.61	59.12 *(13.76)*	0.64	58.09 *(12.73)*	0.67	48.11 *(10.42)*
55 and older (Lho)	0.22	61.87 *(15.62)*	0.21	60.34 *(11.86)*	0.19	49.89 *(9.38)*
Observations		192		96		89

*(M= manufacturing; C = construction; T & A = trade and accommodation; the standard deviations are in parenthesis)

Source: Own calculations