Are there Gender-Separate Education Effects on Growth?

A Dynamic Time Series Analysis.

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This paper investigates the empirical link between gender separate education and economic progress for the case of the small island developing state of Mauritius. It allows for dynamic and feedback effects in the education-growth link by using a multivariate dynamic estimation technique, namely a difference vector autoregressive framework for the period 1960-2000. Results from the analysis suggest that both female and male education are important ingredients in explaining growth. Moreover they are shown to have nearly the same productivity level. Further analysis suggests that bi-causality exist between female/male education and economic growth. Indirect effects via capital stock accumulation, a proxy for investment, are also reported.

Key words: **Human Capital, Education, Economic Development, Difference VAR.**

JEL Classification: I20, H54, O20.

Introduction

There has been an important amount of empirical work on the economic importance of gender-neutral education. Overall there exists a consensus that education attainment has a positive and significant effect on economic growth thus confirming the theoretical predictions. However studies on the gender separate education effects on economic progress have largely ignored until recently even, then there exists a great deal of contradictory evidences. For instance Barro and Lee (1994) find that growth is positively related to male education and negatively related to female education. Caselli, Esquivel and Lefort (1996), however, find the opposite, while Birdsall, Ross and Sabot (1997) report no significant difference between the genders.

Moreover, among this scarce amount of studies, the large majority have been based on cross country and panel data analysis and focused on developed countries cases. Studies on country specific cases using rigorous time series analysis, especially for developing countries, have been particularly lacking. More importantly, to our knowledge, no study has been performed for the case of small island developing states and we should take into account the fact that empirical findings from developed countries' cases are not directly applicable and relevant to island states given their vulnerability and special characteristics and. Moreover, it is only lately that scholars have been implicitly dealing with the issue of reverse causality and dynamics in the education and economic growth link

The aim of this paper is to fill the above gaps and to investigate the empirical link between gender separate education and economic progress for the case of the small island developing state of Mauritius. It allows for dynamic and feedback effects in the education-growth link, an issue often been ignored, by using a multivariate dynamic estimation technique, namely a difference vector autoregressive framework for the period 1960-2000

The structure of this paper is as follows

Section II discusses very briefly the theoretical underpinnings of the link between education and economic growth and the relevant empirical literature. Section III describes the preferred modelling function used and elaborates on the data collection. It also investigates the empirical link between gender separate education and economic growth for the case of Mauritius. Section IV concludes.

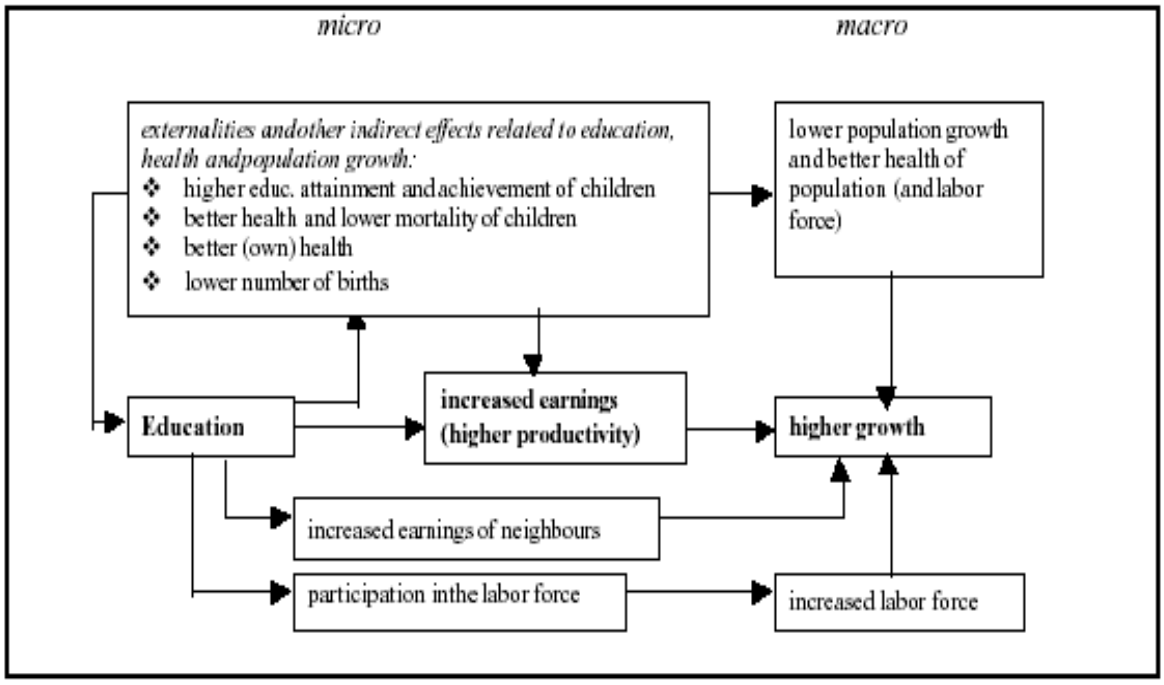
Literature review

Before focusing on the gender-separate theoretical literature, it is first necessary to briefly review the role of aggregate human capital in economic growth. In fact more and better education is a prerequisite for rapid economic development around the world. Education stimulates economic growth and improves people's lives through many channels: by increasing the efficiency and thus increasing an individual's earning potential of the labor force, by fostering democracy (Barro, 1998) and thus creating better conditions for good governance, by improving health and reducing fertility, by enhancing equality (Aghion, Caroli and García-Peñalosa, 1999), and so on. More importantly education in fact

produces a "ripple effect" throughout the economy by way of a series of positive externalities. Michaelowa, 2000) provides a comprehensive overview of theoretical underpinnings about the link between education and economic growth and this is shown in adapted figure below.

Figure 1 summarises the following education-growth theoretical arguments namely that i) educated persons as well as of those who indirectly learn from them benefit from increased earnings and this can be interpreted as a reflection of productivity gains. If the population reaches a higher educational attainment, economic productivity should be fostered and thus leading to higher growth. Moreover, the wage differential reflects the higher value of human capital which, being an input factor in the national production

Figure 1 :The economic return to education



Source : Michaelowa, K., 2000.

function, contributes to an increased national output. ii) Education positively influences another dimension of human capital with similar consequences for increased productivity and growth through its impact on health. iii) Education also leads to reduced birth rates through its impact on reduced population growth. From a statistical point of view this increases national income and growth are considered on a per capita basis. In addition it is clear that the number of childbirths affects women's physical ability to work and their productivity and finally iv) education has often been argued to induce more persons to participate in the labor force. This might in turn lead to a reallocation of the population towards economically more productive activities and ultimately having an impact on growth.

Empirical Evidences

Classical work from Jorgenson, Gallop and Fraumeni (1987) has reported a positive contribution of education and human capital to economic growth. Maddison (1991) while estimating the growth impact of changes in educational attainment and reported output elasticity with respect to quality of labour force between 0.1 and 0.5. One of the best known and most influential contributions to the empirical growth literature, particularly on the growth effects of human capital is that of Mankiw, Romer, and Weil (1992) who reported an output elasticity of education of 0.3. The results are in line with those by Barro (1991, 1993) and Levine and Renelt (1992). Young (1995) also confirmed (elasticity of 0.1) the above for the case of East Asia economies. A survey review by Englander and Gurney (1994) based mostly on studies from G7 suggests that the growth of human capital typically accounts for a tenth to a fifth of growth in total output. In

another comprehensive survey Griliches (1997) reported that increases in educational attainment seem to have accounted for perhaps a third of the productivity residual in the US over the post-war period. More recently Gemmell (1996), Klenow and Rodriquez (1997), Temple (1998) and Hall and Jones (1999) reported output elasticities from education of between 0.1 to 0.3. Accounting for feedback issues, Teixeira and Fortuna (2003) studied the human capital effects on economic growth of Portugal using VAR and cointegration analysis and obtained a long-run estimate for human capital elasticity of 0.42. Pina and St. Aubyn (2004) subsequently confirmed the results using similar techniques. The scarce evidences from developing economies also yield positive returns of education in general (see Psacharopoulos, 1994; Glewwe, 1996; Andreosso-O'Callaghan, 2002 and Baldacci, Clements, Gupta and Cui, 2004)

However several well-known studies have also found the correlation between human capital and growth to be surprisingly weak (for instance Benhabib and Spiegel, 1994; Islam, 1995; Barro and Sala-i-Martin, 1995; Caselli, Esquivel and Lefort, 1996; Pritchett 1997; Durham, 1999; Bils and Klenow, 2000; Temple, 2001). A summary would concur with Temple (2001) who noted that 'the empirical evidence that education matters for growth is surprisingly mixed.'

Gender separate human capital growth literature[1]

The theoretical growth and welfare benefits of female education have mostly generated by microeconomics. Greater female education has often been found to lead to lower fertility rates (see Blau, 1986; Ketkar, 1978; Cain and Weininger, 1973) which in turn

[1] Lorgelly (2000) provides the most comprehensive survey review of the literature.

result in lower rates of infant mortality and longer life expectancies (e.g., Blau, 1986; Benefo and Schultz, 1996; Behrman and Deolalikar, 1988). There is also evidence of the inter-generational effects of maternal education on children's education, health and welfare (e.g., Bach *et al*., 1985; Blau, 1986; Schultz, 1988; Behrman and Deolalikar, 1988; Feinstein and Symons, 1999; Behrman *et al*., 1999).

While there is a large amount of evidences on the aggregate human capital-growth hypothesis, the contribution of gender separate (female and male) education to growth at macroeconomic level has only recently been studied. Benavot (1989) was the first to realise this and notes that "models of the impact of education on economic development largely ignore the issue of gender" (Benavot, 1989, p.14). Benavot (1989) investigated the impact of gender differences in education on development for a sample of 96 countries and found that both female and male primary enrolment rates have a positive and significant effect on growth, with secondary enrolments having little effect. Similar results were found with different sub samples, particularly with respect to less developed countries. Interestingly "the parameter associated with females (.0064) is higher than that associated with the primary education of males (.0056)" (Benavot, 1989) suggesting that the education of females is more important than that of males. So "educational expansion among school-age girls at the primary level has a considerably stronger effect on long-term economic prosperity than does educational expansion among school-age boys" (Benavot, 1989, p.27). Psacharopoulos (1994) also found that the rate of return to female education is positive and marginally higher than that to male education.

The most often cited research remain that of Barro and Lee (1994) who extended the earlier work of Barro (1991) by widening the measure of human capital to include both education and health capital stock (proxied by life expectancy) and further divide education into separate female and male effects. Using Seemingly Unrelated Regression Equations (SURE) technique applied to cross-country data for two time periods (1965-1975 and 1975-1985), the authors find that while growth is positively related to male education, it is negatively related to female education This "puzzling finding" was explained by the fact that "a high spread between male and female secondary attainment is a good measure of backwardness; hence, less female attainment signifies more backwardness and accordingly higher growth potential through the convergence mechanism." (Barro and Lee, 1994). Barro and Sala-i-Marting (1995), Barro (1996) and Lorgelly and Owen (1999) found similar results. However, Barro (1997, 1998, 1999) using revised data for his panel data concluded that the return of female education to growth is essentially zero in fact.

On the other hand, using dynamic GMM panel estimation for 97 countries for the years 1960 to 1985, Caselli, Esquivel and Lefort (1998) surprisingly found the reversal of the signs on the female and male education variable from those reported by Barro and Lee (1994). The authors argued that the changes in their results are due to the impact of GMM. Forbes (1998) subsequently supported these results. As Forbes argues "this pattern of signs may not support traditional human capital theory, these coefficients … are similar to those found in other growth models estimated using the same technique [namely Caselli, Esquivel and Lefort]" (Forbes, 1998, p.13).

Empirical Analysis from Birdsall, Ross and Sabot (1997), in their "Barro-style" regression, reported "that increasing primary school enrolments for girls is just as effective in stimulating growth as increasing primary enrolments for boys".

Other studies while investigating the varying importance of male and female education focused on the gender gaps in human capital and whether this gap hindered economic growth and productivity. Among the first studies is that of Hill and King (1993, 1995) who found support for increases in female education and decreases in the gender gap (measured as the ratio of female to male enrolments) resulting in increases in social well-being. The authors found that that failure to improve female education to at least the same average level as that of males may act as a brake on development. Sadeghi (1995) confirmed the above results.

Klasen (1999) also investigated the economic effect of education gender inequality. Using regression analysis, the author found that the initial gender gap and the expansion of the female-male ratio both have a significantly positive impact on economic growth. Klasen also found a significant role for gender gaps in education indirectly hindering economic growth through its impact on investment and population growth.

A summary of empirical evidences shows that while a relatively large amount of work exists in the aggregate education- growth debate, although with mixed results, gender separate studies have however received due attention. Moreover the existing ones tend to focus on developed country cases and on cross sectional and panel data sets with little or

no time series studies found for the case of developing, especially small island developing states, and taking account dynamic feedback issues that may occur.

Methodology and Analysis

Dynamic Feedback

Endogeniety is an important issue, often overlooked by existing works. In fact there may be the presence of bi-causality in the sense that it not only education that drives growth but that educational attainment are also driven by government policy and income level of the country. It seems plausible that as output and tax revenues increase, governments might allocate more resources to education thus increasing its standards, attainment and quality (See Mincer (1996) and Bils and Klenow (2000) on the two way causality issue). Moreover better education may have a signaling effect and attract more inwards and foreign direct investment which in turn increases output level. The issue of causality and feedback effects is thus important to the analysis of education – growth link.

To incorporate the above issue, the analysis uses dynamic econometrics techniques, namely a Vector Autoregressive Model (VAR), following more recent studies in the field (see Pina and St. Aubyn, 2004; Teixeira and Fortuna, 2003; and Erk and Ate, 1999).

The economic and econometric model

We follow the line of Griliches (1997), who writes that "the main, and possibly only, approach to testing the productivity of schooling directly is to include it as a separate variable in an estimated production function", and other authors (from the classical literature (Barro, 1991; Mankiw, Romer and Weil, 1992; Levine and Renelt, 1992) and

also from more recent works from De la Fuente, 2003 and Pina and St. Aubyn, 2004) and regress standard measures of economic development on measures of human capital (decoupled between male and female), controlling for the other variables found in an aggregate production function.

A Cobb-Douglas production function is thus specified whereby human capital, which is segregated into male and female human capital, enters as additional and separate inputs into the function (equation 1).

$$Y_t = A_t(K_t)^{\beta 1}(L_t)^{\beta 2}(HM_t)^{\beta 3}(HF_t)^{\beta 4} \quad \textbf{(1)}$$

where Y is the country's and is measured by GDP at constant prices, K is the country's capital stock which has been constructed using the Perpetual Inventory Method (PIM) as recommended by the OECD (2001a), L is the amount of people in employment (a proxy of labour), HM and HF are the secondary enrolment ratio of males and females respectively. The latter are measures employed to proxy for the quality of human capital. Male and female secondary enrolment ratios (Barro, 1991; Levine and Renelt, 1992; Englander and Gurney, 1994 and Barro and Sala-i-Martin, 1995) among others also used this proxy) were used as they are the only consistent and available measure available over the period of study (1960-2004). The use of interpolations was kept to a strict minimum.

Data for the dependent variable and for the construction of the capital stock has been obtained from the Penn World Table (6.1) whereas employment and male and female secondary enrolment ratio figures were available from the country's Central Statistical Office's biannual digest of Statistics for employment and education respectively.

Taking logs on both sides in equation 1 and denoting the lowercase variables as the natural log of the respective uppercase variable results in the following:

$$y = \beta_0 + \beta_1 k + \beta_2 l + \beta_3 hm + \beta_4 hf + \varepsilon \qquad \textbf{(2)}$$

where β_0 is the constant term, β_1 , β_2 , β_3 and β_4 represent the elasticity of output relative to capital, labour, male and female education respectively.

We proceed to investigate the univariate time series properties of the data series, particularly with respect to the degree to which they are integrated. The study employes both augmented Dickey-Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) unit-roots tests and the results are summarised in table 1 and 2 below.

Table 1: Summary results of Unit Root Tests in level form: Dickey-Fuller and Phillips/ Perron Test

Variables (in log)	Lag selection	Aug. Dickey Fuller	Phillips Perron	Critical Value	Variable Type	Aug Dickey Fuller (time trend (t)	Critical Value	Variable Type
y	1	+1.45	+2.35	-2.93	***I(1)***	-2.25	-3.52	***I(1)***
k	1	-2.55	-2.24	-2.93	***I(1)***	-1.35	-3.52	***I(1)***
l	1	-2.55	-2.22	-2.93	***I(1)***	-3.23	-3.52	***I(1)***
hm	1	+1.33	+2.43	-2.93	***I(1)***	-1.34	-3.52	***I(1)***
hf	1	+0.76	+2.55	-2.93	***I(1)***	-1.23	-3.52	***I(1)***

Table 2: Summary results of Unit Root Tests in first difference : D/F and Phillips/ Perron Test

Variables (in log)	Lag selection	Aug. Dickey Fuller	Phillips Perron	Critical Value	Variable Type	Aug Dickey Fuller (with time trend(t)	Critical Value	Variable Type
Δy	0	-6.53	-3.54	-2.94	***I(0)***	-4.46	-3.51	***I(0)***
Δk	0	-4.23	-4.45	-2.94	***I(0)***	-3.78	-3.51	***I(0)***
Δl	0	-3.45	-6.45	-2.94	***I(0)***	-5.32	-3.51	***I(0)***
Δhm	0	-5.74	+3.75	-2.94	***I(0)***	-4.21	-3.51	***I(0)***
Δhf	0	-3.45	+3.42	-2.94	***I(0)***	-4.57	-3.51	***I(0)***

The stationarity tests suggest that all our variables are integrated of order 1 and stationary in first difference. The Johansen Maximum Likelihood approach is then used to test the existence of cointegration. The results are reported in table 3 below.

Table 3: Test result from Johansen procedure

Johansen Maximum Likelihood procedure of the cointegrating regression y= (k, l, hm, hf) : number of cointegrating vectors(s) using the cointegration likelihood ratio

	Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value 5%	Critical Value 10%
Maximal eigenvalue of the stochastic matrix	*r=0* *r<=1* *r<=2* *r<=3* *r<=4*	*r=1* *r=2* *r=3* *r=4* *r=5*	*30.61* *24.08* *10.25* *6.53* *0.017*	*33.64* *27.42* *21.12* *14.88* *8.07*	*31.03* *24.99* *19.02* *12.98* *6.500*
Trace of the stochastic matrix	*r=0* *r<=1* *r<=2* *r<=3* *r<=4*	*r>=1* *r>=2* *r>=3* *r>=4* *r>=5*	*63.54* *40.92* *16.83* *6.58* *0.017*	*70.49* *48.88* *31.54* *17.86* *8.070*	*66.23* *45.70* *28.78* *15.75* *6.500*

Refering to table 3, it is observed that the hypothesis of cointegration is rejected and thus no long term relationship exists. In the absence of cointegration (but I(1)) data) , a Differenced Vector Autoregressive (DVAR) model is used to capture the short-run dynamics and to model and compare the contribution of male and female education attainment on growth of the growth rate of the different variables. This is consistent with the standard procedure in the literature (See Pereira and de Frutos, 1999 and Pereira and Sagales, 2003).

The difference VAR Model.

A VAR model in a generalised form is given by

$$Z_t = \Psi_1 Z_{t-1} + \Psi_2 Z_{t-2} + ...\Psi_p Z_{t-p} + \mu + \eta_t \qquad t=1....t \qquad \textbf{(3)}$$

where Z_t is a vector of endogenous variables (n variables), μ is a constant, p is the order of the VAR, Ψ is the matrix of coefficients, and η_t is an error term.

In this study, the VAR consist of four endogeneous variables (n = 5), Z_t =[*y, k, l, hm,hf*] and a constant term . So Z_t is a 5 x 1 vector and the variables are as previously defined and are in logarithmic terms.

The general form of the difference VAR is thus,

$$\Delta Z_t = \omega_1 \Delta Z_{t-1} + \omega_2 \Delta Z_{t-2} + ...\omega_p \Delta Z_{t-p} + \mu + \eta_t \qquad t=1....t \qquad \textbf{(4)}$$

Where Δ is the first difference operator and ω are the parameters.

The order of the VAR was chosen by minimising the final prediction error due to SBC which suggested a VAR specification 1. A constant was also included. The results of the OLS estimation of the unrestricted VAR are presented in table 4.

OLS estimates of the Unrestricted Regression in First Difference

Table 4 : OLS results of the unrestricted regression in difference.

	Δy	Δk	Δl	Δhm	Δhf
Δy_{t-1}	*-0.62** (-3.21)*	*0.13* (1.88)*	*0.26 (0.63)*	*0.11* (1.77)*	*0.07* (1.87)*
Δk_{t-1}	*0.75*** (2.96)*	*0.55*** (10.45)*	*0.16* (1.75)*	*-0.013 (-1.33)*	*0.14 (1.32)*
Δl_{t-1}	*0.112*** (2.92)*	*0.032 (1.14)*	*1.46*** (3.64)*	*0.233 (1.46)*	*0.321 (1.47)*
Δhm_{t-1}	*0.19** (2.18)*	*0.07* (1.82)*	*0.04 (-0.63)*	*0.86*** (6.54)*	*0.16* (1.67)*
Δhf_{t-1}	*0.16* (1.88)*	*0.11* (1.79)*	*-0.014 (-0.29)*	*0.102* (1.84)*	*11.75*** (5.54)*
Constant	*-1.34 (-0.93)*	*0.53 (0.34)*	*1.47 (1.12)*	*3.45** (-2.77)*	*1.35 (1.37)*
R^2	*0.626*	*0.76*	*0.92*	*0.92*	*0.85*
DW	*1.95*	*1.86*	*0.97*	*1.94*	*1.97*

*significant at 10%, ** significant at 5%, ***significant at 1%

The above equations all pass the Lagrange multiplier residual serial correlation test.

Focusing on the first column, it is observed that both male and female education attainment have been positively affecting output level with respective output elasticity of 0.19 and 0.16. In the first case it would appear that a 10% increase in the male secondary enrolment ratio might have led to a 1.9% increase in the country's GDP whereas female a 10% increase in female secondary enrolment ratio is expected to contribute to around 1.6%. Interestingly it is observed that there is no much difference in the contribution of each gender type education and indicates that female workers are as productive as compare to male. The results are consistent with the findings of Birdsall, Ross and Sabot (1997) who found similar results for the case of 108 developed and developing countries over the period 1960-1985 using OLS estimations.

The economy's level of capital stock is reported to have been the most important ingredient of growth (output elasticity of 0.75) and the proxy labour has an elasticity coefficient of 0.11 and is slightly on the lower side of what was expected.

Further analysis from the second column of the table suggests that both male and female education (with a slightly higher contribution) helps in enhancing investment level in the country. Thus this indicates the presence of some indirect effects of education on growth as well.

There is evidence of important feedback effect from the economy's output level to both female and male education as witnessed by the positive and significant coefficient of y_{t-1} in the last two columns of table 4 (where male and female education are the dependent variable respectively). This confirms the bi-causal link between these variables. No reverse causation is observed for the case of education-private investment link though. Moreover one can argue that both genders education mutually drives each other for the betterment of the country's investment and output as revealed by the positive and significant coefficient of female and male education variables respectively.

Impulse response analysis has also been used to investigate the effect of a one percent point shock in the rate of growth of the secondary enrolment ratio, both female and male independently, on the other variables of the model. The analysis confirms that both types of education have a positive effect on the country's level of output and that this is effect

tends to die out after some 25 years. The female/male education-investment link and reverse causation are also confirmed, thus consolidating the previous results.

Summary of results

Using a difference Vector Autoregressive model, the paper investigated the dynamic relationship between gender separate education and the economic performance for the case of the small island developing state of Mauritius for the period 1960-2004. Results from the analysis suggest that both female and male education, as proxied by their respective secondary enrolment ratio, are important ingredient in explaining growth. Moreover they are reported to have nearly the same productivity level. Further analysis suggests that bi-causality exist between female/male education and economic growth. Indirect effects via capital stock accumulation, a proxy for investment, are also reported. The analysis confirms the positive theoretical and empirical link between education, particularly gender separated education, and output level and further on provides new evidences from a small island developing state (SIDS) using recent a dynamic framework.

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