HUMAN CAPITAL AND ECONOMIC GROWTH: THE CASE OF BARBADOS

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Abstract

The study utilises a traditional production function framework to measure the contribution of human capital (Education) to economic growth in Barbados over the period 1964-1993. The methodology decomposes the contribution of labour to economic growth into three components. The first accounts for the contribution to growth due to unskilled labour, while the second accounts for the contribution arising from the educational investment required to bring the skills of new entrants into the labour force to the country's average level of schooling. The third component refers to the contribution arising from increases in the overall level of schooling in Barbados. The main finding is that when this decomposition is applied to Barbados' data in the growth accounting process, labour's contribution explains nearly 50% of economic growth in the country over the period of investigation. This is more than double labour's contribution when such qualitative decomposition is ignored.

I. INTRODUCTION

Since the beginning of the decade of the 1960s, it has increasingly been recognized that the concept of accumulation need not be limited to technology and physical capital but is also applicable to the cluster of factors, including health, education, on-the-job training and general skills of the labour force, which is collectively referred to as human capital.

The pioneering work of Solow (1957) and Denison (1962) suggested that in the process of accounting for economic growth in the US economy, the traditional factors of physical capital and labour explained only a small fraction of the observed

changes in output, leaving a substantial residual. As far as developing countries are concerned, studies by Williamson (1969) in the Philippines and Selowsky (1969) in Chile seem to suggest that the educational contribution to growth in these two countries, although not as large as was found by Denison (1962) for the United States, was nevertheless moderately significant. Physical capital formation accounted for a much larger share of output growth than was normally observed in developed countries. Although most of the early studies on growth accounting attributed a large part of the unexplained residual to increases in the level of education of the labour force, with the possible exception of Selowsky (1969), no attempts were made to set out the framework by which such contribution could be measured. We attempt to do this in this paper.

The literature recognizes three main sources of economic growth: growth in the inputs of production (capital and labour, for instance), improvements in the efficiency of allocation of these inputs across activities and innovation that create new products, new uses of existing products and bring about increases in the productivity of inputs. The strong impact that education has on economic growth lies in the fact that it impacts directly on the latter two sources of growth. Education not only improves the ability of the labour force to work more efficiently with a given level of technology but it also enables the state of technology to advance more rapidly, leading to a faster introduction of more advanced production techniques.

The process of integrating knowledge acquisition into the theories of growth owes its genesis to Arrow (1962) but it was the modern growth theories, led by endogenous growth models of which Romer (1986) is the main proponent that has popularised it. These latter theories recognize, *inter alia,* that the accumulation of knowledge is not only endogenously determined but knowledge itself may have an increasing marginal product.

While it is recognized that both human capital and physical capital, along with technological progress provide the main impetus for economic growth, the determinants of human capital accumulation have attracted less attention in the literature than physical capital mainly because of the extreme difficulties of measuring the former.

Early attempts to measure the educational component of human capital made use of literacy rates and school enrollment ratios. While the latter may be considered an improvement on the former, both are rather unsatisfactory. Literacy rates capture only a basic level of overall education but ignore the fact that some people are much better educated than others. Similarly, school enrollment ratios measure future capital rather than the present.

The wage or income-based approach to human capital measurement avoids some of the pitfalls that come from equating levels of education directly with human capital. It is based on the idea that the amount of human a person possesses should be

reflected in pay. The underlying assumption is that wage rates and therefore labour incomes are determined endogenously by the marginal productivity of the worker. The latter, in turn, is determined by all the exogenous characteristics (such as education, experience, health and cognitive skills), which define human capital. This approach also has its drawbacks but in general, it represents a measure of improvement over the first two.

Barro and Lee (1993) and more recently, Mulligan and Salai-Martin (1995) provide recent examples of studies that have adopted this approach to measure human capital. This study is largely based on this approach.

The paper has two broad objectives:

(i) to provide a framework for measuring human capital (mainly educational capital) in Barbados, a country which has a tradition of high literacy rates as a result of significant investment in education.

(ii) To ascertain the contribution to economic growth of human capital, along with physical capital and 'raw' labour inputs.

The organization of the paper takes the following sequence: Section II outlines the theoretical framework underpinning the analysis; Section III deals with data sources and the empirical problem of generating the time series data necessary for the measurement of human capital contribution to growth. Section IV utilizes

the framework of Section II and the information generated in Section III to measure past contribution of human capital to growth for Barbados. Finally, Section V concludes the paper with a brief summary and some remarks on possible policy implications.

II. THEORETICAL FRAMEWORK

Following Selowsky (1969) one can consider the contribution of human capital to growth as having two components:

(i) The effect of increases in the educational level of the labour force. This is the effect of increases in the level of schooling and general health of the labour force. This effect can be termed as "human capital deepening", analogous to physical capital deepening in capital theory.

(ii) The contribution of human capital that derives from maintaining the average level of schooling of the labour force. This part can be considered as the contribution of human capital that derives from the efforts to equip additions to the labour force with the same skills as the existing labour force. In this paper it is denoted as the "maintenance" component of human capital.

Most of the studies ignore the latter component of human capital contribution to growth but as Selowsky (1969) points out, its neglect tends to under-estimate human capital's contribution to growth and over-estimates the part of growth attributable to increase in the number of workers.

The following section outlines the procedure for deriving the two components of human capital.

II (i) *The General Model*

Consider an augmented neoclassical production function:

$$Y = F(K, L_0, L_i \ldots L_n, Z) \qquad (1)$$

where Y denotes aggregate output, K, the flow of services of physical capital stock, and $(L_0, \ldots L_i, \ldots L_n)$, man-hour inputs of members of the labour force with o,... i,..., n years of schooling, respectively. Similarly, Z represents the contribution to growth of other factors such as external orientation, technology, etc. that may help explain output levels. Equation (1) is a modified form of Solow's 1957 growth model that has been used extensively by, among others, Selowsky (1969), Feder (1983), Ram (1987) and Lin (1994). By differentiating equation (1) with respect to time, rearranging terms,

assuming that wages (W_i) reflect marginal productivities[1], and writing Y', L_i' for $\frac{dY}{dt}, \frac{dL_i}{dt}$ etc., equation (1) could be transferred into an equation of the form:

$$Y' = f_k K' + w_o L' + \sum (w_i - w_o) a_i L' + L \sum w_i a_i' + f_z' \qquad (2)$$

In (2), the term $f_k K'$ is the contribution of physical capital to growth, $w_o L'$ is the contribution of the uneducated component of the labour force, while $\sum(w_i - w_o)\alpha_i L'$ is the contribution to output deriving from the effect to equip additions to the labour force with the same skills as the existing labour force. It represents the "maintenance" component referred to earlier.

Similarly, the term $L \sum_{i=0}^{n} W_i a_i'$ is considered as the contribution to growth due to changes in the relative distribution of workers by years of schooling weighted by the relative marginal products. It must be noted that so long as education creates external economies not captured by wage differentials the third and fourth terms in (2) would underestimate the true contribution of education. On the other hand it would overestimate the contribution too the extent that innate ability, family connections, etc. are correlated with years of schooling.

Equation (2) may further be recast as:*

* Please see the appendix for the full derivation of the model.

$$\frac{Y'}{Y} = \frac{\alpha_K K'}{K} + \frac{\alpha_b L'}{L} + \frac{\alpha_e L'}{L} + \frac{\alpha_q Q'}{Q} + R \qquad (3)$$

where $\alpha_k = \frac{Kf_K}{Y}$ represents the share of physical capital in total output, $\alpha_b = \frac{W_o L}{Y}$ the share of the labour input in total output if every worker were uneducated and $\alpha_e = \frac{\left(\bar{W} - W_o\right)}{Y}$ the share attributable to educational widening in total output . The expression $\frac{Q'}{Q} = \frac{\sum_{i=0}^{n} W_i a_i'}{\bar{w}}$ also denotes relative changes in the index of educational deepening, and $\alpha_q = \frac{\bar{W}L}{Y}$ is the observed share of labour in output. R is a residual summarizing the contribution of other factors to the growth rate.

In discrete approximation of the time derivates one can re-write (3) as:

$$\frac{\Delta Y}{Y} = \frac{\alpha_K \Delta K}{K} + \frac{\alpha_b \Delta L}{L} + \frac{\alpha_e \Delta L}{L} + \frac{\alpha_q \Delta Q}{Q} + R \qquad (4)$$

Both parts of equation (4) can be computed for any time period of which data exist for output capital, labour as well as for the respective shares of capital and labour.

The original decomposition as employed by Solow (1957) takes the form:

$$\frac{\Delta Y}{Y} = \alpha_k \frac{\Delta K}{K} + \alpha_l \frac{\Delta L}{L} + R' \qquad (5)$$

Therefore, in essence, what the decomposition as outlined in (4) does is to split algebraically the original contribution of labour into three parts: first, the contribution

to growth due to 'raw' labour force growth, second the contribution attributable to the educational effort needed to bring new entrants to the national average level of education and thirdly, the contribution due to changes in the composition of the labour force by schooling, weighted by the respective marginal products.

III. DATA SOURCES AND MEASUREMENTS

It can be seen from section II that the weights for the changes in the schooling distribution of the employed labour force are relative wages by categories of educational levels achieved. The 1960 census report for Barbados puts the literacy rate at about 95%. That means that for the period of the analysis almost every member of the labour force would have attained at least primary school level of education. Therefore it is not realistic to obtain the contribution of the labour force in total output if every worker were uneducated. The paper therefore estimates the contribution to output as if every worker were educated up to the primary level.

Three categories of the labour force with different levels of skill and knowledge are identified: those with educational level up to the primary school (L_1), those with secondary/technical and vocational training (L_2) and those with tertiary level of education[2] (L_3). Data for these categories of educational levels are available from various census data as well as Labour Market Information Bulletin published by the Ministry of Labour. The median salaries for the country's civil servants for the three categories identified were assumed to reflect the wages and/or salaries paid to the respective categories in the overall economy.[3] These were assembled from various issues of the "Schedule of Emoluments" published annually by the Ministry of Finance. Information on gross capital formation and the labour force employed were obtained

from the "Annual Statistical Digest of the Central Bank of Barbados, while data for the stock of capital was taken from Boamah (1984).

As explained in section II, α_b represents the share of labour input in total output if every worker were only educated to the primary school level, α_q is the observed share of total labour input and α_k is the share of physical capital in total output. Similarly, α_e denotes the imputed share of labour input attributed to educational quality improvements beyond the primary school level.

As shown in equation (4) the measurements of α_b and α_q are straightforward.
The expression for α_k was obtained residually as $\alpha_k = (1 - \overline{WL/Y})$. The variable $\Delta Q/Q$ represents the growth rate in the index of qualitative changes in the labour force but there is no readily available data on it. To obtain a series for this recall from equation (8) that:

$$\frac{\Delta Q}{Q} = \frac{\sum_{i=1}^{3} w_i a_i'}{\overline{W}} \frac{1}{\overline{W}} \sum_{i=1}^{3} W_i \left(\frac{L_I}{L} \right)' \qquad (6)$$

Through a process of differentiating $\left(\frac{L_i}{L}\right)$ with respect to time and rearranging terms, the expression of $\frac{\Delta Q}{Q}$ in equation (6) becomes:

$$\frac{\Delta Q}{Q} = \frac{1}{w} \sum_{i=1}^{3} w_i a_i \left(\frac{\Delta L_i}{L_i} - \frac{\Delta L}{L} \right) \qquad (7)$$

$$or \quad \frac{\Delta Q}{Q} = \frac{W_1 a_1}{\bar{W}}\left(\frac{\Delta L_1}{L_1} - \frac{\Delta L}{L}\right) + \frac{W_2 a_2}{\bar{W}}\left(\frac{\Delta L_2}{L_2} - \frac{\Delta L}{L}\right) + \frac{W_3 a_3}{\bar{W}}\left(\frac{\Delta L_3}{L_3} - \frac{\Delta L}{L}\right) \qquad (8)$$

Thus a series on Δ Q/Q can easily be derived from the available information on a_i

L_i, W_i *and* $\bar{W}$

Figure 1 - Employment by Highest Level of Education

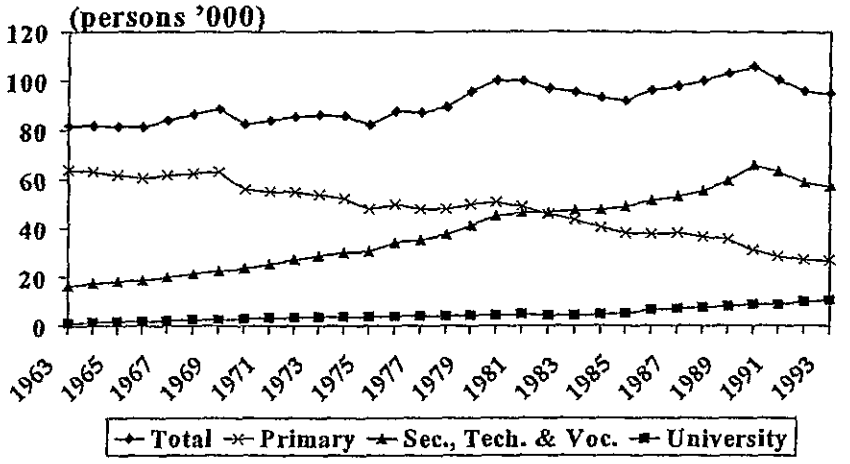

Figure 2 - Real Wages by Highest Level of Education

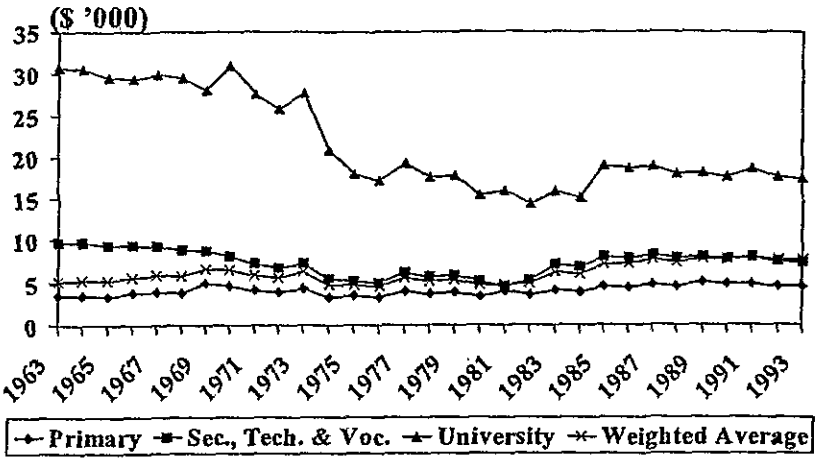

TABLE 1

Contributions to Growth in Barbados
(Without Accounting for Labour Quality)
Selected Years

Year	ΔY/Y	α_k (ΔK/K)	α_l (ΔL/L)	R
1965	0.13424	0.00139	-0.00477	0.13762
1968	0.05267	0.00966	0.02603	0.01698
1971	0.02779	0.02182	0.01294	-0.00697
1974	-0.02298	0.03124	-0.00067	-0.05355
1977	0.03596	0.02774	-0.00440	0.01262
1980	0.04395	0.03120	0.02664	-0.01281
1983	0.00491	0.01678	-0.00658	-0.00529
1986	0.05106	0.01571	0.03390	0.00145
1989	0.03597	0.01039	0.02291	0.00268
1993	0.00808	0.01055	-0.00935	0.00688
Average [a]				
1964-1993	0.04962	0.01484	0.00992	0.02487

Note [a]: The Calculations of the average contributions cover the entire period of analysis and have been restricted to the period of positive rate of growth of output.

TABLE 2

Contributions to Growth in Barbados
(Accounting for Labour Quality)
Selected Years

Year	$\Delta Y/Y$	$\alpha_k (\Delta k/k)$	$\alpha_b (\Delta L/L)$	$\alpha_e(\Delta L/L)$	$\alpha_q(\Delta Q/Q)$	R
1965	0.13424	0.00139	-0.00307	-0.00170	0.02987	0.10775
1968	0.05267	0.00965	0.01709	0.00894	0.02199	-0.00501
1971	0.02779	0.02182	0.00900	0.00393	0.01367	-0.02064
1974	-002298	0.03124	-0.00046	-0.00021	0.00642	-0.05997
1977	0.03596	0.02774	-0.00318	-0.00122	0.00391	0.00871
1980	0.04395	0.03012	0.01901	0.00763	0.00361	-0.01642
1983	0.00491	0.01678	-0.00434	-0.00224	0.00819	-0.01347
1986	0.05106	0.01571	0.02081	0.01309	0.02919	-0.02774
1989	0.03597	0.01039	0.01482	0.00808	0.00795	-0.00527
1993	0.00808	0.01055	-0.00545	-0.00389	0.01039	-0.00351
Average [a]						
1964-1993	0.04962	0.01484	0.00683	0.00309	0.01457	0.01030

Note [a]: The calculations of the average contributions cover the entire period of analysis and have been restricted to the periods of positive rates of growth of output.

Figure 1 represents the evolution of employed labour in Barbados by different levels of education for the period 1963 to 1993. As expected, with the exception of L_1 which decreased over the period, L_2 and L_3 increased on average. Figure 2 illustrates the time series behaviour of relative wages by level of education for the three classes identified. It demonstrates that over the period of investigation relative wages followed a declining trend, particularly for those individuals with higher levels of education.

Individuals with university level education received nearly six times the real average wage in 1963, but by 1993 they were paid only two and a quarter times the average wage. A logical explanation for this is that in 1963, individuals with university level education were relatively more scarce and hence received a higher wage premium. In later years, as proportionately more people acquired higher education, the wage premium gradually declined.

The relative wages of workers with only primary school education showed the least variation from the mean over the period of investigation. Those individuals received a little over 58% of the real average wage in 1993 compared with 69% in 1963 but it is noteworthy that in 1993 they received one-quarter the real wages of individuals with university level education compared with only one-ninth[4] in 1963.

IV. EMPIRICAL RESULTS

The results obtained from applying Barbados' data to model (4) are presented in tables 1 and 2. Table 1 presents the results of aggregating the labour force without taking explicit account of labour quality improvements.

Equation 5 was utilised, and α_k and α_l, the respective shares of capital and labour were defined such that $\alpha_k + \alpha_l = 1$. The table suggests that for the period 1964 to 1993, out of an average growth rate of real output of 4.96%, increases in capital inputs accounted for 1.48% and labour 0.99%, leaving a residual averaging 2.49%. In other

words, increases in capital inputs accounted for approximately 30% of the growth rate of real output, labour approximately 20%, leaving 50% accounted for by other factors.

Table 2 presents the growth accounting results when the decomposition as outlined in equation (4) is utilised. In this decomposition, if the assumption of constant returns to scale is imposed, the implied value of α_k would take the form $\alpha_K = \left(1 - \frac{2\overline{WL}}{Y}\right)$. Given the range of values of $\alpha_l = \frac{\overline{WL}}{Y}$ of around 0.6 and 0.8, the estimated value for α_k would take on negative values, which obviously would not make economic sense. Therefore, on the basis of the 'Kaldorian-stylized' fact that factor shares show little variation over time (see McCombie 2001, P. 607) it was decided to keep the values of α_k unchanged in both scenarios. This implicitly assumes that the bulk of the unexplained original "Solow residual" is accounted for by enhanced human capital for a given level of labour force. It also implies that the decomposition as outlined in equation (4) exhibits increasing returns to scale (since $\sum_i \alpha_i > 1$). Again, this may be justified by the fact that a rising stock of basic knowledge steadily raises the productivity of labour and enhances increasing returns (Romer (1986)). The results in this scenario suggest that, on average, the contribution to real growth of unskilled labour (that is, if it were assumed that every worker were educated only to the primary level) during the period 1964-1993 was about 13.8% (growth rate 0.68%) and that arising from the efforts to equip new job entrants with just enough education to maintain the educational level of the entire work force as previously existing was approximately 6.2% (growth rate 0.31%). At the same time the contribution to growth as a result of qualitative improvements of the work force (human capital deepening) was a significant 29.4% (growth rate

1.46%). In sum, the total contribution to growth by labour when qualitative improvements are taken into account amounts to a significant 49.4% as compared with only 20% when labour quality improvements are ignored. Increases in capital inputs continue to contribute approximately 30% to the growth rate of real output. The residual in this case contribute only 20.8%, compared with about 50% when one does not take labour quality improvements into consideration.

In other words the residual or total factor productivity (see Jorgenson and Grilliches, 1967) becomes the most important factor explaining growth rates in Barbados if no account is taken of labour quality improvements. However, labour's contribution to growth becomes greatly enhanced when one takes changes in increasing skills into consideration, explaining nearly half the growth rate of output. Total factor productivity in this case accounts for only 20% of economic growth. The robust contribution to growth in Barbados resulting from qualitative improvements in labour is further supported by the results of an exploratory regression of a general production function in which labour disaggregated into the respective educational levels enter as separate arguments along with physical capital. The results (available on request) put the estimated combined share of labour in output at approximately 80% compared with only 44% when an aggregated labour variable is fitted along with physical capital. The share of physical capital is approximately 12%.

V. CONCLUSIONS

The main conclusion from the paper is that human capital has contributed significantly to economic growth in Barbados over the period 1964-93 considered. The analysis also suggests that technical change over the period has largely been embodied in labour. This is consistent in an economy like Barbados which is famous for the high investment in education and which boasts a literacy rate of over 90%. Indeed, over the period 1973 to 1996-97, Government spending in education has ranged between 17% to 21% of total Government expenditure, the highest among the social expenditure categories.

The results of the study have some implications for policy. Physical capital has traditionally been subsidized in Barbados by way of fiscal incentives because of its perceived importance in stimulating economic expansion. The results of this study suggest that investment in human capital is an equally effective way to stimulate economic growth so that public policy to upgrade the labour force should continue to receive high priority in the country's development strategy.

Nevertheless, while general education is obviously beneficial, it is rather mistaken to suppose that simply increasing the aggregate amount of 'education' may be sufficient to raise productivity further. Indeed recent research findings (see Barro, 2001) suggest that of all the disciplines, science and mathematics appear to have the strongest impact on economic growth in the US. To that extent, it is necessary for public policy on education in Barbados to identify what kinds of educational activity are likely to be more growth enhancing and emphasise them with some sort of subsidy. Policy makers ought

also to be aware of the economic cost of supporting other types of education whose justification may not necessarily be on economic grounds.

While the results appear plausible, they need to be taken with caution to the extent that the study is based on the neo-classical marginal productivity theory of labour which assumes that labour is paid the value of its marginal product. Naturally market imperfections such as institutional wage setting as obtains in Barbados would create a divergence between marginal product and real wages.

ENDNOTES

1 It should be noted that the assumption that wages paid the respective categories of labour reflect their marginal productivities is only made to simplify the analysis. The implied assumptions of a perfectly functioning labour market do obviously do not hold in Barbados.

2 To be classified in this category, a person must be a university graduate, at the minimum.

3 The assumption is made for convenience in view of the total lack of published information on wages and salaries paid in the private sector. Nevertheless, the relative wages by levels of education in the private sector are not likely to deviate substantially from those in the civil service.

4 Institutional facts such as the influence of labour unions m ay have been partly responsible for the declining wage differential between the least and highest educated workers.

APPENDIX I

The following section outlines the procedure for deriving the two components of human capital.

1. *The General Model*

Consider an augmented neoclassical production function:

$$Y = F(K, Lo, Li \ldots Ln, Z) \qquad (1)'$$

where Y denotes aggregate output, K, the flow of services of physical capital stock, and Lo, Li ... ln, man-hour inputs of members of the labour force with (o,i...n) years of schooling, while Z is an error term.

By differentiating equation (1)' with respect to time and writing Y', L_i' respectively for $\frac{dY}{dt}, \frac{dLi}{dt}$ etc. one can rewrite equation (1) as:

$$Y' = f_k K' + f_{l0} L_i' + f_{li} L_i' + \ldots + f_{\ln} L_n' + f_z Z' \qquad (2)'$$

where f_k, f_{li} represent the marginal productivities of physical capital $\left(\frac{\partial F}{\partial K}\right)$ and labour with i years of schooling $\left(\frac{\partial F}{\partial L_i}\right)$, respectively. Assume that wages reflect marginal productivities; then

$$Y' = f_k K' + \sum_{i=o}^{n} w_i L_i' + f_z Z' \qquad (3)'$$

In equation (3), W_i is the real wage of individuals with i years of schooling.

$$Let\ L = \sum_{i=o}^{n} L_i,\ \ therefore\ \ L' = \sum_{i=0}^{n} L_i'$$

Thus one can write equation (3)′ as

$$Y' = f_k K' + W_o L' + \sum_{i=0}^{n} (W_i - W_o) L_i' + f_z Z' \qquad (4)'$$

From equation (4)′, the expression $\sum_{i=0}^{n} (W_i - W_o) L'$ may be written as:

$\sum_{i=0}^{n} (W_i - W_o)(a_i L)'$ which, in turn becomes

$$L' \sum_{i=0}^{n} (W_i - W_o) a_i + L \sum_{i=0}^{n} W_i a_i' - W_o L \sum_{i=0}^{n} a_i' \qquad (5)'$$

$$\left(\text{since } (a_i L)' = (L a_i' + L' a_i) \right)$$

By definition $\sum_{i=0}^{n} a_i = 1$ and hence $\sum_{i=0}^{n} a_i' = 0.$

Therefore one can write equation (4)′ as

$$Y' = f_k K' + W_o L' + \sum_{i=0}^{n} (W_i - W_o)\ a_i L' + L \sum_{i=0}^{n} W_i a_i' + f_z Z' \qquad (6)'$$

$$\text{and hence } \frac{Y'}{Y} = \frac{f_k K'}{Y} + \frac{W_o L'}{Y} + \frac{L' \sum_{i=0}^{n} (W_i - W_o) a_i}{Y} + \frac{L \sum_{i=0}^{n} W_i a_i'}{Y} + \frac{f_z Z'}{Y} \qquad (7)'$$

Let the average wage, $\overline{W} = \sum_{i=0}^{n} W_i a_i$

$$Therefore \sum_{i=0}^{n} (W_i - W_o)\, a_i = (\overline{W} - W_o), since \sum_{i=0}^{n} a_i = 1$$

Hence equation (7) becomes

$$\frac{Y'}{Y} = \frac{Kf_k K'}{YK} + \frac{LW_o L'}{YL} + \frac{L}{Y}(\overline{W} - W_o)\frac{L'}{L} + \frac{\overline{W}L}{Y}\frac{\sum_{i=0}^{n} W_i a_i'}{\overline{W}} + \frac{f_z Z'}{Y}$$

(8)'

$$or \frac{Y'}{Y} = \frac{\alpha_k K'}{K} + \frac{\alpha_b L'}{L} + \frac{\alpha_e L'}{L} + \frac{\alpha_q Q'}{Q} + R$$

(9)'

In discrete approximation of the time derivates one can re-write (9) as:

$$\frac{\Delta Y}{Y} = \frac{\alpha_k \Delta K}{K} + \frac{\alpha_b \Delta L}{L} + \frac{\alpha_e \Delta L}{L} + \frac{\alpha_q \Delta Q}{Q} + R \qquad (10)'$$

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