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WHAT IS ASSUMED IN THE GTAP DATABASE'S DISAGGREGATION OF LABOR BY SKILL LEVEL?

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ABSTRACT

The 45 region × 50 commodity × 5 primary factor version of the GTAP database provides us with the splits of total labor payments into two categories, viz. skilled and unskilled labor in each sector. The decomposition of total labor payments in all sectors and all regions according to differentials in the skill content of the labor force presupposes substitution possibilities between these two categories of labor. Our interest is to explore the elasticity of substitution implicit in this disaggregation of occupation types. Given the skilled labor payment shares (as calculated from the GTAP database), we offer an ex post rationalization of them within a production-theoretic framework, thereby deriving estimates of the elasticity of substitution between skilled and unskilled labor. The adoption of a suitable nesting of skilled and unskilled labor in GTAP's production function enables us to find a 'reasonable' value for the substitution elasticity that is implicit between the two categories of labor in the GTAP database. This relies on the inter-regional covariation in the GTAP shares and in measures of educational attainment.

JEL classification: J24, J31, O15

Keywords: Elasticity of substitution; Educational attainment; Skilled and unskilled labor payment.

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WHAT IS ASSUMED IN THE GTAP DATABASE'S DISAGGREGATION OF LABOR BY SKILL LEVEL?[#]

1 Introduction

The 45 region × 50 commodity × 5 primary factor version of the GTAP database provides us with the splits of total labor payments into two categories, viz. skilled and unskilled labor (in terms of the ILO one-digit classification of workers by occupation) in each sector.[1] The aggregate labor force going into the production process is, thus, classified into 'raw' labor and specialised 'skilled' labor. The decomposition of total labor payments in all sectors and all regions according to differentials in the skill content of the labor force presupposes substitution possibilities between these two categories of labor. Our interest is to explore the elasticity of substitution implicit in this disaggregation of occupation types[2]. As will be evident from our analysis, the adoption of a suitable nesting of skilled and unskilled labor in GTAP's production function enables us to find a 'reasonable' value for the substitution elasticity that is implicit between the two categories of labor in the GTAP database.

To do this, in Section 2 we describe the GTAP methodology, while Section 3 reviews available data sources on educational attainment and reconciles them with the GTAP data base. Section 4 offers some theoretical underpinning to the basis of our empirical analysis. Section 5 reports the results. Concluding remarks are offered in Section 6.

[#] This short paper is an abridged version of a paper titled "Educational attainment, skilled labor payment and absorption capacity: Empirics and Theory" which forms part of my PhD thesis in progress. I gratefully thank my thesis supervisor Professor Alan Powell for stimulating me to write this paper, and for helpful discussions. The remaining errors are, however, mine.

[1] Sectors and commodities map 1:1—that is, each sector produces only one commodity.

[2] In the context of my thesis, the primary motivation being to study the role of absorption capacity and human capital formation in facilitating technology spillovers, this exploration is a necessary by-product of a larger project. Typically, higher human capital intensity of the work force leads to higher skill formation and augments the capabilities to adapt the current state-of-the-art in their field. With technology transfer, this implies substitution possibilities between skilled and unskilled labor which is being reflected in a higher payment share of the skilled labor.

2. GTAP Methodology

In GTAP, the labor value splits by all sectors and regions rely on regression analysis (Liu et al. 1998). To generate this database, the data on educational attainment of the working age population was used as a measure of skill to predict the skilled labor payment shares for the regions for which no labor force surveys and national censuses were available. Since data on employment by skill categories in each sector were not available for all the regions, inference was based on observations from 15 national censuses and labor surveys. Initially, this was performed for Versions 1-3 of the database. The industry splits for the non-sampled GTAP regions were predicted by fitting a linear regression model to these data.

The data on average lengths of per capita tertiary education for 30 GTAP regions from 1980-1987 were obtained from the World Bank (1993) sources. Data for per capita GDP measured at 1987 prices were also acquired from the World Bank database.

A mathematical relationship linking the skilled labor payment share with the stages of development (proxied by regional per capita GDP) and educational attainment (measured by average years of tertiary education) was postulated by Liu et al (1998). An OLS regression model relating payment share of skilled labor to average years of tertiary education and per capita GDP for 30 GTAP regions was used to predict labor payment shares in the unobserved regions on the basis of these observed linkages. The data on the mean years of tertiary education per capita were extrapolated backward to 1970 and forward to 1992 to generate matched-year data for the observation period.

However, initially regressions were run using average years of secondary education for the workers as another explanatory variable in addition to the two mentioned above. As in the regressions at the sectoral level, this variable was not significant, and was omitted from the regression equation. Thus, in the regression model fitted, skilled labor payment share (MHP) is the dependent variable whilst per capita GDP (GDPC) and mean years of tertiary education (TER) for the region as a whole are explanatory variables. Hence, the equation fitted is the model:

$$MHP = F\ (GDPC,\ TER)$$

where F is a linear function. The prediction of sectoral splits of labor payments is based on this fitted equation.

As the education data are unavailable, for Hong Kong, Taiwan, New Zealand, Former Soviet Union and Central European Associates, the data for Singapore, Korea, Australia and European Free Trade respectively were used as proxies. However, it is not clear how the education data used for the prediction of skilled labor payment shares for the composite regions were obtained. We now document our empirical procedures.

3. Data Reviews and Reconciliation

To start with, we document alternative data sources measuring human capital formation at the aggregative country level. In the domain of empirical economics, the most widely cited databases for analysing interlinkage between human capital, growth and development are: (a) the Barro-Lee (1993, 1996) database (henceforth, BL) and (b) Nehru, Dubey and Swanson's (1995) dataset (henceforth, DNS). Both (a) and (b) make use of data on educational attainment at different levels of education from UNESCO data collected according to its international standard classification of education (ISCED)[3].

We give a brief overview of each of these prior to describing our methodology for reconciling them with the published GTAP data base.

3.1) Barro-Lee Dataset: BL (1993) estimate the proportion of the total population with primary, secondary and higher schooling level of education for male and female individuals aged 25 years and above. They present educational attainment data quinquennially from 1960 to 1985 for 129 countries. BL (1996) update it to include the figures for 1990 and the population aged 15 and over as well. However, BL (1996) have complied data on educational quality of each year of schooling at primary and secondary level, across countries. They measure educational attainment on the basis of gross/nett enrolment ratios at the primary, secondary and higher schooling levels. Thus, average years of schooling in the total population aged 15 and over is their proxy for human capital.

[3] These datasets are usually reported in UNESCO's *World Education Report*, various issues.

3.2) DNS Dataset: DNS (1995) provide estimates of education stocks based on mean school years of education per working person for working age population between the ages of 15 and 64 for 85 countries over 28 continuous years (1960-87). Theirs is an improvement over BL (1993, 1996) on several grounds. First, their calculation is based on enrolments nett of drop-out and retention rates at each grade and year. Secondly, they made adjustments for depreciation of education stock by incorporating the age-specific mortality rate for each enrollee in each grade in a year. Thirdly, as has been argued by the authors themselves, by dividing the primary, secondary and tertiary education stocks (in person-years) by the working population (in persons), this database captures the human-capital intensity of the work force. Unlike BL (1996), DNS do not have any proxy measure for quality of educational investment. From the foregoing discussion, it is evident that the DNS database scores over BL.

We now discuss the methodology adopted for checking consistencies between each of these alternative definitions and the skilled labor payment share calculated from the GTAP database.

The primary motivation is to find any correlation between human capital (proxied by average years of schooling and/or, enrolment, at different levels of education) and the GTAP data on the payment shares of skilled labor. For this purpose, we consider both BL (1996) and DNS (1995) data sets and see how these alternative measures of human capital stock are related to the skilled labor payment shares in the GTAP database. Thus, following DNS (1995), we consider mean school years of education per working age person as a potential index of human capital (MEDY_AC), expecting that the higher is MEDY_AC, the higher will be the skilled payment share. Similar consideration applies in the case of BL (1996) where average schooling years in the total population (TYR_BL) proxies human capital formation.

We start with the construction of skilled labor payment share (SKL_AC) at the sectoral and aggregative levels according to the Version 4 of GTAP database. Sector-wide skilled payment share (SKL_AC_i) for each traded GTAP sector 'i' is defined as the 'share of skilled labor payment to total labor payment in that sector for any GTAP region r'. All these sectoral indexes are reported in Appendix

Table A1. The region-specific aggregative share SKL_AC_r is the ratio of total skilled labor payments to aggregate labor payments across all 50 sectors.

Our next step is to match the GTAP regions with those covered in the BL (1996) and DNS (1995) databases for educational attainment and then to plot the scattergrams for the matched observations of the data sets. All countries for which data are available are considered. However, contingent upon which regions have the necessary data, we include a subset of the GTAP regions in each regression. We exclude those regions (composite as well as single) which are not common in all these data sets. Moreover, for some of the GTAP composite regions not covered in either of the data sets for educational attainment, we have calculated simple averages of the data points related to schooling years of education for their component countries. This procedure assigns equal weights to each of the component countries, and hence does not reflect relative size differences of the constituent countries.

Subsections below document our proposed consistency checks.

3.3) Reconciliation of GTAP Database and DNS(1995) Database

Since GTAP uses average years of tertiary education in the work force as an index of educational attainment in the construction of the database[4], we consider mean years of tertiary education per working person as an indicator of human capital stock (MTRY_AC). However, as mentioned before, because MEDY_AC encapsulates mean years of total education at *all* levels of education, it is a suitable candidate index for human capital for the working age persons between age-group 15 and 64.

Our choices of countries are governed by the data availability for each of MTRY_AC and MEDY_AC series. So far as the single regions are concerned, we exclude Vietnam (VNM), Taiwan (TWN), Hong Kong (HKG) and Former Soviet Union (FSU) as the data for them are missing in DNS (1995). Version 4 of the

[4] In GTAP, a linear regression model relating skilled payment share to the country-wide per capita GDP (measured at 1987 prices) and the educational attainment has been fitted. It recognises that "the average years of tertiary education and the average years of secondary education for the whole work force can be used to represent the educational attainment". However, the variable of secondary education is dropped on the ground that "after the regression, …[it] is not significant for the model." (see pg. 18-3, Chapter 18, GTAP Version 4 Database). By adopting a broader definition as MEDY_AC, however, we, incorporate education at the tertiary as well as secondary and primary level in our proxy measure of human capital induced absorption capacity.

GTAP database has 12 composite regions of which 5 are excluded on the same grounds as before and also due to our lack of information about their individual country coverage in the GTAP database. These five composite regions are Rest of South America (RSM), Central European Associates (CEA), Rest of Middle East (RME), Rest of Southern Africa (RSA), and the Rest of the world (ROW). For the remaining 7 composite GTAP regions, we have calculated simple averages of DNS data of MEDY_AC for 1987 for their component countries to derive the composite regions' MEDY_AC. These 7 composite regions are Rest of Asia (RAS-includes Bangladesh, Pakistan, Myanmar), Central America and Caribbean (CAM-includes Jamaica and El Salvador), Rest of Andean Pact (RAP-includes Bolivia, Ecuador, Peru), Rest of European Union (REU-includes France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain), EFT (Iceland, Norway, Switzerland), Rest of North Africa (RNF-includes Tunisia) and Rest of Sub-Saharan Africa (RSS-includes Senegal, Zimbabwe). We drop HKG, TWN, VNM from our sample of selected countries.

Table A2 presents the list of all GTAP regions and the values of SKL_AC and MEDY_AC *without* exclusion of the regions/countries not covered in the DNS study. Table A3 reports their values for the matched country list. For MTRY_AC, the number of matched regions are reduced to 28 as DNS (1995) does not have data for them. The regions excluded are mostly composite regions viz., CAM, RAS, RAP, REU, EFT, RNF, RSS and single region SAF. These are reported in Table A4. All these tables are presented in the appendix.

SKL_AC is now plotted against MEDY_AC and MTRY_AC across regions in two scatter diagrams in Figures 1 and 2, which also show fitted regression lines. However, we made adjustments to the DNS data for MEDY_AC. This is due to the fact that in our sample of observations the values of SKL_AC lie between 0.163 and 0.416 whereas the values for MEDY_AC vary from 2 to 12; for graphical presentation, we have scaled MEDY_AC by dividing all values by 10. USA is the outlier in both the scatter plots.

Figure 1: Scatter-plot of SKL_AC and MEDY_AC and fitted regression

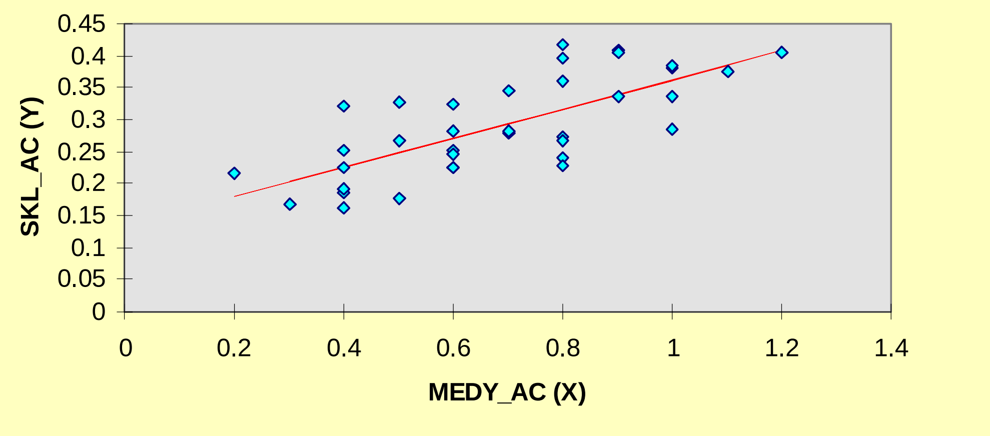
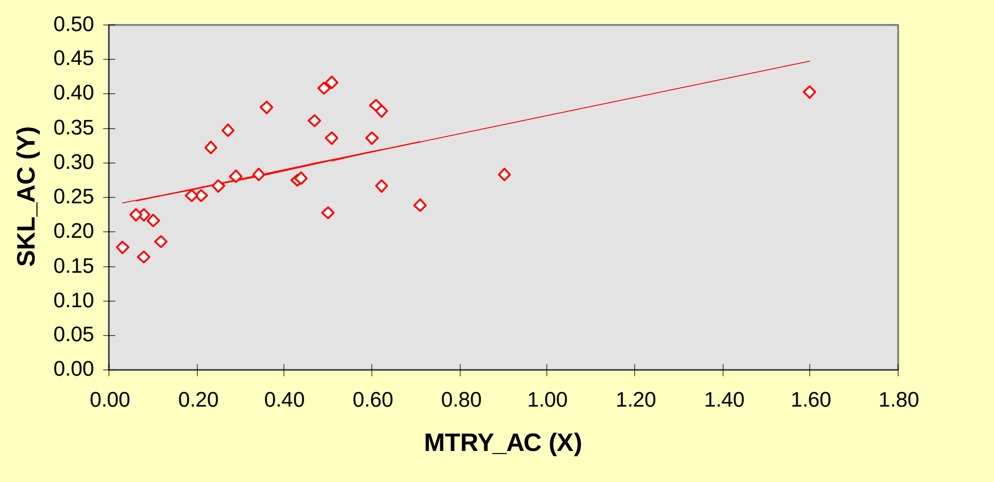


Figure 2: Scatter-plot of SKL_AC and MTRY_AC and fitted regression



Both scatter plots show distinctive upward co-movements between SKL_AC and the relevant measure of human capital (MEDY_AC or MTRY_AC).

Typically, our equation to be estimated is written as:

$$SKL\_AC_r = A + b\ X_r + \varepsilon_r \qquad (3.1)$$

where $X_r \in \{$ $MEDY\_AC_r$, $MTRY\_AC_r$ $\}$ and SKL_AC_r is regressed on each X_r individually to estimate the intercept 'A' and the slope parameter 'b'. 'r' ranges over a cross-section of countries/regions. The ε_r's are assumed to be identically, independently distributed with zero mean and constant variance (σ^2_ε). The estimation procedure is the OLS regression method. The fitted regression lines for each X_r are shown below. t-statistics are included in the parentheses below the estimated coefficients.

$$\hat{SKL\_AC}_r = 0.1345 + 0.227\ MEDY\_AC_r,\ R^2=0.53,\ F=38.43 \qquad (3.1a)$$
$$\qquad\qquad (5.069) \qquad (6.20)$$

and

$$\hat{SKL\_AC}_r = 0.237 + 0.131\ MTRY\_AC_r,\ R^2=0.33,\ F=12.93 \qquad (3.1b)$$
$$\qquad\qquad (12.51) \qquad (3.60)$$

Inspection of Figures 1 and 2 reveals that the extremely high level of MTRY_AC (but non-extreme value of SKL_AC) in USA is substantially responsible for the difference between the estimated slopes in the two regressions.[5]

Using the t-statistics, we would reject the null hypothesis (that 'b' is zero) at the 1 per cent as well as the 5 percent level of significance in both cases. As expected, these significant t-statistics on the estimated slope parameter 'b' support the postulated relationship between SKL_AC and both the proxies of educational attainment level. The data used by the GTAP researchers (MTRY_AC) surprisingly does not fit the GTAP skill shares as well as the alternative (MEDY_AC).

3.4) Reconciliation of GTAP Database and BL (1996) Database

In the case of the BL database, the number of matched observations is 35. Similar considerations to those applying to the DNS data set govern the selection of regions in conformity with GTAP database. The regions excluded are VNM, MAR, RAS, RME, RSM, REU, CEA, FSU, RSA and ROW. We consider two measures of educational attainment available in the BL (1996-7) data set viz., 'average years of higher schooling in the total population' (HYR_BL) and 'average schooling years in the total population' (TYR_BL) for the population aged 15 and over. TYR_BL includes average years of primary, secondary and higher schooling for the relevant age group in the total population. This has been motivated by our curiosity to check whether 'total schooling years' is better than 'higher schooling years' as a proxy for human capital. All these figures are reported in Table A5 of the appendix.

Scattergrams of SKL_AC values plotted against TYR_BL and HYR_BL respectively are shown with the corresponding fitted regression lines in Figures 3 and 4. As in the case of the DNS data set, we have normalised TYR_BL by dividing all values by 10.

Figure 3:Scatter-plot of SKL_AC and TYR_BL and fitted regression

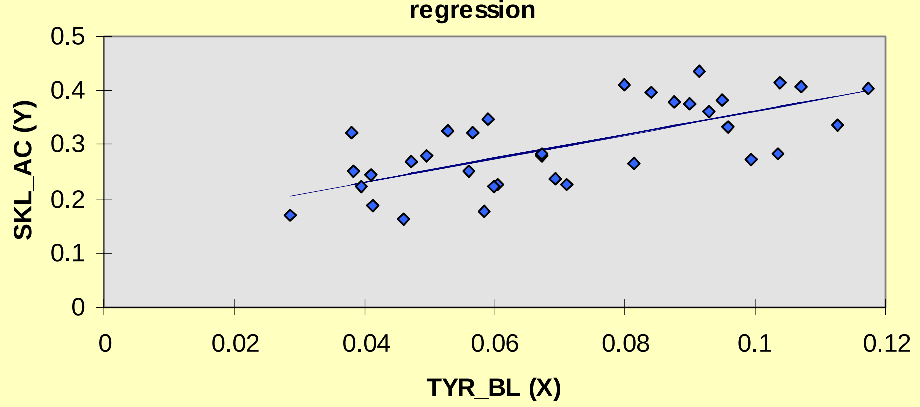
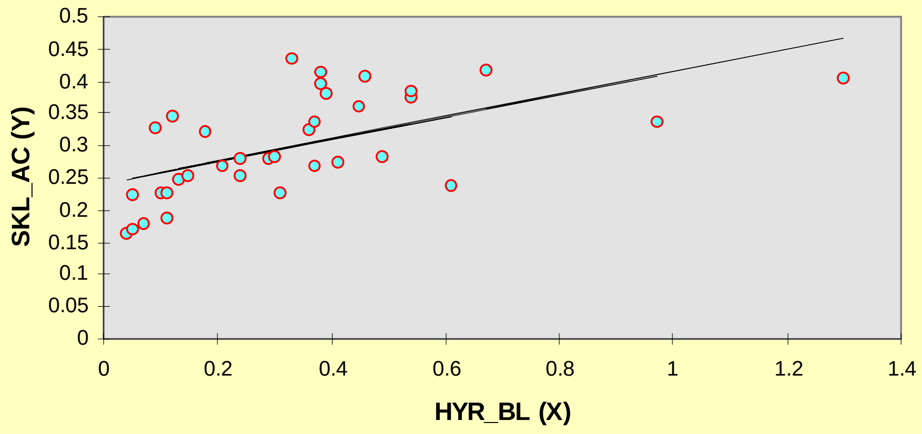


Figure 4: Scatter-plot of SKL_AC and HYR_BL and fitted regression



The scatter plots show that SKL_AC has a positive correlation with both the BL-measures of human capital formation. The correlation is stronger for TYR_BL, though.

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[5] *Exclusion* of USA from the sample of observations increases the value of the estimated slope coefficient in (3.1b) to 0.169 whilst $R^2 = 0.30$.

As before, we fit a linear regression model linking SKL_AC with TYR_BL and HYR_BL. The equation we estimated is written below:

$$SKL\_AC_r = A + b\ X_r + \varepsilon_r \qquad (3.2)$$

where $X_r \in \{ TYR\_BL_r, HYR\_BL_r \}$ and all other variables are defined as before. The fitted regression line for each X_r is given below.

$$\widehat{SKL\_AC}_r = 0.144 + 2.182\ TYR\_BL_r,\ R^2 = 0.48,\quad F = 30.62 \qquad (3.2a)$$

$$\qquad (4.871) \quad (5.533)$$

and

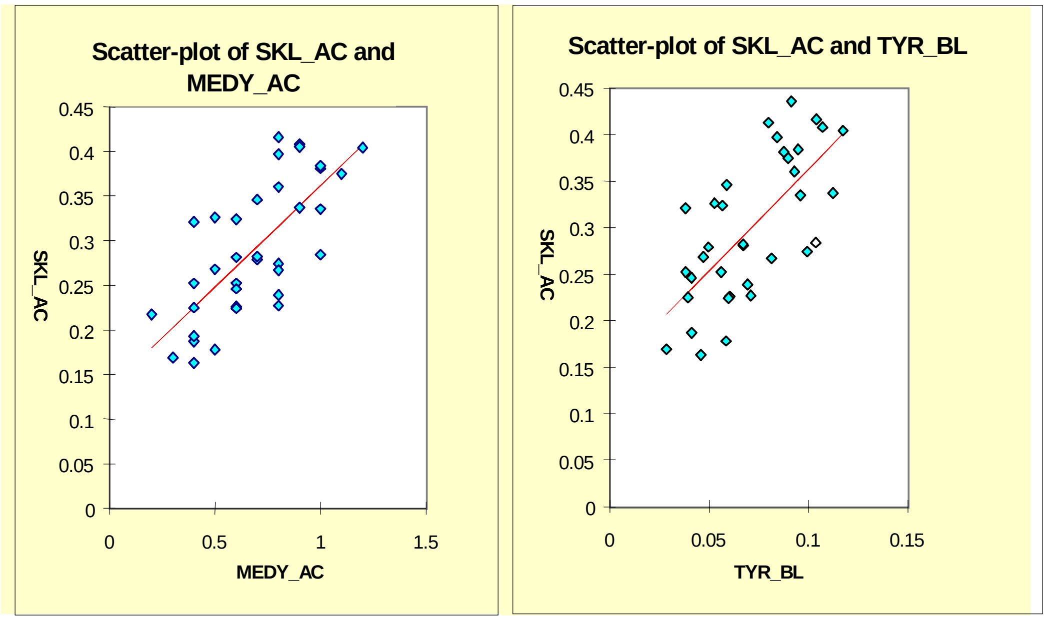
$$\widehat{SKL\_AC}_r = 0.241 + 0.173\ HYR\_BL_r,\ R^2 = 0.35,\quad F = 17.44 \qquad (3.2b)$$

$$\qquad (13.65)\ (4.18)$$

The higher value of R^2 and the t-statistics on the slope coefficient in the case of (3.2a) suggest that mean years of total education (schooling) over all levels of education is a better measure of skill intensity of the workforce than the average schooling years at a specific level of education (such as tertiary or secondary).

Comparison of the fitted regression lines for (3.1a) and (3.2a) as shown in Figure 5 demonstrates that MEDY_AC and TYR_BL exhibit almost exactly the same degree of compatibility with the SKL_AC data calculated from the GTAP database.

Figure 5: Comparison between the regression lines



Nevertheless, the regression involving the DNS data (MEDY_AC) fits the skilled share data slightly better than the BL data (TYR_BL). As seen above in Section 2b, the DNS (1995-96) data is also preferred on other grounds.

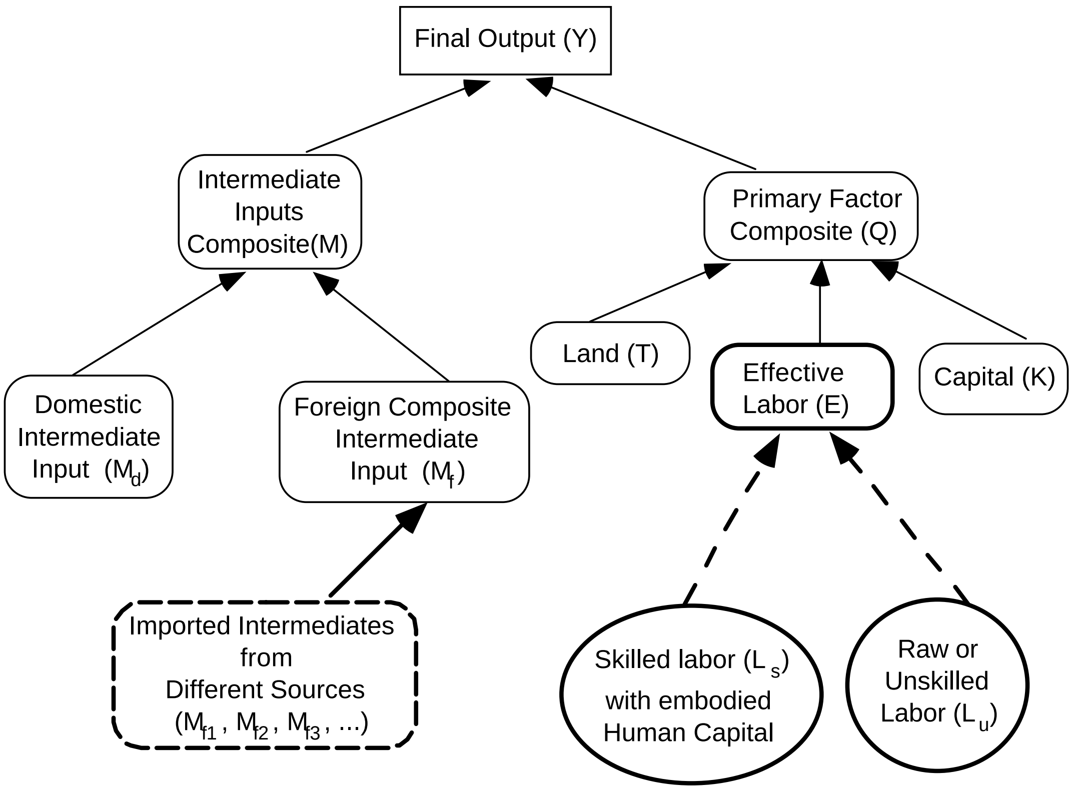
Having specified an *a priori* relationship between various measures of human capital formation and skilled labor payment share and having checked the relationship statistically, it can be inferred (as expected) from the previous analysis that educational attainment explains quite significantly the GTAP shares of aggregate labor payments going to the skilled work force. This prompted us to investigate whether skilled labor embodying human capital and 'raw' or unskilled labor can be combined in a production nest which allows for substitutability between them. A 'reasonable' estimated value of the elasticity of substitution between them would validate our surmise in the sense that the existing GTAP data, including the partition of the wage bill into skilled and unskilled, is consistent with an empirically realistic degree of substitutability between the two classes of labor. The next section documents a formal theory to rationalize the procedures and the results of the skill disaggregation in GTAP.

4. From Empirics to Theory

4.a) Production Nest

In the GTAP production structure, the standard production technology tree is a nested production function where a CES-primary factor composite of Land (T), Labor (E) and Capital (K) combines with a CES intermediate composite of domestically sourced and foreign sourced intermediate inputs at the top level in a Leontief nest to produce final gross output (Y). This gross production function is separable into a value-added nest (nett output) and a nest of intermediate inputs. For incorporating human capital and relating it to skilled labor payment shares, we add a new nest to the production structure so that labor is now split into two components, raw labor (L_u) and skilled labor (L_s), so that total effective labor (E) is a constant elasticity of substitution (CES) combination of L_s and L_u. The underlying assumption is that human capital does not enter as an additional independent factor of production in the conventional way; rather, human capital proxied by educational attainment is embodied in the supply of skilled labor. Competition ensures that the payment to the labors with skill differentials are proportionate to their productivities. Such a production nesting is shown in Figure 6.

Figure 6: A Production tree for GTAP incorporating human capital



Thus, the production function for nett output is written as:

$$Y = BH\ (K, T, E) \tag{4.1}$$

where 'H' is homogeneous of degree one (i.e., constant returns to scale) in the factor inputs and B is a technological coefficient. In intensity form, (4.1) is written as:

$$y = B\ h\ (k, t) \tag{4.2}$$

where y = Y/E, k = K/E, and t = T/E.

As we assume that 'L_s' and 'L_u' are combined in a Constant Elasticity of Substitution (CES) production nest to yield 'E', we write

$$E = \Gamma\ [\ \delta^E_u\ (L_u)^{-\rho} + \delta^E_s\ (L_s)^{-\rho}\ ]^{-1/\rho} \tag{4.3}$$

Note that $\sigma = 1/(1+\rho)$ is the elasticity of substitution between L_s and L_u.

(4.3) may be written:

$$\delta^E_s (L_s)^{-\rho} = (E/\Gamma)^{-\rho} - \delta^E_u (L_u)^{-\rho} \qquad (4.4)$$

δ^E_j' s are the distribution parameters which can be normalised to sum to unity (provided Γ is chosen appropriately). The shares of each factor computed from the quantity side are expressed as:

$$S_j = \delta^E_j X_j^{-\rho} / \Sigma_k \delta_k X_k^{-\rho} \qquad (4.5)$$

where j is either of the categories of labor i.e., L_s or L_u. Equations (4.4) and (4.5) yield

$$S_j = \delta^E_j X_j^{-\rho} / (E/\Gamma)^{-\rho} \qquad (4.6)$$

Therefore,

$$S_j = \Gamma^{-\rho} \delta^E_j (X_j/E)^{-\rho} \qquad (4.7)$$

When $X_j = L_s$, we can write that

Skilled labour payment share = [Constant] × [Distribution parameter] ×

[Human Capital intensity]$^{-\rho}$.

Natural logarithmic transformation of (4.7) yields

$$\ln S_{Ls} = -\rho \ln (L_s/E) + \ln \delta^E_j - \rho \ln \Gamma$$

or,

$$\ln S_{Ls} = (\ln \delta^E_j - \rho \ln \Gamma) - \rho \ln (L_s/E) \qquad (4.8)$$

where S_{Ls} is SKL_AC in our notation for calculation of skilled labor payment share as described in Sections 2 and 3 above.

4.b) Estimation Procedure

Equation (4.8) is estimated from the GTAP cross section of regions/countries to find the estimated coefficient ρ. Hence, the log-linear regression model fitted for estimating ρ is

$$\ln S_{Ls} = \Lambda - \rho \ln (L_s/E) + \varepsilon_I \quad (4.9)$$

where $\Lambda = (\ln \delta^E_j - \rho \ln \Gamma)$ is a constant representing the intercept of the fitted regression line. By applying the OLS estimation procedure, we get the least-squares estimate $\hat{\rho}$ of ρ. This is used to calculate the estimated value of the elasticity of substitution between skilled labor (L_s) and raw labor (L_u) i.e., $\hat{\sigma}$. The estimated standard error and approximate t-value of $\hat{\sigma}$ are also derived[6]. This method has been followed for both the data sets viz., BL and DNS. The estimation results are discussed in the following section.

5. Estimation Results

As mentioned in Section 3, the educational attainment data for the selected GTAP composite regions are obtained by calculating the simple averages of the education data for the constituent countries. Here, for estimating σ, we present one set of results i.e., excluding those composite regions. However, values of $\hat{\sigma}$ do not differ substantially if we include these composite regions from our sample of observations.[7] The list of the sample regions included in the regressions are presented in the Tables A6 and A7 in the appendix.

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[6] From the asymptotic distribution theory for large sample sizes (N→∞), we can say that for any differentiable scalar function ζ of a random variable Ψ, the asymptotic mean and variance-covariance matrix of ζ respectively are ζ ($\bar{E}$ (Ψ)) and j′Σj, where $\bar{E}$ indicates asymptotic expectation, Σ is the asymptotic variance-covariance matrix of Ψ, and j is matrix of derivatives of the elements of ζ with respect to those of ζ evaluated at Ψ = $\bar{E}$(Ψ). In practice, we estimate $\bar{E}$(Ψ) by Ψ, an unbiased estimate of E (Ψ), in order to evaluate the entities above. In the present application, ζ and Ψ are scalars. In fact, ζ ≡ σ, our estimated inter-skill substitution elasticity, while Ψ ≡ $\hat{\rho}$ (our estimate of ρ). Thus, $\zeta(\hat{\rho}) = 1/(1+\hat{\rho})$ and $j = \partial\{1/(1+\hat{\rho})\}/\partial\hat{\rho}$ (evaluated at our estimate–$\hat{\rho}$) $= -1/(1+\hat{\rho})^2$. Therefore, our estimated (asymptotic) standard error for our estimate ζ of σ is $\cong \sqrt{[(\partial\hat{\sigma}/\partial\hat{\rho})^2 \text{Var}(\hat{\rho})]} = [1/(1+\hat{\rho})^2] \times$ Standard error $(\hat{\rho})$. See A. Goldberger, *Econometric Theory* (New York: Wiley, 1964), pp. 115-125 for detailed theoretical derivations which are beyond the scope of this paper.

[7] The regression equations incorporating the composite regions in the sample have R^2 of 0.50 (in case of DNS) and 0.47 (in case of BL). The estimated $\hat{\rho}$ are 0.4799 (t-statistics=5.891) and 0.505 (t-statistics=5.433) for DNS and BL respectively. Estimated $\hat{\sigma}_{us}$ are 0.6757 (approximate t-statistics=18.165) and 0.6644 (approximate t-statistics=16.19) for DNS and BL respectively. For MTRY_AC, we have the same sets of regions. Table A8 in the appendix reports these results.

The regression model fitted is the one specified in Equation (4.9). $\hat{\rho}$ is the slope estimate resulting from the specific sample used in each regression. We use logarithmic transformation of MEDY_AC and MTRY_AC—both from the DNS data sets—as a proxy for $[L_s/E]$ in separate regressions. Also, natural logarithmic transformation of TYR_BL from BL (1996-97) has been used as a proxy for $[L_s/E]$. Table 1 summarises the results from regressions using these alternative proxies for educational attainment.

From the results, we observe that in case of TYR_BL and MEDY_AC, the elasticity of substitution between skilled and unskilled labor [i.e., σ_{us}] is relatively well determined, with point estimates in the range of 0.67-0.70. t-statistics for tests of significant difference both from zero and from unity exceed 6. The latter result indicates significant difference from a Cobb-Douglas specification for the aggregator of the two types of labor.[8]

The estimated value $\hat{\sigma}_{us}$ of σ_{us} in the case where MTRY_AC is the proxy for human capital intensity yields the highest of the results obtained (0.83). The ranking of $\hat{\sigma}_{us}$ in terms of their estimated magnitudes based on alternative measures of educational attainment is

$$\hat{\sigma}_{us}(\text{MTRY\_AC}) > \hat{\sigma}_{us}(\text{MEDY\_AC}) > \hat{\sigma}_{us}(\text{TYR\_BL})$$

Empirical evidence of the elasticity of substitution between different skill categories in the Australian economy[9] suggests the following point estimates (for the Australian economy), for the value of 'σ': between skilled white collar and unskilled white collar, 0.63; between unskilled blue collar and skilled white collar, 0.24; between unskilled white collar and skilled blue collar, 0.75. The first and last of these numbers suggest that the values of $\hat{\sigma}_{us}$ found above are reasonable.

[8] The calculation involved is: *new* t-statistics = ($\hat{\sigma}_{us}$– 1)/(estimated standard error of $\hat{\sigma}_{us}$).

[9] Higgs, Peter J., Dean Parham, and Brian Parmenter (1981) "Occupational Wage Relativities and labour-labour substitution in the Australian Economy: Applications of the ORANI model. IMPACT Project, *Preliminary Working Paper* No. OP-30, Melbourne, August 1981. They reported 'implied' CRESH elasticity of substitution between occupations in ORANI simulations.

Table 1: Elasticity of substitution regressions excluding GTAP composite regions*

Dependent Variable: Skilled labour's share in total labor payment, (SKL_AC)			
Independent Variables	Mean years of education per working person (MEDY_AC)	Mean years of tertiary education per working person (MTRY_AC)	Mean years of schooling in total population (TYR_BL)
Data Set	DNS (1995-96)	DNS (1995-96)	BL (1995-96)
Observations	29	28	30
R^2	0.42	0.53	0.39
F-value	19.18	29.70	18.14
Estimated $\hat{\rho}$	0.4156	0.2088	0.4943
t-statistics for $\hat{\rho}$ (a)	4.3793	5.4499	4.2596
Estimated $\hat{\sigma}_{us}$	0.7064	0.8272	0.6692
approximate t-statistics for $\hat{\sigma}_{us}$ (a)	14.9163	31.544	12.8769
approximate t-statistics for $\hat{\sigma}_{us}$ (b)	-6.1996	-6.5895	-6.3653

* All variables are in natural logarithms.
(a) Test for significant difference from zero.
(b) Test for significant difference from 1.

6. Summary

We have been concerned here to identify educational data that can be used as a proxy for human capital endowment. The above analysis reveals that the available alternative educational attainment data sets all conform with the share of aggregate labor payments accruing to the skilled labor categories incorporated in the Version 4 of GTAP database. This comes as no surprise, since the GTAP labor split is based on one of these educational data sources. However, there is room for disagreement on some of the details. Amongst the alternative data sources, DNS (1995) data scores over BL (1996) on some desirable grounds.

The derivation by Liu et al. (1998) of the shares of skilled and unskilled labor in the work force of the 45 GTAP regions from data on educational attainment follows an *ad hoc* regression approach. In this paper the GTAP data on such shares have been taken as given, although it might have been preferable if the shares had been derived within a production-theoretic framework. Given the shares, we offer an ex post rationalization of them within such a framework, thereby deriving estimates of the elasticity of substitution between skilled and unskilled labor. This relies on the inter-regional covariation in the GTAP shares and in measures of educational attainment. The resulting point estimates are in the range 0.67 (±0.05) to 0.83 (±0.03), depending on the educational data used. These point estimates differ significantly from zero and from unity at a high level of significance.

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Table A1: Skilled labor payment shares in GTAP sectors and regions									
	GTAP Regions								
GTAP Sectors	**AUS**	**NZL**	**JPN**	**KOR**	**IDN**	**MYS**	**PHL**	**SGP**	**THA**
1 pdr	0.067	N.A.	0.015	0.005	0.000	0.013	0.019	N.A.	0.001
2 wht	0.052	0.028	0.015	0.000	N.A.	N.A.	0.000	N.A.	N.A.
3 gro	0.049	0.026	0.014	0.005	0.001	0.000	0.018	N.A.	0.000
4 v_f	0.052	0.034	0.015	0.005	0.001	0.014	0.019	0.033	0.000
5 osd	0.054	0.000	0.018	0.000	0.002	0.012	0.000	0	0.000
6 c_b	0.052	N.A.	0.015	N.A.	0.000	0.000	0.019	0	0.002
7 pfb	0.052	0.000	0.000	0.000	0.001	0.000	0.029	0	0.000
8 ocr	0.051	0.048	0.015	0.004	0.000	0.013	0.019	0.040	0.000
9 ctl	0.052	0.034	0.015	0.007	0.002	0.000	0.016	0	0.000
10 oap	0.051	0.035	0.015	0.005	0.000	0.013	0.019	0.038	0.000
11 rmk	0.053	0.033	0.015	0.005	0.000	0.017	0.000	0	0.000
12 wol	0.052	0.034	0.000	0.000	N.A.	N.A.	N.A.	N.A.	0.000
13 for	0.052	0.029	0.015	0.004	0.001	0.012	0.019	N.A.	0.002
14 fsh	0.050	0.050	0.015	0.005	0.000	0.015	0.019	0	0.000
15 col	0.192	0.133	0.412	0.143	0.261	N.A.	0.000	N.A.	0.086
16 oil	0.398	0.300	0.429	N.A.	0.261	0.184	N.A.	N.A	0.172
17 gas	0.398	0.263	0.409	N.A.	0.120	0.149	0.200	N.A.	0.142
18 omn	0.239	0.211	0.410	0.152	0.261	0.140	0.113	0	0.132
19 cmt	0.253	0.192	0.311	0.246	0.117	0.000	0.079	0	0.146
20 omt	0.252	0.200	0.310	0.243	0.113	0.170	0.073	0.269	0.145
21 vol	0.256	0.231	0.308	0.273	0.115	0.190	0.167	0.269	0.182
22 mil	0.253	0.185	0.310	0.202	0.200	0.154	0.051	0.278	0.133
23 pcr	0.241	0.250	0.311	0.268	0.115	0.188	0.122	N.A.	0.160
24 sgr	0.254	0.230	0.310	0.222	0.116	N.A.	0.167	0.250	0.182
25 ofd	0.253	0.230	0.310	0.254	0.115	0.188	0.167	0.264	0.182
26 b_t	0.254	0.216	0.390	0.213	0.116	0.142	0.109	0.271	0.129
27 tex	0.273	0.179	0.272	0.163	0.155	0.153	0.099	0.224	0.135
28 wap	0.274	0.167	0.153	0.162	0.123	0.131	0.129	0.180	0.129
29 lea	0.274	0.173	0.153	0.124	0.154	0.000	0.104	0.212	0.133
30 lum	0.194	0.178	0.351	0.174	0.117	0.132	0.086	0.234	0.116
31 ppp	0.295	0.256	0.415	0.296	0.239	0.181	0.152	0.314	0.168
32 p_c	0.455	0.265	0.376	0.201	0.239	0.212	0.000	0.397	0.169
33 crp	0.397	0.289	0.370	0.281	0.239	0.193	0.210	0.324	0.193
34 nmm	0.248	0.209	0.378	0.210	0.239	0.164	0.118	0.280	0.147
35 i_s	0.289	0.202	0.368	0.206	0.239	0.168	0.095	0.274	0.140
36 nfm	0.289	0.213	0.378	0.224	0.240	0.179	0.114	0.280	0.171
37 fmp	0.258	0.218	0.361	0.221	0.239	0.168	0.133	0.262	0.153
38 mvh	0.245	0.257	0.400	0.231	0.239	0.174	0.182	0.290	0.171
39 otn	0.245	0.258	0.400	0.231	0.240	0.176	0.167	0.293	0.170
40 ele	0.390	0.306	0.382	0.269	0.239	0.197	0.231	0.332	0.200
41 ome	0.390	0.305	0.382	0.269	0.239	0.197	0.230	0.332	0.201
42 omf	0.264	0.208	0.345	0.185	0.065	0.135	0.092	0.266	0.118
43 ely	0.365	0.342	0.417	0.152	0.493	0.354	0.248	0.400	0.322
44 gdt	0.365	0.333	0.417	0.152	0.492	0.355	0.253	0.411	0.333
45 wtr	0.365	0.350	0.417	0.152	0.490	0.351	0.245	0.407	0.321
46 cns	0.254	0.214	0.421	0.167	0.154	0.174	0.101	0.286	0.150
47 t_t	0.281	0.229	0.387	0.206	0.084	0.204	0.091	0.323	0.169
48 osp	0.483	0.456	0.407	0.352	0.320	0.410	0.514	0.402	0.438
49 osg	0.654	0.566	0.365	0.473	0.553	0.593	0.633	0.525	0.606
50 dwe	0.000	N.A.	0.000	N.A.	0.000	0.000	0.000	N.A.	0.000
REGION-WIDE	**0.416**	**0.337**	**0.375**	**0.274**	**0.163**	**0.226**	**0.239**	**0.346**	**0.252**

Source: Calculated from Version 4 of GTAP Database

Table A1(continued): Skilled labor payment shares in GTAP sectors and regions

	GTAP Regions								
GTAP Sectors	VNM	CHN	HKG	TWN	IND	LKA	RAS	CAN	USA
1 pdr	0.007	0.008	N.A.	0.030	0.001	0.006	0.009	N.A.	0.071
2 wht	N.A.	0.008	N.A.	0.000	0.001	N.A.	0.009	0.078	0.071
3 gro	0.000	0.008	N.A.	0.030	0.001	N.A.	0.010	0.078	0.071
4 v_f	0.008	0.008	0.059	0.030	0.001	0.007	0.009	0.079	0.071
5 osd	0.000	0.008	N.A.	0.031	0.001	0.000	0.009	0.078	0.071
6 c_b	0.008	0.007	N.A.	0.029	0.001	0.000	0.009	0.083	0.071
7 pfb	0.000	0.008	0	0.000	0.001	0.000	0.010	N.A.	0.071
8 ocr	0.007	0.008	0.0588	0.029	0.001	0.009	0.009	0.075	0.071
9 ctl	0.000	0.008	0.0597	0.030	0.001	0.000	0.008	0.079	0.071
10 oap	0.008	0.008	0.0586	0.029	0.001	0.000	0.009	0.078	0.071
11 rmk	0.000	0.008	N.A.	0.038	0.001	0.000	0.009	0.077	0.071
12 wol	N.A.	0.007	N.A.	0.000	0.000	N.A.	0.000	N.A.	N.A.
13 for	0.012	0.008	N.A.	0.025	0.001	0.000	0.010	0.078	0.071
14 fsh	0.000	0.008	0.091	0.030	0.000	0.014	0.009	0.078	0.071
15 col	0.111	0.107	N.A.	0.091	0.096	0.000	0.143	0.269	0.141
16 oil	0.155	0.155	0	0.200	0.156	N.A.	0.147	0.268	0.431
17 gas	0.095	0.113	N.A.	0.245	0.114	N.A.	0.115	0.268	0.431
18 omn	0.118	0.124	0.217	0.218	0.122	0.122	0.122	0.268	0.283
19 cmt	0.000	0.165	0.333	0.246	0.125	0.000	N.A.	0.180	0.141
20 omt	0.158	0.162	0.333	0.245	0.000	N.A.	N.A.	0.180	0.141
21 vol	0.200	0.178	0.333	0.345	0.175	0.000	0.176	0.181	0.271
22 mil	0.000	0.146	0.330	0.208	0.142	0.125	0.148	0.180	0.141
23 pcr	0.167	0.162	N.A.	0.233	0.161	0.200	0.000	N.A.	0.239
24 sgr	0.125	0.177	N.A.	0.346	0.175	N.A.	0.176	0.200	0.271
25 ofd	0.176	0.177	0.327	0.343	0.175	0.179	0.175	0.180	0.271
26 b_t	0.120	0.120	0.328	0.187	0.118	0.143	0.114	0.182	0.324
27 tex	0.143	0.140	0.304	0.242	0.134	0.141	0.133	0.119	0.178
28 wap	0.122	0.121	0.260	0.144	0.122	0.122	0.123	0.161	0.216
29 lea	0.136	0.136	0.399	0.179	0.130	0.167	0.130	0.145	0.200
30 lum	0.110	0.113	0.265	0.214	0.109	0.111	0.107	0.151	0.226
31 ppp	0.167	0.155	0.419	0.199	0.153	0.143	0.153	0.300	0.355
32 p_c	N.A.	0.175	N.A.	0.204	0.171	0.000	0.000	0.271	0.356
33 crp	0.171	0.167	0.393	0.262	0.171	0.169	0.172	0.352	0.439
34 nmm	0.146	0.147	0.357	0.212	0.142	0.140	0.142	0.190	0.252
35 i_s	0.167	0.151	0.303	0.172	0.141	0.200	0.141	0.165	0.206
36 nfm	0.000	0.159	0.286	0.230	0.151	0.000	0.167	0.165	0.244
37 fmp	0.250	0.150	0.315	0.221	0.149	0.143	0.167	0.208	0.278
38 mvh	0.167	0.151	0.451	0.268	0.154	0.000	0.151	0.302	0.387
39 otn	0.167	0.151	0.452	0.268	0.154	0.200	0.155	0.302	0.387
40 ele	0.161	0.170	0.452	0.322	0.175	0.200	0.200	0.370	0.478
41 ome	0.165	0.170	0.451	0.322	0.176	0.154	0.179	0.370	0.478
42 omf	0.115	0.109	0.353	0.226	0.106	0.000	0.105	0.207	0.285
43 ely	0.350	0.345	0.474	0.391	0.332	0.343	0.330	0.257	0.332
44 gdt	N.A.	0.344	0.47	0.391	0.333	0.333	0.318	0.257	0.332
45 wtr	0.000	0.344	0.471	0.392	0.332	0.357	0.333	0.257	0.332
46 cns	0.153	0.154	0.270	0.216	0.146	0.153	0.145	0.193	0.251
47 t_t	0.183	0.185	0.428	0.335	0.171	0.181	0.170	0.195	0.207
48 osp	0.409	0.408	0.451	0.369	0.422	0.414	0.424	0.381	0.628
49 osg	0.606	0.605	0.682	0.775	0.609	0.606	0.610	0.641	0.494
50 dwe	0.000	0.000	0	0.000	0.000	N.A.	0.000	0.000	0.000
REGION-WIDE	0.177	0.178	0.436	0.413	0.187	0.224	0.193	0.284	0.404

Source: Calculated from Version 4 of GTAP Database

Table A1(continued): Skilled labor payment shares in GTAP sectors and regions

GTAP Sectors	MEX	CAM	VEN	COL	RAP	ARG	BRA	CHL	URY
				GTAP Regions					
1 pdr	0.014	0.013	0.000	0.010	0.017	0.032	0.034	0	0.021
2 wht	0.017	0.000	0.021	0.013	0.017	0.027	0.035	0.017	0.015
3 gro	0.017	0.014	0.018	0.012	0.016	0.027	0.034	0.022	0.026
4 v_f	0.017	0.013	0.019	0.014	0.016	0.027	0.034	0.017	0.021
5 osd	0.024	0.012	0.026	0.012	0.013	0.027	0.034	0	0.000
6 c_b	0.017	0.013	0	0.011	0.017	0.028	0.034	0.020	0.000
7 pfb	0.019	0.014	0	0.014	0.017	0.026	0.032	0	0.000
8 ocr	0.018	0.013	0.020	0.013	0.016	0.028	0.034	0.013	0.000
9 ctl	0.017	0.013	0.019	0.013	0.016	0.027	0.034	0.015	0.020
10 oap	0.017	0.014	0.022	0.013	0.016	0.027	0.034	0.017	0.018
11 rmk	0.017	0.017	0.017	0.011	0.014	0.027	0.034	0.014	0.020
12 wol	0.000	N.A.	0	0.011	0.030	0.026	N.A.	0	0.018
13 for	0.017	0.014	0	0.017	0.000	0.026	0.034	0.015	0.000
14 fsh	0.019	0.011	0.019	0.000	0.020	0.027	0.032	0.02	0.000
15 col	0.091	0.088	0.074	0.073	N.A.	0.000	0.000	0.077	N.A.
16 oil	0.198	0.176	0.195	0.173	0.178	0.238	0.186	0.200	N.A.
17 gas	0.167	0.134	N.A.	0.120	0.134	N.A.	0.167	0.200	N.A.
18 omn	0.148	0.131	0.138	0.123	0.121	0.168	0.139	0.14	0.125
19 cmt	0.153	0.149	0.125	0.131	0.100	0.139	0.141	0.14	0.120
20 omt	0.153	0.136	0.167	0.143	0.118	0.137	0.141	0.140	0.000
21 vol	0.185	0.175	0.184	0.176	0.167	0.201	0.140	0.333	0.200
22 mil	0.143	0.140	0.119	0.127	0.095	0.129	0.141	0.137	0.108
23 pcr	0.000	0.162	N.A.	0.149	0.160	0.178	0.141	0.000	0.182
24 sgr	0.194	0.179	0.179	0.182	0.176	0.199	0.141	0.19	0.200
25 ofd	0.190	0.180	0.183	0.179	0.174	0.201	0.141	0.19	0.184
26 b_t	0.146	0.128	0.135	0.125	0.117	0.168	0.141	0.14	0.143
27 tex	0.142	0.134	0.129	0.131	0.116	0.141	0.141	0.14	0.136
28 wap	0.136	0.128	0.136	0.128	0.132	0.149	0.141	0.13	0.135
29 lea	0.140	0.137	0.126	0.127	0.113	0.141	0.141	0.13	0.129
30 lum	0.127	0.117	0.112	0.108	0.098	0.136	0.141	0.12	0.125
31 ppp	0.183	0.164	0.174	0.161	0.155	0.208	0.141	0.18	0.185
32 p_c	0.189	0.168	0.250	0.159	0.134	0.192	0.141	0.17	0.250
33 crp	0.211	0.188	0.213	0.189	0.199	0.253	0.141	0.21	0.221
34 nmm	0.159	0.147	0.144	0.142	0.133	0.166	0.141	0.15	0.144
35 i_s	0.152	0.142	0.129	0.135	0.117	0.148	0.141	0.14	0.143
36 nfm	0.168	0.167	0.152	0.154	0.141	0.173	0.141	0.16	0.250
37 fmp	0.166	0.155	0.159	0.151	0.148	0.181	0.141	0.16	0.164
38 mvh	0.187	0.167	0.186	0.169	0.176	0.221	0.141	0.18	0.184
39 otn	0.188	0.165	0.189	0.173	0.172	0.221	0.141	0.18	0.200
40 ele	0.221	0.195	0.222	0.200	0.213	0.270	0.141	0.22	0.243
41 ome	0.221	0.195	0.228	0.197	0.214	0.270	0.141	0.22	0.231
42 omf	0.133	0.115	0.143	0.115	0.104	0.152	0.141	0.14	0.133
43 ely	0.326	0.325	0.298	0.316	0.288	0.301	0.239	0.32	0.300
44 gdt	0.324	0.325	0.298	0.314	0.276	0.301	0.239	0.32	0.333
45 wtr	0.326	0.326	0.295	0.318	0.294	0.301	0.239	0.32	0.296
46 cns	0.161	0.149	0.140	0.143	0.125	0.163	0.176	0.15	0.145
47 t_t	0.179	0.170	0.148	0.160	0.131	0.167	0.159	0.17	0.150
48 osp	0.443	0.434	0.470	0.444	0.474	0.482	0.529	0.45	0.474
49 osg	0.599	0.607	0.611	0.610	0.620	0.667	0.529	0.60	0.609
50 dwe	N.A.	0.000	N.A.	N.A.	N.A.	N.A.	0.000	0	0.000
REGION-WIDE	0.281	0.246	0.279	0.268	0.324	0.267	0.321	0.282	0.227

Source: Calculated from Version 4 of GTAP Database

Table A1(continued): Skilled labor payment shares in GTAP sectors and regions

						GTAP Regions			
GTAP Sectors	RSM	GBR	DEU	DNK	SWE	FIN	REU	EFT	CEA
1 pdr	0	0	0.059	N.A.	0	N.A.	0.071	0	0.016
2 wht	0	0.042	0.054	0.058	0.066	0.056	0.068	0.067	0.018
3 gro	0	0.043	0.054	0.061	0.061	0.049	0.068	0.064	0.017
4 v_f	0	0.042	0.054	0.060	0.063	0.052	0.068	0.065	0.017
5 osd	0.014	0.042	0.055	0.053	0.063	0.048	0.068	0.064	0.016
6 c_b	0	0.041	0.054	0.065	0.064	0.041	0.068	0.068	0.016
7 pfb	0.015	0.063	0.053	0.000	0	N.A.	0.067	0.063	0.018
8 ocr	0	0.042	0.054	0.060	0.066	0.050	0.068	0.065	0.016
9 ctl	0	0.042	0.054	0.060	0.063	0.05	0.068	0.065	0.017
10 oap	0	0.042	0.054	0.059	0.063	0.049	0.068	0.065	0.017
11 rmk	0	0.042	0.054	0.059	0.063	0.050	0.068	0.065	0.017
12 wol	0	0.040	0.056	0.000	N.A.	0	0.071	0	0.019
13 for	0	0.043	0.054	0.056	0.063	0.05	0.068	0.064	0.018
14 fsh	0	0.038	0.054	0.058	0.067	0.083	0.068	0.065	0.017
15 col	0.088	0.256	0.313	N.A.	N.A.	N.A.	0.295	0.397	0.066
16 oil	0	0.341	0.411	0.438	N.A.	N.A.	0.664	0.472	0.189
17 gas	N.A.	0.338	0.420	0.458	N.A.	N.A.	0.665	0.5	0.149
18 omn	0.111	0.267	0.319	0.348	0.352	0.289	0.323	0.379	0.131
19 cmt	0.167	0.265	0.305	0.329	0.322	0.258	0.263	0.37	0.119
20 omt	0	0.265	0.305	0.327	0.323	0.260	0.263	0.370	0.119
21 vol	0	0.266	0.297	0.314	0.317	0.273	0.239	0.334	0.182
22 mil	0.143	0.261	0.302	0.325	0.321	0.256	0.248	0.369	0.109
23 pcr	0	N.A.	0.308	N.A.	N.A.	N.A.	0.280	0.346	0.149
24 sgr	0.167	0.265	0.297	0.310	0.319	0.271	0.239	0.333	0.178
25 ofd	0.179	0.265	0.297	0.312	0.316	0.277	0.239	0.334	0.179
26 b_t	0.143	0.276	0.332	0.359	0.367	0.298	0.269	0.396	0.127
27 tex	0.167	0.222	0.252	0.268	0.268	0.224	0.211	0.295	0.123
28 wap	0.143	0.184	0.207	0.217	0.221	0.196	0.178	0.229	0.132
29 lea	0	0.208	0.234	0.248	0.247	0.212	0.195	0.269	0.124
30 lum	0.107	0.232	0.276	0.297	0.301	0.244	0.194	0.330	0.107
31 ppp	0.143	0.317	0.376	0.404	0.413	0.343	0.301	0.441	0.166
32 p_c	0.164	0.391	0.471	0.512	0.515	0.405	0.548	0.579	0.144
33 crp	0.189	0.334	0.394	0.419	0.435	0.372	0.370	0.447	0.205
34 nmm	0.143	0.266	0.310	0.331	0.334	0.276	0.250	0.365	0.138
35 i_s	0	0.268	0.312	0.333	0.335	0.271	0.269	0.376	0.123
36 nfm	0	0.267	0.307	0.333	0.329	0.275	0.248	0.359	0.147
37 fmp	0.125	0.264	0.305	0.325	0.331	0.279	0.248	0.353	0.152
38 mvh	0	0.300	0.353	0.376	0.389	0.331	0.283	0.404	0.179
39 otn	N.A.	0.300	0.353	0.376	0.389	0.331	0.283	0.404	0.179
40 ele	0.25	0.344	0.407	0.433	0.451	0.388	0.380	0.459	0.218
41 ome	0	0.344	0.407	0.433	0.451	0.388	0.380	0.459	0.218
42 omf	0	0.266	0.323	0.351	0.358	0.286	0.237	0.390	0.112
43 ely	0.327	0.400	0.423	0.438	0.429	0.385	0.574	0.470	0.295
44 gdt	0.316	0.400	0.423	0.437	0.438	N.A.	0.574	0.469	0.295
45 wtr	0.333	0.400	0.423	0.438	0.430	0.385	0.574	0.470	0.295
46 cns	0.150	0.281	0.329	0.353	0.355	0.289	0.242	0.393	0.134
47 t_t	0.170	0.313	0.361	0.388	0.384	0.310	0.270	0.437	0.142
48 osp	0.432	0.418	0.419	0.414	0.428	0.446	0.536	0.393	0.470
49 osg	0.610	0.527	0.498	0.483	0.482	0.521	0.563	0.4599	0.614
50 dwe	0	0	0.000	0	0	N.A.	0.000	0	0.000
REGION-WIDE	0.222	0.381	0.360	0.408	0.384	0.335	0.405	0.397	0.225

Source: Calculated from Version 4 of GTAP Database

Table A1(continued): Skilled labor payment shares in GTAP sectors and regions

GTAP Sectors	FSU	TUR	RME	MAR	RNF	SAF	RSA	RSS	ROW
					GTAP Regions				
1 pdr	0.017	0	0.016	N.A.	0	0	0.010	0.008	0.010
2 wht	0.018	0.014	0.015	0.009	0.014	0	0.010	0.008	0.011
3 gro	0.017	0.014	0.015	0.010	0.014	0.011	0.011	0.008	0.009
4 v_f	0.017	0.014	0.015	0.010	0.014	0.013	0.006	0.008	0.010
5 osd	0.018	0.015	0.012	0	0.013	0	0.007	0.008	0.010
6 c_b	0.018	0.015	0.014	0	0.013	0.014	0.009	0.008	0.010
7 pfb	0.017	0.015	0.016	0.01	0.013	0	0.007	0.008	0.008
8 ocr	0.015	0.015	0.015	0.02	0.018	0.015	0.008	0.008	0.010
9 ctl	0.017	0.013	0.015	0.01	0.014	0.011	0.000	0.008	0.010
10 oap	0.017	0.013	0.015	0.01	0.014	0.012	0.005	0.008	0.010
11 rmk	0.016	0.013	0.015	0.01	0.014	0.009	0.010	0.008	0.010
12 wol	0.020	0	0.015	0.01	0.013	0.025	0.000	0.000	0.011
13 for	0.017	0.015	0.015	0	0.012	N.A.	0.015	0.008	0.010
14 fsh	0.016	0.014	0.013	0.017	0.014	N.A.	0.014	0.008	0.009
15 col	0.067	0.112	0.105	0	0.167	0.122	0.118	0.116	0.108
16 oil	0.186	0.182	0.183	N.A.	0.180	0.184	0.160	0.157	0.165
17 gas	0.148	0	0.146	N.A.	0.142	0.143	0.000	0.091	0.126
18 omn	0.131	0.140	0.135	0.130	0.137	0.143	0.130	0.126	0.130
19 cmt	0.119	0.163	0.140	N.A.	N.A.	0.173	0.167	0.160	0.161
20 omt	0.121	0.167	0.142	N.A.	0.000	0.178	0.143	0.167	0.157
21 vol	0.179	0.188	0.181	0.154	0.179	0.186	0.200	0.179	0.180
22 mil	0.109	0.152	0.129	0.158	0.146	0.165	0.000	0.152	0.153
23 pcr	0.149	0	0.154	N.A.	0.000	N.A.	0.125	0.158	0.164
24 sgr	0.183	0.188	0.183	0.184	0.184	0.189	0.171	0.179	0.181
25 ofd	0.179	0.187	0.182	0.181	0.184	0.190	0.182	0.178	0.181
26 b_t	0.128	0.140	0.132	0.129	0.132	0.141	0.105	0.123	0.127
27 tex	0.123	0.144	0.134	0.143	0.138	0.149	0.142	0.141	0.141
28 wap	0.132	0.131	0.131	0.125	0.130	0.131	0.126	0.120	0.125
29 lea	0.124	0.140	0.132	0.135	0.136	0.143	0.111	0.137	0.137
30 lum	0.107	0.123	0.115	0.115	0.119	0.127	0.120	0.114	0.117
31 ppp	0.166	0.176	0.169	0.160	0.169	0.177	0.154	0.157	0.162
32 p_c	0.144	0.191	0.165	0.190	0.179	0.200	0.000	0.182	0.180
33 crp	0.205	0.195	0.199	0.178	0.193	0.192	0.173	0.168	0.177
34 nmm	0.138	0.157	0.146	0.149	0.153	0.162	0.155	0.148	0.151
35 i_s	0.123	0.155	0.138	0.145	0.149	0.163	0.158	0.154	0.152
36 nfm	0.148	0.167	0.156	0.167	0.158	0.172	0.156	0.160	0.163
37 fmp	0.152	0.162	0.156	0.15	0.158	0.165	0.143	0.148	0.154
38 mvh	0.179	0.175	0.176	0.156	0.171	0.173	0.133	0.152	0.160
39 otn	0.179	0.175	0.176	0.158	0.174	0.173	0.143	0.153	0.160
40 ele	0.219	0.202	0.208	0.183	0.2	0.197	0.200	0.169	0.181
41 ome	0.219	0.201	0.208	0.184	0.201	0.197	0.171	0.171	0.181
42 omf	0.113	0.124	0.118	0.109	0.121	0.132	0.107	0.111	0.115
43 ely	0.295	0.337	0.316	0.338	0.330	0.347	0.347	0.346	0.342
44 gdt	0.296	0.338	0.315	N.A.	N.A.	0.346	0.333	0.346	0.342
45 wtr	0.295	0.339	0.316	N.A.	N.A.	0.348	0.333	0.348	0.342
46 cns	0.134	0.162	0.147	0.154	0.155	0.169	0.156	0.156	0.157
47 t_t	0.142	0.187	0.163	0.180	0.177	0.197	0.188	0.187	0.185
48 osp	0.470	0.425	0.448	0.420	0.432	0.415	0.406	0.407	0.414
49 osg	0.614	0.599	0.607	0.605	0.603	0.596	0.603	0.604	0.603
50 dwe	0.000	0	0.000	N.A.	N.A.	N.A.	0.000	0.000	0.000
REGION-WIDE	0.314	0.252	0.333	0.217	0.225	0.326	0.202	0.169	0.257

Source: Calculated from Version 4 of GTAP Database

Table A2: Mean years of education per working person and skilled labor payment shares for All GTAP Regions

GTAP Regions	Skill Payment Share (SKL_AC)	Education Years (MEDY_AC)
AUS	0.416	8
NZL	0.337	9
JPN	0.375	11
KOR	0.274	8
IDN	0.163	4
MYS	0.226	6
PHL	0.239	8
SGP	0.346	7
THA	0.252	6
VNM	0.177	N.A.
CHN	0.178	5
HKG	0.436	N.A
TWN	0.413	N.A
IND	0.187	4
LKA	0.224	6
RAS	0.193	4
CAN	0.284	10
USA	0.404	12
MEX	0.281	6
CAM	0.246	6
VEN	0.279	7
COL	0.268	5
RAP	0.324	6
ARG	0.267	8
BRA	0.321	4
CHL	0.282	7
URY	0.227	8
RSM	0.222	N.A
GBR	0.381	10
DEU	0.36	8
DNK	0.408	9
SWE	0.384	10
FIN	0.335	10
REU	0.405	9
EFT	0.397	8
CEA	0.225	N.A.
FSU	0.314	N.A.
TUR	0.252	4
RME	0.333	N.A.
MAR	0.217	2
RNF	0.225	4
SAF	0.326	5
RSA	0.202	N.A.
RSS	0.169	3
ROW	0.257	N.A.

Source: For MEDY_AC, DNS (1995), World Bank Dataset; for SKL_AC, Table A1.

Table A3: Skilled labor payment shares and mean school years of education for selected GTAP regions

GTAP Regions	Skill Payment Share (SKL_AC)	Scaled School Years of Education (MEDY_AC)	School Years of Education (MEDY_AC)
AUS	0.416	0.8	8
NZL	0.337	0.9	9
JPN	0.375	1.1	11
KOR	0.274	0.8	8
IDN	0.163	0.4	4
MYS	0.226	0.6	6
PHL	0.239	0.8	8
SGP	0.346	0.7	7
THA	0.252	0.6	6
CHN	0.178	0.5	5
IND	0.187	0.4	4
LKA	0.224	0.6	6
RAS	0.193	0.4	4
CAN	0.284	1	10
USA	0.404	1.2	12
MEX	0.281	0.6	6
CAM	0.246	0.6	6
VEN	0.279	0.7	7
COL	0.268	0.5	5
RAP	0.324	0.6	6
ARG	0.267	0.8	8
BRA	0.321	0.4	4
CHL	0.282	0.7	7
URY	0.227	0.8	8
GBR	0.381	1	10
DEU	0.36	0.8	8
DNK	0.408	0.9	9
SWE	0.384	1	10
FIN	0.335	1	10
REU	0.405	0.9	9
EFT	0.397	0.8	8
TUR	0.252	0.4	4
MAR	0.217	0.2	2
RNF	0.225	0.4	4
SAF	0.326	0.5	5
RSS	0.169	0.3	3

Source: For MEDY_AC, DNS (1995), World Bank Dataset; for SKL_AC, Table A1.

Table A4: Skilled labor payment shares and mean years of tertiary education for selected GTAP regions

GTAP Regions	Mean Years of Tertiary Education (MTRY_AC)	Skilled labor payment share (SKL_AC)
AUS	0.51	0.42
NZL	0.51	0.34
JPN	0.62	0.38
KOR	0.43	0.27
IDN	0.08	0.16
MYS	0.08	0.23
PHL	0.71	0.24
SGP	0.27	0.35
THA	0.21	0.25
CHN	0.03	0.18
IND	0.12	0.19
LKA	0.06	0.22
CAN	0.90	0.28
USA	1.60	0.40
MEX	0.29	0.28
VEN	0.44	0.28
COL	0.25	0.27
ARG	0.62	0.27
BRA	0.23	0.32
CHL	0.34	0.28
URY	0.50	0.23
GBR	0.36	0.38
DEU	0.47	0.36
DNK	0.49	0.41
SWE	0.61	0.38
FIN	0.60	0.34
TUR	0.19	0.25
MAR	0.10	0.22

Source: For MTRY_AC, DNS (1995), World Bank Dataset; for SKL_AC, Table A1.

Table A5: Skilled labor payment shares, average years of higher and total schooling for selected GTAP regions

GTAP Regions	Avg.Years of total schooling (TYR_BL)	Avg.Years of higher schooling (HYR_BL)	Skill Payment related AC (SKL_AC)
AUS	10.39	0.67	0.416
NZL	11.25	0.97	0.337
JPN	8.98	0.54	0.375
KOR	9.94	0.41	0.274
IDN	4.59	0.04	0.163
MYS	6.04	0.1	0.226
PHL	6.93	0.61	0.239
SGP	5.89	0.12	0.346
THA	5.61	0.24	0.252
CHN	5.85	0.07	0.178
HKG	9.15	0.33	0.436
TWN	7.98	0.38	0.413
IND	4.12	0.11	0.187
LKA	5.98	0.05	0.224
CAN	10.36	0.49	0.284
USA	11.74	1.3	0.404
MEX	6.72	0.24	0.281
CAM	4.11	0.13	0.246
VEN	4.96	0.29	0.279
COL	4.71	0.21	0.268
RAP	5.67	0.36	0.324
ARG	8.13	0.37	0.267
BRA	3.81	0.18	0.321
CHL	6.71	0.3	0.282
URY	7.1	0.31	0.227
GBR	8.76	0.39	0.381
DEU	9.3	0.45	0.36
DNK	10.7	0.46	0.408
SWE	9.48	0.54	0.384
FIN	9.59	0.37	0.335
EFT	8.41	0.38	0.397
TUR	3.83	0.15	0.252
RNF	3.94	0.11	0.225
SAF	5.28	0.09	0.326
RSS	2.85	0.05	0.169

Source: For TYR_BL and HYR_BL, BL (1996) Dataset; for SKL_AC, Table A1.

Table A6: Mean school years of education per working person (DNS database) and skilled labour payment shares for single GTAP regions

GTAP Regions	Skilled Payment share (SKL_AC)	Mean school years of education (scaled) (MEDY_AC)
AUS	0.416	0.8
NZL	0.337	0.9
JPN	0.375	1.1
KOR	0.274	0.8
IDN	0.163	0.4
MYS	0.226	0.6
PHL	0.239	0.8
SGP	0.346	0.7
THA	0.252	0.6
CHN	0.178	0.5
IND	0.187	0.4
LKA	0.224	0.6
CAN	0.284	1
USA	0.404	1.2
MEX	0.281	0.6
VEN	0.279	0.7
COL	0.268	0.5
ARG	0.267	0.8
BRA	0.321	0.4
CHL	0.282	0.7
URY	0.227	0.8
GBR	0.381	1
DEU	0.36	0.8
DNK	0.408	0.9
SWE	0.384	1
FIN	0.335	1
TUR	0.252	0.4
MAR	0.217	0.2
SAF	0.326	0.5

Source: Same as mentioned in Table A3

Table A7: Mean school years of education per working person (BL database) and skilled labour payment shares for single GTAP regions

GTAP Regions	Skilled labor Payment share (SKL_AC)	Average years of schooling (TYR_BL)
AUS	0.416	10.39
NZL	0.337	11.25
JPN	0.375	8.98
KOR	0.274	9.94
IDN	0.163	4.59
MYS	0.226	6.04
PHL	0.239	6.93
SGP	0.346	5.89
THA	0.252	5.61
CHN	0.178	5.85
HKG	0.436	9.15
TWN	0.413	7.98
IND	0.187	4.12
LKA	0.224	5.98
CAN	0.284	10.36
USA	0.404	11.74
MEX	0.281	6.72
VEN	0.279	4.96
COL	0.268	4.71
ARG	0.267	8.13
BRA	0.321	3.81
CHL	0.282	6.71
URY	0.227	7.1
GBR	0.381	8.76
DEU	0.36	9.3
DNK	0.408	10.7
SWE	0.384	9.48
FIN	0.335	9.59
TUR	0.252	3.83
SAF	0.326	5.28

Source: Same as mentioned in Table A5.

Table A8: Elasticities of substitution regressions including GTAP composite regions#

Dependent Variable: Skilled labour's share in total labor payment (SKL_AC)			
Independent Variables	**Mean years of education per working person (MEDY_AC)**	**Mean years of tertiary education per working person (MTRY_AC)**	**Mean years of schooling in total population (TYR_BL)**
Data Set	DNS (1995-96)	DNS (1995-96)	BL (1995-96)
Observations	36	28	35
R^2	0.51	0.53	0.47
F-value	34.71	29.70	29.52
Estimated $\hat{\rho}$	0.4799	0.2088	0.5052
t-statistics for $\hat{\rho}$	5.8911	5.4499	5.4331
Estimated $\hat{\sigma}_{us}$	0.6757	0.8272	0.6644
approximate t-statistics for $\hat{\sigma}_{us}$	18.165	31.544	16.19

#All variables are in natural logarithms.