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Global Institute for Agri-Tech Economics,

Food, Land and Agribusiness Management Department,

Harper Adams University

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The Impact of Female Tertiary Education and Climate Change on Economic Growth in Developing Countries

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Abstract

This study examines how female tertiary education and climate change affect economic growth in a set of 33 chosen developing countries from around the world. Previous literature examines the relationship between gender inequality and economic growth and climate change and economic growth both theoretically and empirically, in this study empirical analysis of panel data set will be made using a cross section fixed effects model.

Annual growth rate of female tertiary graduates with a ten-year lag, gross fixed capital formation, and gross domestic product growth rate with a one-year lag have been found to have a positive and significant effect on the economic growth rate for developing countries. A significant and positive relationship has been found between the annual growth rate of mean temperature and annual growth rate of gross domestic product where the annual growth rate of gross domestic product is the independent variable.

Enrolment rates or years of schooling of primary and secondary levels have been used in previous literature as proxies for female education; in this study the annual growth rate of female tertiary graduates is used to highlight the importance of tertiary level education and graduate growth rate is used to provide better proxy for the completion of the whole period of study and not only enrolment. Additionally, climate change is usually included in economic models as a dependent variable, in this study an attempt to explore climate change as an independent variable is made to provide more insights into the nature of the relationship between climate change and economic growth.

Keywords

Developing countries; economic growth; female tertiary education; gender inequality; climate change; panel data.

Presenter Profiles

Aya Moataz graduated from the German University in Cairo with double majors in Finance and Economics. She then started her academic career as a teaching assistant and then an Assistant Lecturer of Economics at the German University in Cairo. She received her master's degree in Economic Development with highest honors from the GUC and managed to study two more majors, namely, Strategic Management and Marketing. Currently, Aya is an Assistant Lecturer of Finance and Economics at the Business School at Coventry University branch in Egypt at The Knowledge Hub Universities.

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Introduction

This study aims to examine the impact of female tertiary education and climate change on economic growth in a set of 33 developing countries from the years 2001-2019. In previous literature the focus has been mainly on female primary and secondary schooling effects, limited studies have examined the effect of female tertiary education on economic growth. This study focuses on the tertiary educational level in attempt to further explore a less visited aspect of female education and its effect on economic growth. Also, previous literature mainly focuses on climate change as a dependent variable and not an independent one, which encouraged the inclusion of this specific variable in the study to test for a different direction for the relationship between climate change and economic growth.

This paper is structured as follows: Firstly, previous literature on gender inequality, education, climate change and economic growth along with the theoretical approach on which the study is based is provided. Secondly, the methodological approach used is discussed. Thirdly, results of the analysis are explained. Followed by a discussion section where results are compared with those of previous scholars. Finally, a conclusion with the main finding is provided along with limitations, policy, and future recommendations of the study.

Gender Inequality in Developing Countries

Although women and girls have made significant efforts towards achieving gender equality since 1990, they are yet to achieve their goal. Gender inequality is the discrimination against women which leads to hindering female's development; it includes yet is not exclusive to discrimination in health, education, political affairs, job opportunities, etc. A main source of this gender inequality is the hindrances that women and girls face in societies (UNDP HDR, 2015).

The commonly used method for determining the relationship between gender inequality and economic growth has been through examining effect of gender gaps on economic growth through the regression of growth variables, some of which are proxies for gender inequality on a country's growth rate represented by per capita income (Cuberes and Teignier,2014). A positive relation between women's status and developing socially and economically has been emphasized by social workers over time. The educational gender gap was highlighted by comparing between the richest and poorest quartiles in 1990, where in the richest quartile 51% of adult women had obtained secondary level education, while the percentage was an 88% for men. On the other hand, the poorest quartile only 5% of adult women had any secondary education which is half of the level for men (Dollar and Gatti,1999). Disparities in both productivity and salaries between women and men arise due to the isolation of women in a limited number of fields. Examples of this segregation include Nigeria and India, where in Nigeria in the year 2007 the ratio of women to men's earnings was 60c:1 dollar and in India it was 64c:1 dollar (World Development Report,2012).

On the other hand, previous literature indicates there can be a positive effect of the gender gap given that the pay gap remains constant, and the educational gender gap is reduced, this provides qualified female labour that accept low wages. Although there have been arguments against this finding since on the long-term wages cannot remain low and eventually will be subject to pressure that will elevate female wages (Seguino,2000 a, b).

Theoretical background

One of the most prominent growth models in literature is the Solow Neoclassical Growth Model (1956). The model indicates that given the fact that two economies share equal rates of savings, depreciation, growth of labour force and growth in productivity will lead to the conditional convergence to same income level (Solow, 1956).

$$Y = K^{\alpha}. (AL)^{1-\alpha} \quad (1)$$

In the model equation (1), gross domestic product is represented by Y, Capital Stock (both human and physical capital) represented by K, labour represented by L and A as an indicator of labour productivity given that its growth rate is external (at approximately 2% for developed countries but variant for developing countries depending on whether they are in a period of stagnation or improvement). The assumptions of the Solow Growth Model are:

1. Compensation for factors of production whether capital or labour depends on marginal physical productivities.
2. Flexibility of both prices and wages in economy.
3. Full employment of both labour and capital available.
4. Possibility of substituting labour for capital and vice versa.
5. Neutrality of Technological progress
6. A constant saving ratio.

Assumptions 1-3 imply a perfectly competitive market. Model has been found to be more relevant in developed economies rather than developing ones (Todaro, 2009).

According to Figure 1 for Unemployment percentage for the developing countries that have been used in this research, none of the countries fulfil the assumption of full employment level in the economy proposed by Solow (1956), therefore violation of one or more of the assumptions of the model affects the eligibility of the model thus requires its modification.

The proposed modifications upon which our model is built is to use the annual rate of growth of female tertiary graduates instead of Labour and using annual growth rate of gross fixed capital formation as a representative of physical capital in the model. Additionally, climate change is represented in the model through annual growth rate of mean temperature, as in more recent decades the impact of climate change has become more prominent than earlier years (1956) when the Solow model was first developed.

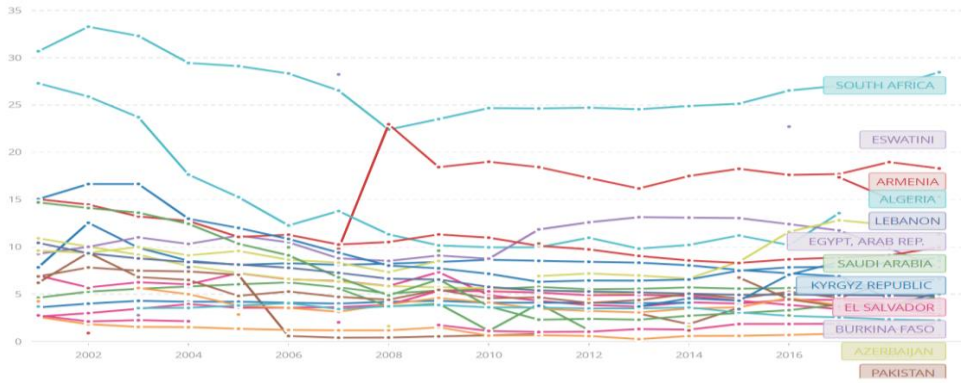

Figure 1: Unemployment, total (% of total labour force) (2001 – 2019). Source: World Bank data (2021) (https://bit.ly/3rC2szH)

Education, Economic Growth and Sustainable Development Studies

The achievement of sustainable development and a wholesome, productive life for all depends on the provision of quality education and lasting learning opportunities (Guterres,2017). "Whether we view sustainable development as our greatest challenge (Annan, in UNESCO 2005) or a subversive litany (Lomborg 2001), every phase of our education system is being urged to declare its support for education for sustainable development (ESD)" (Vare & Scott,2007).

Differences in educational standards and public expenditure on education shape the two most common reasons behind the existing per capita income gap between developed and less developed countries. Improvement in developed countries has not been exclusive to literacy rates in general, but more specifically the reduction of the disparity between the female to male rates (Akram et al.,2011). Despite the advancements made in gender equality, empowerment of women and enrolment in different educational levels, the higher educational levels suffer from the widest gender disparities in several regions and countries (Guterres,2017).

The importance of examining the relationship between education and economic growth can be attributed to two main reasons. Firstly, from a generic perspective to either be a beneficiary of or contributor to the progression of science, education is a must. Secondly, and more precisely, a vast pool of econometric research has made a link between one's attainable income level and the educational level reached. If there are wage differences that arise in many cases due to differentials in education, then the same could apply for countries as well. If production per labour is dependent on the individual's education, and expenditure on education does provide a kind of return, in the same manner that expenditure on fixed capital does. Then it is reasonable to view expenditure on human capital as an alternative to that of fixed (Oztunc et al.,2015).

Empirical analysis on gender inequality in education and economic growth mostly covers period from 1960-2000. The literature in this period analyses the effect of female education on economic growth from two perspectives; the first perceives effect of each female and male education independently while the second uses a ratio for female to male education in the analytical process (Licumba et al.,2015).

Firstly, (Barro and Lee,1994) paper was one of the first in the perception of female and male education independently and their effect on economic growth. The (1994) paper by the title of Sources of Economic Growth used a sample of 115 countries and years of schooling as a proxy for female education. It indicated that both secondary school attainment and life expectancy are significant when it comes to growth regressions, emphasizing that when it comes to comparing both, life expectancy has the more significant effect. They also refer to the long run effect on growth which arises from the impact that schooling has on decisions regarding both quantity and quality of children.

Four of the countries in the sample of Barro and Lee's (1994) study namely (Hong Kong, Singapore, Taiwan and Korea) are characterized by advanced growth levels and low levels of female education which lead to attributing the study results reached to the presence of these four countries and the indication that if the female variable were to be removed the statistical significance of the male educational variable would be in question (Stokey,1994). In a different study, a division according to degree of industrialization in the sample of developing countries

was made, resulting in the significance of female secondary education in only the industrialized portion of the sample (Dollar and Gatti,1999).

A classification according to a country's level of human capital was applied in another study to the sample of developing countries and accordingly 11 developing countries were split into economies of high and low human capital. Relevance of female primary education was present only in developing countries characterized by low human capital (Kalaitzidakis et al.,2001).

Brummet (2008) used Barro and Lee's (1994) data set, yet only 72 out of 138 countries were used due to the lack of available data the period studies extended from 1960-1985. As previously mentioned, Barro and Lee's (1994) data set suffered from multicollinearity issues, multicollinearity was accounted for by Brummet (2008) by introducing the natural log of the ratio between men's and women's education, this adjustment decreased the multicollinearity problem greatly yet did not manage to eliminate it completely. Results for the study highlighted the inverse relation between underinvestment in women's education and economic growth. Also highlighted when comparing discrepancies in primary education and secondary education, primary education had the larger impact, and those results were more prominent in developing nations. In their study (Baliamoune - Lutz and McGillivray, 2009) used panel data for 31sub- Saharan African and 10 Arab countries throughout a period from 1974 to 2001 to test for the relation between the ratio of 15–24-year-old literate females to males and growth for countries in sample. The finding indicates the negative relationship between gender inequalities in literacy and growth.

In a study conducted on a sample of countries from the MENA region covering the period from 2000-2014, it was found that despite the significant and fast increase in educational attainment female labour force participation did not match that increase. It was also highlighted that literature commonly attributed this to supply side effects, while the study argued that changes in the nature of employment opportunities for women such as decrease in public sector employment might have led to this decreased participation (Ragui et al., 2018). In another paper that surveyed and analysed the trends of female labour force participation in developing countries, it was found that increased female education, economic growth and decreased fertility do not necessarily reflect positively on the female participation rate, but specific conditions must be provisioned for this to happen. Such conditions are associated with phase of educational growth, household situation, the extent to which educated women are limited to specific jobs, and expansion in employment opportunities preferred by educated women (Klasen,2019).

One of many variables that affect GDP is climate change. The link between female education, GDP growth and climate change can be highlighted in Blankespoor's et al. (2010) study where developing countries were studied throughout the period 1960 – 2003, the study concluded that countries which had higher percentages of educated females were more capable of enduring the climate change related disasters in comparison to other countries that were less fortunate even though they enjoyed similar income and climate.

Impact of Climate change on Economic Growth

The degree of economic activity determines the extent of humans' generation of greenhouse gases (GHG). Therefore, models of economic growth have been extensively used in literature on climate change. Nevertheless, the likelihood of climate change impacting economic growth is also present. There are varying and intricate methods to which those impacts affect

economies through trends in production and consumption, available resources, and productivity (Eboli et al.,2010). Intra-generational equity is another characteristic of climate change, where more wealthy economies have more moderate climates in comparison to much poorer ones such as sub-Saharan Africa, which also happens to have less financial and institutional capabilities to mitigate effects of climate change (Tsigaris and Wood,2016).

In a study that uses a multi-regional Computable General Equilibrium (CGE) Model, it was found that climate change impacts were experienced by developing countries the most, where it acts as a hurdle in the path of income convergence and equity. Developing countries such as China and India suffered from a significant negative impact on real GDP (Eboli et al.,2010). In another study where, overall economic damaged cause by climate change was assessed, it was projected that losses in the range of 2-20% of GDP are expected to occur in the poorest third of countries by the end of the 21st century (Solomon et al.,2017). In a different study, a cross validation exercise was performed on 800 models depicting the temperature-GDP relationship. Results showed that the impact of marginal temperature on GDP growth globally was not statistically significant (Newell et al.,2021).

In previous literature the focus has been mainly on female primary and secondary schooling effects on economic growth, yet limited studies have examined the effect of female tertiary level education on economic growth. This study focuses on the tertiary educational level in attempt to further explore a less visited aspect of female education. Additionally, from a climate change perspective, this study attempts to incorporate mean temperature in a modified Solow growth model to account for how climate changes can impact GDP growth where in previous literature this relation is mainly study in separate models as mentioned earlier such as CGE models. Accordingly, the proposed hypotheses for this study are:

H1: Female tertiary education does affects economic growth.

H2: Mean temperature affects economic growth.

Methods

Study area and data collection

A balanced panel of data is used consisting of 297 observations from 33 developing countries from all over the world covering the period from 2001-2019, namely: Kazakhstan, Kyrgyz Republic, Azerbaijan, Armenia, India, Pakistan, Vietnam, Thailand, Philippines China, Bahrain, Lebanon, Saudi Arabia, El Salvador, Mexico, Panama, Brazil, Colombia, Paraguay, Ecuador, Uruguay, Algeria, Egypt, Nigeria, Democratic Republic of Congo, South Africa, Kenya, Mozambique, Burkina Faso, Senegal, Rwanda, Burundi and Eswatini. The choice of these specific countries and timeframe is based on the Millennium Development Goals 2015 report and its Regional Fact Sheet, as specific regions were applauded for their progress in the millennium development goals and more specifically education. Accordingly, this study's developing countries were targeted from the aforementioned regions. The period from 2001-2019 was chosen to coincide with the timeframe set for achievement of the goals from 2000-2015 so that impact of the goals is highlighted whether for education or environmental stability.

The cross-sectional fixed effects model is used for the panel data analysis with a period random effects specification. The dependent variable is the annual growth rate of real gross domestic product per capita (GR_R_GDP) obtained from the World Bank Data. Independent variables are annual growth rate of gross fixed capital formation (GR_FC) obtained from World

Bank Data, annual growth rate of female tertiary graduates (GR_F_TG) data was triangulated and interpolated from three sources, namely: UNESCO institute of Statistics, Barro and Lee dataset (2013) and World Bank Data and annual growth rate of mean temperature variable is obtained from National Centers for Environmental Information (NOAA).

This research study uses secondary data, panel data has been used for availability purposes as no sufficient time series data could be collected for individual countries. In addition, both missing and unobserved variables are considered under panel estimation (Arellano and Bond,1991; Matyas and Sevestre,2013).

Measurement of the variables

In this study the dependent variable is represented by annual growth rate of gross domestic product per capita (GR_R_GDP), while independent variables are annual growth rate of female graduates from tertiary education with a ten-year lag (GR_F_TG(-10)), annual growth rate of gross fixed capital formation (GR_FC), annual growth rate of mean temperature (GR_MT), annual growth rate of gross domestic product per capita with a one-year lag are the independent variables (GR_R_GDP(-1)).

Data analysis and tools

Multiple regression analysis using ordinary least squares method was used to test the relationship between the dependent and independent variables. The used software was e-Views.

Results

A multiple regression using ordinary least squares was carried out to test the proposed hypotheses. The final model that was reached after taking into consideration multi-collinearity (no significant correlation was present between the independent variables) and heterogeneity is represented below in equation (2):

$$GR_R_GDP = c + \beta_1 GR_R_GDP(-1) + \beta_2 GR_F_TG(-10) + \beta_3 GR_MT + \beta_4 GR_FC \quad (2)$$

Table (1) below shows the estimation results of equation (2) using least squares and cross section fixed effects and period random effects methods before checking for Heteroskedasticity.

Table 1: Estimation results of equation (2) using least squares and cross – section fixed effects and period random effects.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.569126	0.247475	10.38134	0.0000
GR_R_GDP(-1)	0.233113	0.052896	4.407014	0.0000
GR_F_TG(-10)	0.012479	0.006162	2.025097	0.0439
GR_MT	0.045536	0.012131	3.753698	0.0002
GR_FC	0.050858	0.007738	6.572335	0.0000

Adjusted R^2	0.570073
D.W stat	1.900868
F-stats (prob.)	0.000000

A Breusch Pagan test was run to test for heteroskedasticity in the model. The below Table (2) shows the output of the test for equation (2). It is indicated that there is a high degree of heteroskedasticity from a cross-sectional perspective since p is at a 0 while a much lower degree of heteroskedasticity is present from a period perspective where p is equal to 0.8. The high heteroskedasticity of the cross-sectional effect is accounted for through white cross-section adjustment.

Table 2: Breusch Pagan test output for equation (2)

Null (no rand. effect) Alternative	Cross-section One-sided	Period One-sided	Both
Breusch-Pagan	6.540552 (0.0105)	0.026352 (0.8710)	6.566904 (0.0104)

Note: Probability in ( )

To correct for the heteroskedasticity White cross-section adjustment was performed. Table (3) below shows output for White cross-section adjustment for estimation results of equation (2).

Table 3: White cross-section adjustment output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.569126	0.391167	6.567847	0.0000
GR_R_GDP(-1)	0.233113	0.071927	3.240950	0.0013
GR_F_TG(-10)	0.012479	0.004709	2.649913	0.0085
GR_MT	0.045536	0.022351	2.037298	0.0426
GR_FC	0.050858	0.011295	4.502829	0.0000

Adjusted R^2	0.570073
D.W stat	1.900868
F-stats (prob.)	0.000000

The adjusted R-squared shows that the model explains 57% of the variation in the gross domestic product growth rate (dependent variable). As expected, coefficient for female tertiary graduates (GR_F_TG) with a 10-year lag, gross fixed capital formation growth rate (GR_FC) and annual growth rate of Gross domestic product with a 1-year lag (GR_R_GDP(-1)) are positive and significant at a 1% significance level indicating a directly proportional relation to the gross domestic product growth rate (GR_R_GDP). Unexpectedly, coefficient for annual growth rate of mean temperature is positive and significant at a 5% significance level, indicating a positive relationship between mean temperatures and GDP growth.

The coefficient of female tertiary graduates (GR_F_TG) with a 10-year lag, shows that when rate of female tertiary graduates increases by 1% rate of GDP growth increases by 0.012%, the 10-year lag indicates the time needed for this to take effect; this can reflect time needed for employment of educated females and might be indicative of hindrances that females in developing countries face: lack of adequate employment opportunities matching their skill set, social and cultural hinderances.

As for coefficient of gross fixed capital formation it indicates that as rate of gross fixed capital formation increases by 1%, GDP growth rate increases by 0.05%, which is justifiable since gross fixed capital formation is an indication of net investments. The small coefficient might be attributable to the fact that the sample consists of developing countries that are not always the most favourable attraction for investments especially foreign ones.

When the annual growth rate of GDP with a 1–year lag increases by 1% this leads to an increase in the annual growth rate of GDP by 0.23%, this can be attributable to the nature of the business cycle.

As for mean temperatures, when annual growth rate in mean temperature increases by 1% annual growth rate of GDP increases by 0.04% which was an unexpected result as in most of the previous literature on climate change a negative impact is usually present. Those unexpected results led to the questioning of the direction of the relationship between climate change and economic growth in this study. Accordingly, the below Granger causality test was performed to assess the direction of causality:

Table 4: Granger Causality Test for Growth rate of real GDP and growth rate of Mean Temperature (6 year – lag)

Null Hypothesis:	Obs	F-Statistic	Prob.
GR_MT does not Granger Cause GR_R_GDP	429	1.51522	0.1715
GR_R_GDP does not Granger Cause GR_MT	5.97080	5.E-06	

From the above table, it can be deduced that direction of causality is opposite to what is proposed in this study, since the null hypothesis "GR_MT does not Granger Cause GR_R_GDP" is not rejected and the null hypothesis "GR_R_GDP does not Granger Cause GR_MT" is rejected. It should be noted that the opposite direction of causality found might be due to the relatively short period studied as climate changes take place over much longer periods of time. Descriptive statistics are displayed in Table (5) below for the independent variables.

The average growth rate of tertiary female graduates is around 6.53%, where maximum growth rate is 158.9% and minimum is -50.6%. The rate of growth of gross fixed capital formation is of average 10.71%, where maximum is 129% and minimum is -81.9%. The average growth rate of annual mean temperature is around 0.42%, where maximum growth rate is 81.25% and minimum is -42.75%.

"The crucial distinction between fixed and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not" (Greene, 2008). The cross sectional fixed effects* adjusted for annual growth rate in mean temperature coefficient for each of the 33 countries

are displayed in Figure (2) below. Despite that the average coefficient for mean temperature shows a positive relationship to annual growth rate in GDP, when observing the cross-sectional fixed effects for individual countries it can be noted that countries such as Lebanon and Brazil showed a negative relation between mean temperature growth rate and GDP while other countries showed a positive one such as India. These different percentages reflect the magnitude of the possibly omitted variables that have not been included in the model given that they are assumed to be fixed and thus do not change over the years.

*The standard error for female tertiary graduate's variable was found to be bigger when applying the Hausmann test than in the regression applying both the cross-sectional fixed and period random effects, indicating that there is heteroskedasticity in the data and thus applying the Hausmann test would lead to misleading conclusions.

Table 5: Descriptive Statistics for Female graduates from tertiary education (GR_F_TG), Mean Temperature (GR_MT) and Gross fixed capital formation (GR_FC)

	GR_F_TG	GR_MT	GR_FC
Mean	6.539239	0.428504	10.71631
Median	4.793943	0.268097	8.694395
Maximum	158.9270	81.25000	129.1797
Minimum	-50.61083	-42.75862	-81.99275
Std. Dev.	15.66635	7.156826	19.40645
Skewness	2.694130	5.246404	0.925559
Kurtosis	23.00100	68.18734	7.991434
Jarque - Bera	11209.64	113891.6	740.4099
Probability	0.000000	0.000000	0.000000
Sum	4100.103	268.6718	6719.125
Sum Sq. Dev.	153642.0	32063.82	235758.0
Observations	627	627	627

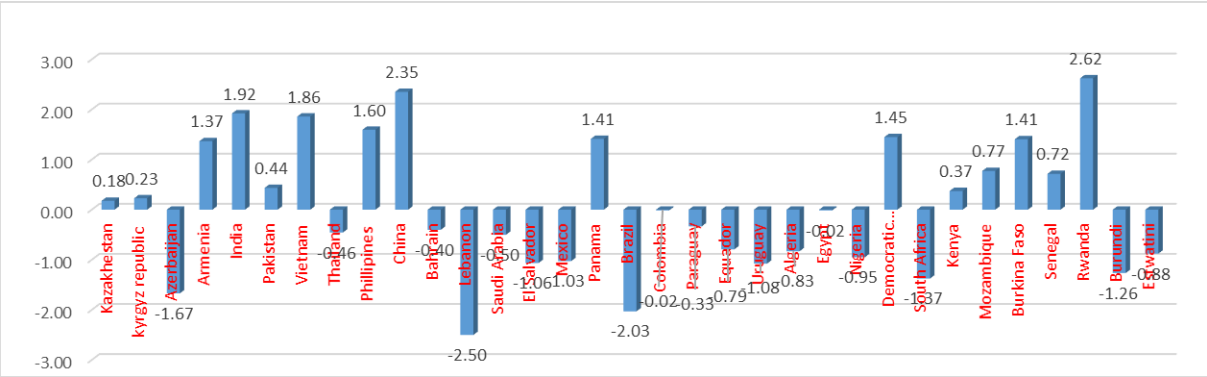

Figure 2: Percentage Effect of Annual Growth Rate of Mean Temperature on Growth rate of GDP

Discussion and Conclusion

This study helped highlight the positive and direct relationship between female tertiary education and economic growth, as well as the correct direction of the relationship between climate change and economic growth for the sample countries. The coefficient for female tertiary graduates (GR_F_TG) with a 10-year lag, the gross fixed capital formation growth rate (GR_FC), the coefficient for mean temperature (GR_MT) and annual GDP growth rate (GR_R_GDP(-1)) with a 1-year lag are all positive and significant indicating a directly proportional relation to the GDP growth rate (GDPG_C).

In previous literature (Mitra, Bang and Biswas, 2015) similar findings to our study have been found where secondary completion rate as a proxy for education was found to be positive and significant yet at an only 10% significance level where a 1% increase in secondary completion rate is accompanied by a 0.1% increase in GDP growth which is the closest results to the impact of our female education coefficient at 0.012% increase in GDP yet at a 1% significance level. The larger coefficient might be attributable to the larger number of female students enrolled in secondary education versus those graduated from tertiary education in the sample studied. Regarding investment, a positive and significant effect of 1% significance level has been found, where a 1% increase in investment increases GDP growth by 0.149% slightly higher than our investment coefficient of 0.05%. With regards to lagged growth rate of GDP the results show a significant yet negative effect where a 1% increase in GDP growth of a 1-year lag causes an 0.549% decrease in GDP growth, on the other hand this study shows a both positive and significant effect for lagged GDP of 1-year specifically an 0.23% increase in GDP. This difference might be caused by the different periods studied and the nature of the business cycle at the studied time period.

Previously mentioned results are consistent with results of (Knowles, Lorgelly and Owen, 2002) where it was found that female education coefficient is both positive and statistically significant at a 5% significance level and the t-statistic is of a 2.92 value and female education was represented by the average of schooling of the population aged 15 and above. Coefficient of female education reflects that a 1% increase in female schooling causes an 0.663% increase in output per worker, which is of a larger impact than our female education coefficient of 0.012%, although it is of a lower significance level. This difference can be due to the different periods covered: our study covers years 2001-2019 while this study covers years 1960-1990, additionally our paper uses a very specific proxy for female education, female tertiary graduates, while the study uses a much more generic proxy.

Also consistent with our study is (Klasen, 2002) where ratio of years of schooling was used as a proxy for education. Results of that study show that female-male ratio of expansion in schooling has a significant and positive effect on economic growth at a1% significance level, coefficient of female-male ratio of expansion of schooling reflects that when a 1% increase in female- male ratio of expansion of schooling occurs it causes 0.69% increase in growth of GDP, also indicating a higher impact for the coefficient when compared to our study's coefficient of 0.012% increase. Positive investment coefficient was also found to be significant at a 5% significance level, where it showed that when investment increased by 1% it reflected an increase of 0.056% in GDP, identical to our study's coefficient of 0.05% increase in GDP, yet of a higher 1% significance level.

Our results were parallel to previous literature (Baliamoune-Lutz and McGillivary, 2009) where the gap in youth literacy between females and males had a negative and significant impact on

income, where Coefficient for gap was significant at a 1% significance level, where a 1% increase in the gap causes a 0.2% decrease in income growth reflecting a higher impact on income growth than our study does at 0.012% percentage change in GDP. The coefficient of investment was both positive and significant at a 1% significance level where a 1% increase in investment caused an increase in income growth ranging between 0.13 - 0.16% again compared to this study's coefficient of 0.05% it is of relatively larger impact.

On the other hand, our findings were inconsistent with (Oztunc, Oo and Serin, 2015) where female tertiary education is negatively related to annual GDP per capita growth, where GDP decreases by 1 unit when tertiary female education is increased by 10 units reflecting an influence of 10 % of female tertiary education on GDP per capita. We believe the reason for the contradiction to our results is the nature of jobs available in the sample countries in this specific study where it was stated that most jobs for female workforce are unskilled labor jobs and thus obtaining a tertiary education is deemed unnecessary. Another finding that was inconsistent with ours is (Licumba et al., 2015) that used human capital as a proxy of education found that with a two-year lag it was both negative and insignificant for growth. Again, contradiction to our results here may have originated from the fact that the sample under study was restricted to 5 Southern African countries and the proxy was primary enrolment.

With regards to our climate change proxy variable, annual growth rate in mean temperature has a positive and a 5% significance level coefficient reflecting the direct relationship to GDP growth rate, which is contradictory to what previous literature highlighted where climate change had a negative impact in most cases (Eboli et al., 2010; Solomon et al., 2017) or no significant impact was observable from an aggregate worldwide perspective (Newell et al., 2021). This study's unexpected results led to rethinking the direction of the relationship and conducting the previously mentioned Granger Causality test to deduce that the results are significant, yet the relation should be tested in the opposite direction. Another recommendation would be to increase the time period studied and to test for the direction of the causality again.

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