On the Gender-Separate Education Effects of Economic Growth
Evidence from an African Economy

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Abstract
This research assesses the link between female and male education and economic
development for the case of one of the best performing African nation namely Mauritius.
Given the dynamic and endogenous nature of economic growth, the study uses recent
dynamic time series analysis, namely a difference vector autoregressive framework, to model
the economic effect of gender separate education for the period 1970-2014. Results from the
analysis show that both female and male education are important ingredients in explaining
growth and that moreover they are shown to have nearly the same output elasticities. Further
analysis suggests that bi-causality exists between female and male education and economic
growth. Indirect effects via capital stock accumulation, a proxy for investment, are also
reported.

Key words: Education, Economic Development, Difference VAR.
JEL Classification: I20, H54, O20.
1. Introduction

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) posits that education is closely linked with economic growth through the following channels namely 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 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 research on the education growth nexus overwhelmingly confirmed the positive growth effect of education. These writings started with Jorgenson, Gallop and Fraumeni (1987), Lucas (1988) and Romer (1990). Barro (1991), Mankiw, Romer and Weil (1992) and Islam (1995) and various cross-country or time series studies produced uncontested evidence that increasing educational levels and health improves labor productivity contributing to greater economic growth. Among recent studies feature those of Teixeira and Fortuna (2003), Stevens (2003), Pina and St. Aubyn (2004), Hanushek (2007), Aghion (2009) and Mercana and Sezerb (2014). Interestingly 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, Clemens, Gupta and Cui, 2004). However several well-known it is noteworthy that few 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.’

While there exist rich literature on the role education in general in explaining economic progress, research on gender separate effect of education has been relatively scant. 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 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).

Former research suggest that female education has direct and indirect positive effects on economic growth, especially per capita growth through reducing fertility rate and increasing labor participation, and thus creates better setting for economic growth to occur (Hill & King 1995, Knowles and others 2005 in Klasen 2002; Psacharopoulos 1994; Barro, 1996). Benavot (1989) was the first researcher to point out that male and female education may impact economic development differently since the dynamic effect of the increase in female education differs from that of male education in particular on labor force participation, age at marriage, fertility and migration. Barro and Lee (1994) extended the earlier work of Barro (1991) and their controversial finding is that while male education is positively related to growth, the female education is negatively related to growth. Caselli, Esquivel and Lefort (1996), however, find the opposite, while Birdsall, Ross and Sabot (1997) report no significant difference between the genders. Other scholars such as Birdsall, Ross and Sabot (1997), Sadeghi (1995), Klasen (1999), and more recently Ince (2011) and Tansel and Gungor (2012) highlighted the positive growth effects of female education.

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 supplement the literature by bringing additional evidences on the empirical link between gender separate education and economic progress from an African perspective, namely Mauritius. The latter poses as an interesting case study as it remains as one of the best performers of the continent and has registered a successful growth history since its independence in 1968. Our estimation framework allows for dynamic and endogeneity in the education-growth link, an issue often been ignored, by using a multivariate dynamic time series estimation technique, namely a difference vector autoregressive framework (DVAR) over the period 1970-2014.

The rest of the paper is structured as namely Section II describes the preferred economic specification function and provides an econometric estimation of the gender separate education on economic growth while Section III concludes.

2. Methodology and Analysis

2.1 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).

2.2 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).
\[ Y_t = A_t (K_t)^{\beta_1} (L_t)^{\beta_2} (HM_t)^{\beta_3} (HF_t)^{\beta_4} \] (1)

Where \( Y \) is the country’s GDP at constant prices, \( K \) is the country’s capital stock which has been measured by the investment ratio, \( L \) 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 (1970-2014). The use of interpolations was kept to a strict minimum. Data was obtained from the country’s Central Statistical Office.

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:

\[ y = \beta_0 + \beta_1 k + \beta_2 l + \beta_3 hm + \beta_4 hf + \epsilon \] (2)

Where \( \beta_0 \) is the constant term, \( \beta_1, \beta_2, \beta_3 \) and \( \beta_4 \) represent the elasticity of output relative to capital, labour, male and female education respectively.

The stationarity tests conducted using both augmented Dickey-Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) unit-roots tests suggest that all data series are integrated of order 1 and stationary in first difference. The Johansen Maximum Likelihood approach did not confirm any no long term relationship. 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).

2.3 The Difference VAR Model.

A VAR model in a generalised form is given by

\[ Z_t = \Psi_1 Z_{t-1} + \Psi_2 Z_{t-2} + \ldots + \Psi_p Z_{t-p} + \mu + \eta_t \quad t=1\ldots T \] (3)

Where \( Z_t \) is a vector of endogenous variables (n variables), \( \mu \) is a constant, \( p \) is the order of the VAR, \( \Psi' \) is the matrix of coefficients, and \( \eta_t \) 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,

\[ \Delta Z_t = \omega_1 \Delta Z_{t-1} + \omega_2 \Delta Z_{t-2} + \ldots + \omega_p \Delta Z_{t-p} + \mu + \eta_t \quad t=1\ldots T \] (4)

Where \( \Delta \) is the first difference operator and \( \omega \) 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 1: OLS results of the unrestricted regression in difference.

<table>
<thead>
<tr>
<th></th>
<th>$\Delta y_{t-1}$</th>
<th>$\Delta k_{t-1}$</th>
<th>$\Delta l_{t-1}$</th>
<th>$\Delta hm_{t-1}$</th>
<th>$\Delta hf_{t-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta y_{t-1}$</td>
<td>$-0.45^{**}$</td>
<td>0.14*</td>
<td>0.22</td>
<td>0.12*</td>
<td>0.11*</td>
</tr>
<tr>
<td></td>
<td>(-3.34)</td>
<td>(1.86)</td>
<td>(0.75)</td>
<td>(1.87)</td>
<td>(1.84)</td>
</tr>
<tr>
<td>$\Delta k_{t-1}$</td>
<td>0.77***</td>
<td>0.51***</td>
<td>0.17*</td>
<td>-0.015</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>(2.66)</td>
<td>(9.4)</td>
<td>(1.99)</td>
<td>(-1.55)</td>
<td>(1.54)</td>
</tr>
<tr>
<td>$\Delta l_{t-1}$</td>
<td>0.12***</td>
<td>0.04</td>
<td>1.34***</td>
<td>0.26</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>(2.92)</td>
<td>(1.18)</td>
<td>(3.22)</td>
<td>(1.55)</td>
<td>(1.43)</td>
</tr>
<tr>
<td>$\Delta hm_{t-1}$</td>
<td>0.21**</td>
<td>0.08*</td>
<td>-0.04</td>
<td>0.78***</td>
<td>0.15*</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(1.88)</td>
<td>(-0.43)</td>
<td>(4.56)</td>
<td>(1.77)</td>
</tr>
<tr>
<td>$\Delta hf_{t-1}$</td>
<td>0.18*</td>
<td>0.12*</td>
<td>-0.013</td>
<td>0.15*</td>
<td>7.34***</td>
</tr>
<tr>
<td></td>
<td>(1.98)</td>
<td>(1.88)</td>
<td>(-0.66)</td>
<td>(1.89)</td>
<td>(3.44)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.434</td>
<td>0.58</td>
<td>1.12</td>
<td>-1.56**</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>(-0.943)</td>
<td>(0.34)</td>
<td>(1.65)</td>
<td>(-2.67)</td>
<td>(1.23)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.64</td>
<td>0.74</td>
<td>0.87</td>
<td>0.85</td>
<td>0.73</td>
</tr>
<tr>
<td>$DW$</td>
<td>1.96</td>
<td>1.87</td>
<td>0.96</td>
<td>1.98</td>
<td>1.91</td>
</tr>
</tbody>
</table>

*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 0.21 and 0.18. In the first case it would appear that a 10% increase in the male secondary enrolment ratio might have led to a 2.1% increase in the country’s GDP whereas female a 10% increase in female secondary enrolment ratio is expected to contribute to around 1.8%. 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 Birdsell, 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 0.77) and the proxy labour has an elasticity coefficient of 0.12 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 20 years. The female/male education-investment link and reverse causation are also confirmed, thus consolidating the previous results.

5. Conclusions and Recommendations

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 1970-2014. Results from the analysis suggest that both female and male education, as proxied by their respective secondary enrolment ratios, are important ingredients 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 an African economy using recent a dynamic framework.

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