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Assessing Productivity Channels of Human Capital in the Southern African Development Community: New Insights from Women's Empowerment

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Abstract: There is massive and growing volume of literature on human capital and productivity. However, there is little emphasis on the growth channels of human capital, particularly on women's empowerment, despite its theoretical underpinning and relevance in the Southern African Development Community (SADC). Understanding the effective channels of human capital is essential for policymakers in promoting sustainable growth and improved welfare. Given this, the study examines the effect of women's empowerment through the 'factor accumulation channel' and the 'productivity channel' on SADC using cross-sectionally augmented autoregressive distributed lag (CS-ARDL) and the Dumitrescu–Hurlin non-causality test. Evidence from short- and long-run effects using the CS-ARDL shows that the factor accumulation and productivity channels of women's empowerment have not benefited productivity growth in the SADC, although causality flows from the human capital indicators to productivity growth. The vital way for policy to boost productivity in SADC is to improve investment in female education and ensure that human capital is appropriately distributed and matches the economy's dynamic demands. Based on the findings, the study suggests developing a framework to ascertain from time to time the marginal benefits of investment in female education compared to the marginal costs, both at the levels of the factor accumulation channel and the productivity channel in SADC.

Keywords: productivity; human capital; women's empowerment; long-run; causality

JEL Classification: D02; O17; P31; C54

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1. Introduction

An investment in the talents and capabilities of women for productive purposes is represented as part of human capital development, which is an intentional and continual process of gaining and growing the number of females with the necessary knowledge, education, skill and experience for economic development. Continuous productivity growth through human capital has long been recognised as the cornerstone of long-term sustainable economic growth. Productivity gains enable businesses and, by extension, the economy to create more output with the same level of inputs (Asaleye et al. 2021; Australian Workforce and Productivity Agency 2013; Isaacs et al. 2022). In addition, innovation, growth in human capital and competition are possible productivity boosters. In this regard, one of the Southern African Development Community's (SADC) key goals is to achieve long-term development and economic progress, reduce poverty, improve the standard of living and quality of life of South Africans, and assist the socially marginalized by promoting regional cooperation. However, the SADC's economy has been growing slower than the economies of the rest of the continent. For example, the SADC's growth rate stood at 2.2 per cent in 2019 and 2.8 per cent in 2020. The fundamental headwinds of high inflation, rising government debt and weak productivity growth are at the root of this slow pace of growth (African Development Bank 2022).

Similarly, women are the backbone of several African economies, and they also play a critical part in the economics of each SADC member state. Evidence has shown that women account for more than half of the impoverished people in the SADC and that poverty can only be alleviated through programmes that mainly target the poor (SADC 2012; World Bank 2022). Therefore, women's education has long been considered to be one of the most beneficial investments to reduce poverty and promote sustainable growth and development (Kaffenberger and Pritchett 2021). United Nations Sustainable Development Goal (SDG) 4 emphasises the need to develop human capital through inclusive and high-quality education, while SDG 5 stresses the importance of discouraging all forms of discrimination against women and girls, not only as a fundamental human right, but also as essential for long-term future sustainable development. Therefore, it has been demonstrated that empowering women and girls in order to promote productivity is imperative in SADC, which has a high rate of jobless women (World Bank 2022).

Consequently, investment in human capital to promote productivity growth depends on understanding the channels through which the investment can increase aggregate output and welfare. There is a massive and rapidly expanding volume of literature on human capital and productivity (Ghosh and Parab 2021; Mazhar and Rehman 2022; Okunade et al. 2022; Timothy 2022). However, there is little emphasis on the growth channels of human capital despite its theoretical underpinning. A strand of the literature has documented that human capital is merely an input used in production activities (Lucas 1988; Mankiw et al. 1992). Hence, since growth is predominantly driven by the build-up of human capital stock, referred to as the 'factor accumulation channel', the growth rates of various economies are positively connected with the rates at which human capital is accumulated over the given period. Another thread of the literature shares the perspective that human capital influences growth primarily through its impact on total factor productivity, since a greater level of human capital (i.e., investment in the empowerment of people, specifically women and girls in the context of this work) boosts a country's ability to innovate and/or adapt to existing technology, referred to as the 'productivity channel' (Aghion and Howitt 1992; Romer 1990). According to this channel, disparities in growth rates between nations are mostly due to differences in human capital levels in the respective countries.

In addition, several empirical studies have been carried out in order to evaluate the beneficial effects of human capital on productivity (Ghosh and Parab 2021; Mazhar and Rehman 2022; Popoola et al. 2019; Timothy 2022). Despite this, the effect of women's empowerment via education on productivity has remained under-researched. Although given that the numerous empirical works on human capital and growth nexus and that past research have yielded numerous findings, their outcomes and expectations vary significantly (De la Fuente and Domenech 2006; Li and Wang 2016). In spite of the massive and growing volume of literature on human capital and productivity, there is a disconnect in most studies regarding the growth channels of human capital, more especially on women's empowerment. In view of this, we investigated the two hypotheses for the individual and combined effects of productivity channels on women's empowerment as follows; firstly, 'factor accumulation channel' and 'productivity channel' do not have significant short- and long-term effects on women's empowerment productivity growth in SADC. Secondly, there is no causal relationship between 'factor accumulation channel' indicators on one hand and 'productivity channel' indicators on the other hand, with women's empowerment productivity growth in SADC. The two hypotheses were analysed using cross-sectionally augmented autoregressive distributed lag (CS- ARDL) and Dumitrescu–Hurlin non-causality test, respectively. To this end, this study adds to the existing literature by investigating the effect of women's empowerment via human capital channels on productivity growth in SADC. The specific objectives are as follows:

i. Analyse the individual and combined effects of 'factor accumulation channel' and 'productivity channel' of women's empowerment on productivity growth in SADC.

ii. To examine the individual and combined causal effects of 'factor-accumulation' and 'productivity channel' indicators of women's empowerment on productivity growth in SADC.

The introductory section is followed by Section 2, where a literature review is presented. Section 3 describes the method of analysis and data sources. Section 4 includes the presentation of results, while Section 5 concludes this article.

2. Literature Review

According to human capital theory, individual education and training are critical to the aggregate value of human capital in countries (Becker 1962; Schultz 1961) and can provide a significant benefit to productivity (Lee et al. 2019). Two channels have been documented in the theoretical literature in which human capital promotes productivity. Firstly, Lucas (1988) established that human capital accumulation boosts growth. In this sense, productivity growth is primarily driven by the accumulation of human capital stock, often known as the 'factor accumulation channel', and the growth rates of distinct countries are positively related to the rates at which human capital is accumulated throughout a given period's activities (Lucas 1988; Mankiw et al. 1992). Secondly, Romer (1990) stressed that productivity is subject to existing human capital stock as input, which generates new knowledge and facilitates the imitation or adoption of foreign technologies. In this regard, human capital drives growth largely through its impact on total factor productivity because a higher level of human capital improves a country's ability to innovate and/or adapt to current technologies, also known as the 'productivity channel.' According to this channel, disparities in growth rates between nations are mostly attributable to variances in human capital levels in separate countries (Aghion and Howitt 1992; Romer 1990). In conclusion from both the 'factor accumulation channel' and productivity channel', the effect of human capital on growth can be determined by the type of human capital accumulated during a certain period. Understanding the effective channels of human capital to promote women's empowerment is essential in order for policymakers to achieve sustainable growth and improved welfare.

As noted in the introductory section, the empirical influence of human capital on productivity is inconclusive. Scholars have reported mixed results in the empirical literature. For example, Ghosh and Parab (2021) document that long-term productivity growth in India is influenced by foreign direct investment and human capital, whereas research and development-based models and technological spillovers via the import channel show conflicting evidence of support. As a result, Ghosh and Parab (2021) recommend persistent increases in human capital and foreign direct investment. Bengoa et al. (2017) show a significant direct effect of public research and development capital on productivity in Spain. Furthermore, a study conducted in Taiwan by Chang et al. (2016) find that higher-educated employees will increase the productivity of a company and the influence on productivity was greater when technology was intensified. In contrast, Pablo-Romero and Gómez-Calero (2013) argue that technology and human capital are complimentary and demonstrate diminishing returns during production activities in Spanish regions. In addition, Van Lottum and Van Zanden (2014) demonstrate that there is a positive relationship between the level of labor productivity and the quality of the workforce.

Mazhar and Rehman (2022) report that, irrespective of other factors affecting human nature, human capital is essential to increasing productivity. Hou et al. (2020) state that human capital is significant in relating the connection between productivity and technology spillovers. By this they mean that the benefit of human capital through research and development is not only limited to the firms that incurred the cost, but other firms can benefit as well, with zero cost. Therefore, investing in human capital can boost a country's potential to accelerate spillovers. In Belgium, Onkelinx et al. (2016) concluded that the investment in the human capital in small-scale business organizations pays off when it is carefully aligned with the chosen internationalization strategy. Onkelinx et al. (2016) also revealed that firm-level investments in employee human capital are crucial for labour

productivity and internationalization in businesses that internationalize quickly, but not in firms that internationalize slowly. In Greek regions, Benos and Karagiannis (2016) show that human capital has a positive connection to labour productivity through access to upper secondary and tertiary education, but primary school education has a negative relationship and lower secondary education has no relationship with productivity. Benos and Karagiannis (2016) further stated that policymakers should consider education quality as well as technological benefit spillovers and direct their efforts toward a more efficient and enhanced education system with a focus on high education levels in order to improve overall labour productivity and reduce spatial productivity disparities. Ramos et al. (2010) find that tertiary and secondary education both enhance labor productivity and growth in Spain, however basic education has no effect on either. Surprisingly, they discovered negative spatial spillovers from higher education; the negative externality from higher education documented by the authors contradicts the findings of other studies. A similar study in China by Ding and Knight (2011) discovered that higher education enrolments have a more positive growth impact than secondary enrolments do; however, primary school enrolment has no effect.

Okunade et al. (2022) used the Dumitrescu–Hurlin non-causality test and cross-sectionally augmented autoregressive distributed lag (CS-ARDL) to investigate the relationship between human capital development and productivity growth in Africa. Okunade et al.'s (2022) findings show that globalization has a positive influence on productivity growth in the long run, but that human capital is not statistically significant in productivity growth in the short and long run. Likewise, Timothy (2022) reports that top managers with higher education qualifications place a larger value on non-technological innovation, and that managers with more years of industry expertise value technical innovation more than their less experienced counterparts. Furthermore, Timothy's (2022) findings reveal that small and medium enterprises (SMEs) with managers who have higher-education had greater productivity than SMEs managed by their less-educated counterparts. While this study is related to the studies of Li and Wang (2016) and Popoola et al. (2019) which analyze the effect of human capital channels on China and Nigeria, respectively, it is, however, different in several ways. The current study contributes to the existing literature by giving new insight into women's empowerment and using a region panel dataset of Southern African countries; this is important given the large number of women that are impoverished in the region (World Bank 2022). In addition, we examine both the short and long-run implications using CS-ARDL and causal relationship using Dumitrescu and Hurlin's (2012) panel non-granger causality test.

3. Material and Methods

3.1. Theoretical Framework for the Human Capital Channels

The theoretical human capital channels for this study take their starting points from the Cobb-Douglas production with the inclusion of technology as an input factor, given as:

$$PDG_{it} = TLE_t \, GCF_{it}^{\alpha} \, WHC_{it}^{\beta} \, EMR_{it}^{\lambda} \tag{1}$$

In Equation (1), PDG represents the aggregate productivity; GCF is the capital input used in production; WHC is the investment in human capital, such as government expenditure on female education, health, job training and enrolments; EMP is the aggregated labour input used in production; TLE is the elasticity ratio of technology and not determining within the model; while 'i' and 't' are the section and period of observation, respectively. EMP and TLE grows at the rate of ϑ and υ, given as:

$$EMP = EMP_{(0)} \ell^{\vartheta} \tag{2}$$

$$TLE = TLE_{(0)} \ell^{\upsilon} \tag{3}$$

The per capita form of Equation (1) is restated as:

$$pdg_{it} = tle_{it}\, gcf_{it}^{\alpha}\, whc_{it}^{\beta}\, emr_{it}^{\varpi} \tag{4}$$

In Equation (4), $\varpi = \lambda + \alpha + \beta - 1$. Taking the log form of Equation (4) and incorporating Equations (2) and (3) we have:

$$\Delta \ln pdg_{it} = \alpha_i + \alpha_{i1}\Delta \ln gcf_{it} + \alpha_{i2}\Delta \ln whc_{it} + \alpha_{i3}\Delta\, emr_{it} + v_{it} \tag{5}$$

Equation (5) is used to express the factor accumulation channel (Li and Wang 2016; Popoola et al. 2019). For this study, Equation (5) is slightly modified to achieve the objective of the study as follows:

$$\ln pdg_{it} = \beta_i + \beta_{i1} \ln gcf_{it} + \beta_{i2} \ln fpe_{it} + \beta_{i3} \ln fse_{it} + \beta_{i4} \ln emr_{it} + \beta_{i5} In\ \text{int}_{it} + \beta_{i6} In\ exr_{it} + \varepsilon_{it} \tag{6}$$

Equation (6) is referred to as the factor accumulation channel model (Model 1), and fpe and fse represent female primary school enrolment and female secondary school enrolment, respectively. The two variables (fpe and fse) are used as indicators of women's empowerment for factor accumulated inputs. Furthermore, Model 1 is a way of thinking about the impacts of human capital on growth and the rate at which human capital is accumulated to influence growth rate. The interest rate (int) and exchange rate (exr) are control variables; their inclusion is as a result of the relevance from output–human capital literature (Asaleye et al. 2022a; Okunade et al. 2022). Conversely, scholars have argued that human capital differs fundamentally from physical capital in the way it influences growth. Human capital influences growth through the productivity channel, and capital formation in this stage increases a nation's ability to innovate and/or adjust to current technologies (Li and Wang 2016; Popoola et al. 2019). Therefore, Equation (5) is adjusted to capture the effect of the productivity channel as follows:

$$\ln pdg_{it} = \psi_i + \psi_{i1} \ln gcf_{it} + \Psi_{i2} \ln fte_{it} + \Psi_{i3} \ln fge_{it} + \Psi_{i4} \ln emr_{it} + \Psi_{i5} In\ \text{int}_{it} + \Psi_{i6}\ In\ exr_{it} + \mu_{it} \tag{7}$$

Equation (7) is referred to as the productivity channel model (Model 2), where fte and fge represent female tertiary school enrolment and the ratio of female government on research and development, respectively. The two variables (fte and fge) are used as indicators of women's empowerment for productivity channel inputs.

$$\ln pdg_{it} = \lambda_i + \lambda_{i1} \ln gcf_{it} + \lambda_{i2} \ln fac_{it} + \lambda_{i3} \ln pdc_{it} + \lambda_{i4} \ln emr_{it} + \lambda_{i5} In\ \text{int}_{it} + \lambda_{i6}\ In\ exr_{it} + e_{it} \tag{8}$$

Finally, the combined model of the factor accumulation channel and the productivity channel is given in Equation (8), where *fac* represents 'factor accumulation channels' indicators, that is, *fpe* and *fse*, while *pdc* represents the productivity channel indicators, that is, *fte* and *fge*. Both channels boost growth at the same time, although independently. The former promotes growth via the factor accumulation channel, while the latter promotes growth via the productivity channel. Equations (6)–(8) will be interpreted from the concept of elasticity, that is, percentage changes in productivity growth for a given percentage change in the explanatory variable.

3.2. Techniques of Estimation

In this study, we first test for non-stationarity in the variables and then for the presence of a cointegration connection in the specifications. When all variables are cointegrated, the error term follows a stationary process (that is, it is integrated of order zero I (0)). Then, correlations based on long-term associations are not misleading, and panel data inference may be used. Based on the outcome, we proceed to use CS-ARDL, given as:

$$dpdg_{it} = \Omega_i + \delta_i \left[pdg_{i,t-1} - \mathrm{I}_i k_{i,t-1} - \rho_{1i}\, \overline{pdg}_{t-1} - \rho_{2i} \bar{k}_{t-1} \right] + \sum_{n=1}^{q-1} m_{in}\ dpdg_{i,t-n} + \sum_{n=0}^{j-1} r_{in}\ d\ k_{i,t-n} + \phi_{1i} \overline{dpdg}_{t-1} + \phi_{2i}\ \bar{dk}_{t-1} + v_{it} \tag{9}$$

In Equation (9), $dpdg_{it}$ is the dependent variable and the long-run independent variables are represented by $k_{i,t-1}$ (that is, gross fixed capital formation, indicators of channels of human capital, employment, interest rate and exchange rate). In addition, $\overline{pdg}_{t-1}$ and $\overline{k}_{t-1}$ are the long-run mean of dependent and independent variables respectively. The short-run dependent and independent variables are represented by $dpdg_{i,t-n}$ and $d\,k_{i,t-n}$, while the mean of dependent and independent variables are represented by $\overline{dpdg}_{t-1}$ and $\overline{dk}_{t-1}$. The symbol I_i is the coefficient of the independent variables, the period of observation is represented by 't', while 'n' is the cross-sectional dimension. Likewise, the short-run coefficients of the dependent and independent variables are given as m_{in} and r_{in}, while the mean coefficient of both variables are represented by ϕ_{1i} and ϕ_{2i}. Finally, v_{it} is the disturbance term.

To explain the causal link between productivity growth and women's empowerment, we use Dumitrescu and Hurlin's (2012) panel non-Granger causality test. The choice of this approach to the causality test is because it uses the block bootstrapping method, which rectifies the experimental confidence intervals of the panel causality test statistic in order to cope with the cross-sectional dependency problem, and, in addition, it is not dependent on cointegration in cross–country panel models (Dumitrescu and Hurlin 2012). The non-causality equation is given as:

$$pdg_{it} = a_i + \sum_{q=1}^{n} C_i^n pdg_{i,t-q} + \sum_{q=1}^{n} d_i^n whc_{i,t-q} + e_{it} \quad (10)$$

In Equation (10), pdg and whc are the productivity growth and women's empowerment indicators via human capital formation, which is comprised of factor accumulation (fac) and productivity channels (pdc). The null hypothesis is that there is no causal relationship between the variables. Four results can be obtained: first, a bi-directional relationship between productivity growth and human capital channels indicators (stating both variables can predict each other); secondly, a unidirectional relationship from one of the human capital channels to productivity growth (indicating that human capital can predict productivity growth); thirdly, a unidirectional relationship from productivity growth to human capital (indicating that productivity growth can predict human capital); and, finally, independence, meaning that none of the variables can predict each other. Table 1 presents data sources and measurement.

Table 1. Data Sources and Measurement.

Variable	Definition	Measurement and Source	Theoretical Expectations
pdg	Productivity growth	GDP annual percentage growth rate at market prices in constant local currency. The aggregates are calculated using constant 2015 prices expressed in US dollars–World Development Indicators (WDI).	Dependent variable
gcf	Gross capital formation	Gross capital formation annual growth rate in constant local currency. The aggregates are calculated using constant 2015 prices expressed in US dollars–WDI.	Positive
fpe	Female primary school enrolment	Female elementary school students represented by enrolments in both public and private schools–United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics.	Positive

Table 1. *Cont.*

Variable	Definition	Measurement and Source	Theoretical Expectations
fse	Female secondary school enrolment	Female students as a proportion of total secondary students comprises enrolments in both public and private institutions–UNESCO Institute for Statistics.	Positive
fte	Female tertiary school enrolment	Female School enrolment in tertiary school, computed as percentage of gross: minimum condition of admission, the successful completion of education at the secondary level–UNESCO Institute for Statistics.	Positive
fge	Government expenditure on female education	Ratio of percentage of government expenditure on education and percentage female in total population–computed by the authors using WDI data.	Positive
emr	Employment rate	Labour force to population ratio is the proportion of a country's population that is employed–WDI.	Positive
int	Interest rate	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator–WDI.	Negative
exr	Exchange rate	The ratio of a purchasing power parity (PPP) conversion factor to an exchange rate–WDI.	Positive/negative

Source: Authors' compilation.

The data for this study covers the period of 2000 to 2020 for the 11-member states of the Southern African Development Community (based on data availability), namely Angola, Botswana, Congo, Eswatini, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, South Africa and Tanzania.

4. Presentation of Results and Discussion

4.1. Preliminary Analyses

Table 2 presents the results of the preliminary analyses of the correlation analysis, descriptive statistics and stationarity result. The result of the correlation analysis shows a weak association between the pair variables. A negative correlation is found between productivity growth and the human capital indicators. However, the correlation result, while intriguing, does not lend itself to experimental interpretation, which is a feature of econometric model results carried out in this study (Asaleye et al. 2022b). The descriptive statistics show that the interest rate has the highest mean value, at 10.5, and that the exchange rate has the lowest, at 0.45. Likewise, the gross fixed capital has the highest standard derivation, at 18.9, and the exchange rate has the lowest, at 0.11.

The cross-section dependence and stationarity results show that we cannot reject the null hypothesis of dependency. In addition, the cross-sectional Im-Pesaran-Shin unit root test (CIPS) and cross-sectional augmented Dickey-Fuller (CADF) tests show that EXR, FGE, FSC and GCF are stationary at the level form, while EMR, FPE, FTE, INT and PDG are integrated of order one. The presence of cross-dependence and mixed-order integration supports the application of a CS-ARDL in this study.

Table 2. Preliminary Analysis Result.

Correlation Analysis									
	EMR	**EXR**	**FGE**	**FPE**	**FSC**	**FTE**	**GCF**	**INT**	**PDG**
EMR	1								
EXR	−0.2393	1							
FGE	−0.2042	0.1534	1						
FPE	−0.2908	−0.3011	−0.0414	1					
FSC	−0.5372	−0.0465	−0.0760	0.6595	1				
FTE	−0.4252	0.20848	0.08354	0.2841	0.3589	1			
GCF	0.20090	−0.1208	−0.0700	−0.1125	−0.1484	−0.2243	1		
INT	0.52612	−0.2266	−0.4180	−0.0819	−0.2485	−0.2644	0.1454	1	
PDG	0.25012	0.11907	−0.0466	−0.1329	−0.1382	−0.3267	0.2626	0.0493	1
Descriptive Statistics									
	EMR	**EXR**	**FGE**	**FPE**	**FSC**	**FTE**	**GCF**	**INT**	**PDG**
Mean	4.052384	0.450861	6.571123	3.872352	3.847529	9.600901	7.854467	10.51269	3.75688
Median	3.97293	0.457492	6.688473	3.892187	3.903751	5.02359	5.004439	7.651995	4.14926
Maximum	4.454708	0.906357	7.867733	3.949447	4.090415	52.60554	115.0313	52.43679	15.0289
Minimum	3.577361	0.190568	−1.235525	3.57426	3.27418	0.07184	−36.3908	−15.69025	−14.895
Std. Dev.	0.285784	0.110118	1.260646	0.055856	0.166484	11.18476	18.86787	10.60656	4.1121
Obs.	231	231	231	231	231	231	231	231	231

Cross-section Dependence and Stationarity Results							
Series	**Cross-section Dependence Test**		**CIPS Test**		**CADF Test**		**Order of Integration**
	CD	**Prob.**	**Level**	**First Diff.**	**Level**	**First Diff.**	
EMR	2.328582 **	0.0199	16.9034	34.6921 **	12.2612	49.3535 ***	I (1)
EXR	16.23575 ***	0.0000	45.8418 ***	–	33.5627 **	–	I (0)
FGE	3.216843 **	0.0423	60.4224 ***	–	114.417 ***	–	I (0)
FPE	2.170767 **	0.0299	30.4121	130.519 ***	32.7662 *	155.674 ***	I (1)
FSC	1.710046 *	0.0873	46.8864 ***	–	54.9471 ***	–	I (0)
FTE	16.93830 ***	0.0000	16.5783	69.6716 ***	29.3293	306.781 ***	I (1)
GCF	2.584870 **	0.0130	92.0979 ***		372.029 ***		I (0)
INT	1.865772 *	0.0866	18.4401 ***		0.56367	12.2024 ***	I (1)
PDG	16.87079 ***	0.0000	29.9034	105.737 ***	53.9062 ***	441.255 ***	I (0)

*** shows significance @ 1 per cent, ** and * indicate significance @ 5 per cent and 10 per cent, respectively. Source: Authors' compilation.

4.2. Long-Run Behavior Result

Table 3 presents the CS–ARDL estimation results for the factor accumulation channel. The factor accumulation channel indicators 'female school enrolment (FPE)' and 'female secondary school enrolment (FSC)' are insignificant, both in the long and short run; this result contradicts the study by Popoola et al. (2019).

Likewise, Loening (2005) stressed the notion that investment in primary and secondary education is one of the most important factors for productivity growth. The gross capital formation (GCF), employment (EMR) and exchange rate (EXR) are statistically significant with productivity growth (PDG). In the long run, a percentage change in GCF, EMR and EXR will lead to an approximate 0.05 per cent, 4.89 per cent and 7.95 per cent increase in PDG, respectively. In the short run, GCF, EMR and EXR are statistically significant. A percentage change in GCF, EMR and EXR will lead to an approximate 0.05 per cent, 44.2 per cent and 18.2 per cent increase in PDG, respectively. The interest rate (INT) is insignificant in both the short and long run.

Table 3. CS-ARDL Estimation Result for Factor Accumulation Channel.

Long Run				
Variable	**Coefficient**	**Std. Error**	**Z-Statistics**	**Probability**
GCF	0.053328 ***	0.013741	3.880952	0.0001
EMR	4.886291 ***	1.228539	3.977317	0.0001
FPE	0.795425	6.450351	0.123315	0.9020
FSC	1.435605	2.2969	0.625019	0.5326
EXR	7.950707 ***	2.597294	3.06115	0.0025
INT	−0.039279	0.028178	−1.393965	0.1647
C	−28.23855	22.91342	−1.232402	0.2191
Short run				
Variable	**Coefficient**	**Std. Error**	**Z−Statistics**	**Probability**
D(GCF)	0.045387 ***	0.010356	4.382589	0.000
D(EMR)	44.17262 ***	13.66226	3.233186	0.0014
D(FPE)	10.72489	8.089247	1.32582	0.1863
D(FSC)	3.597951	3.68032	0.977619	0.3294
D(EXR)	18.22965 ***	3.950021	4.615077	0.0000
D(INT)	0.012218	0.040521	0.301536	0.7633
C	0.073607	0.239124	0.307819	0.7585
ECT	−0.779395 ***	0.076691	−10.16278	0.0000
R-squared: 0.594898 Observation: 220 Cross-section: 11				

*** shows significance at 1 percent. Source: Authors' compilation.

In the SADC, the insignificance of the factor accumulation channels, both in the short and long run, raises questions about female human capital formation sustainability in SADC. The foundation skills, through the metrics of the factor accumulation channel, are likely to have a great influence on productivity. This is not unexpected considering that basic skills serve as the framework for additional learning and effective involvement in the production in the long run. Likewise, to build skills at this level is one of the most challenging factors that can affect the sustainability of female productivity in the long run (Australian Workforce and Productivity Agency 2013).

Table 4 presents the CS-ARDL estimation result for the productivity channel. In the long run, gross capital formation (GCF), employment (EMR), female tertiary enrolment (FTE) and exchange rate (EXR) are statistically significant at the level of one per cent, while interest rate (INT) is significant at ten per cent and government expenditure on female education at the higher level (FGE) is insignificant. A percentage change in GCF, EMR and FTE will lead to an approximate 0.04 per cent, 2.98 per cent and 0.10 per cent increase in productivity growth (PDG), respectively, while a percentage change in EXR and INT will lead to an approximate 8.53 per cent and 0.05 per cent decrease in PDG, respectively. In the short run, GCF, EMR, FTE, FGE and EXR are statistically significant and exhibit a positive relationship with PDG. A percentage change in GCF, EMR, FTE, FGE and EXR will lead to an approximate 0.04 per cent, 37.8 per cent, 0.17 per cent and 17.1 per cent increase in PDG, respectively. The interest rate (INT) is statistically insignificant.

Table 4. CS-ARDL Estimation Result for the Productivity Channel.

Long run				
Variable	**Coefficient**	**Std. Error**	**Z-Statistics**	**Probability**
GCF	0.044264 ***	0.013349	3.315881	0.0011
EMR	2.977328 ***	1.076133	2.766691	0.0061
FTE	0.099735 ***	0.024495	4.071712	0.0001
FGE	0.190096	0.212987	0.892522	0.3731
EXR	−8.529099 ***	2.315979	−3.682719	0.0003
INT	−0.051709 *	0.029207	−1.770462	0.0780
C	−9.751208 **	4.742055	−2.056325	0.0409
Short run				
Variable	**Coefficient**	**Std. Error**	**Z−Statistics**	**Probability**
D(GCF)	0.037845 ***	0.009782	3.868979	0.0001
D(EMR)	37.75875 ***	12.94523	2.916809	0.0039
D(FTE)	0.172288 ***	0.045972	3.747706	0.0002
D(FGE)	0.718498 ***	0.247714	2.900508	0.0041
D(EXR)	17.12972 ***	3.651362	4.691323	0.0000
D(INT)	0.023138	0.038072	0.607734	0.5440
C	0.14643	0.227332	0.644124	0.5202
ECT	−0.783411 ***	0.071953	−10.8878	0.0000
R-squared: 0.65727 Observation: 231 Cross-section: 11				

*** shows significance at 1 percent, ** and * indicate significance at 5 percent and 10 percent, respectively. Source: Authors' compilation.

The productivity channels indicators are positively significant in the short run in SADC. However, government expenditure on female education at the higher level is insignificant in the long run. This contradicts the findings by Li and Wang (2016) and Popoola et al. (2019). The accumulation of relatively high skills through investment in the productive channels of female human capital becomes extremely relevant in SADC. In the long run, this will enable industries and female labor to adopt improved techniques or innovate more to boost productivity. Given the situation in SADC regarding women's empowerment, this might increase the productivity if investment in female schooling is carefully aligned with a chosen strategy. Onkelinx et al. (2016) stressed that investment in human capital pays off when it is aligned with the chosen strategy. In addition, Benos and Karagiannis (2016) pointed out that high education levels are necessary to improve overall productivity and reduce productivity disparities.

Table 5 presents the CS-ARDL estimation result for the aggregate model. In the long run, gross capital formation (GCF), employment (EMR), female tertiary school enrolment (FTE) and exchange rate (EXR) are significant at the level of one per cent, while interest rate is significant at ten per cent. Female primary school enrolment (FPE), female secondary school enrolment (FSC) and government expenditure on female education at the higher level (FGE) are insignificant. A percentage change in GCF, EMR and FTE will lead to an approximate 0.05 per cent, 3.84 per cent and 0.11 per cent increase in PDG, respectively, while a percentage change in EXR and INT will lead to an approximate 10.2 per cent and 0.05 per cent decrease in PDG, respectively.

Table 5. CS-ARDL Estimation Result for the Aggregate Model.

Long run				
Variable	**Coefficient**	**Std. Error**	**Z-Statistics**	**Probability**
GCF	0.045748 ***	0.013337	3.430209	0.0007
EMR	3.837664 ***	1.207831	3.17732	0.0017
FPE	5.746112	6.321528	0.908975	0.3643
FSC	1.726976	2.272856	0.759827	0.4482
FTE	0.11119 ***	0.025245	4.404353	0.0000
FGE	0.134435	0.218177	0.616174	0.5384
EXR	−10.24371 ***	2.553652	−4.011396	0.0001
INT	−0.051466 *	0.029239	−1.760181	0.0798
C	−43.17623	22.41757	−1.926	0.0554
Short run				
Variable	**Coefficient**	**Std. Error**	**Z−Statistics**	**Probability**
D(GCF)	0.039942 ***	0.009871	4.046239	0.0001
D(EMR)	35.40101 ***	12.96708	2.730068	0.0069
D(FPE)	10.3797	7.715465	1.345312	0.1800
D(FSC)	4.318744	3.48978	1.237541	0.2173
D(FTE)	0.177486 ***	0.046052	3.854025	0.0002
D(FGE)	0.669142 ***	0.249342	2.683632	0.0079
D(EXR)	−18.20381 ***	3.763821	−4.836524	0.0000
D(INT)	0.013466	0.038615	0.348732	0.7276
C	0.130362	0.227723	0.572459	0.5676
ECT	−0.768446 ***	0.072887	−10.54303	0.0000
R-squared: 0.56003 Observation: 220 Cross-section: 11				

*** shows significance at 1 percent, * indicates significance 10 percent, respectively. Source: Authors' compilation.

In the short run, GCF, EMR, FTE, FGE and EXR are significant at the level of one per cent, while FPE, FSC and INT are insignificant. A percentage change in GCF, EMR, FTE and FGE will lead to an approximate 0.04 per cent, 35.4 per cent, 0.18 per cent and 0.67 per cent increase in PDG, respectively. A percentage change in EXR will lead to an approximate 18.2 per cent decrease in PDG.

The findings of the aggregate model are similar for both the factor accumulation and the productivity channels, which show lower performance of female human capital formation on productivity growth in SADC. The findings contradict the literature that focuses on aggregate human capital (non-gender human capital) and growth nexus (Australian Workforce and Productivity Agency 2013; Li and Wang 2016; Loening 2005; Popoola et al. 2019). Also, using non-gender human capital, Benos and Karagiannis (2016) document that lower secondary education has no relationship with productivity in Greek regions, while Ramos et al. (2010) report that tertiary and secondary educations both enhance productivity and growth in Spain.

4.3. Causality Test Result

Table 6 presents the Dumitrescu-Hurlin panel causality test result for the productivity growth and female human capital channels indicators. The null hypotheses are that productivity growth does not homogeneously cause female human capital development

and that female human capital development does not homogenously cause productivity growth. Using government expenditure on female education at the higher level (FGE) as a proxy for human capital, there is a unidirectional relationship flowing from productivity growth (PDG). We accept the null hypothesis that FGE does not cause PDG and reject the hypothesis that PDG does not cause FGE.

Table 6. Dumitrescu-Hurlin Panel Causality Test Result.

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.	Hypothesis's Evaluation
PDG does not homogeneously cause FGE	4.31186 **	2.37683 **	0.0175	$PDG \Rightarrow FGE$
FGE does not homogeneously cause PDG	2.72539	0.47098	0.6377	
PDG does not homogeneously cause FPE	5.09858 ***	3.32192 ***	0.0009	$PDG \Rightarrow FPE$
FPE does not homogeneously cause PDG	3.13066	0.95784	0.3381	
PDG does not homogeneously cause FSC	2.17151	−0.1944	0.8459	$FSC \Rightarrow PDG$
FSC does not homogeneously cause PDG	3.86121 *	1.83546 *	0.0664	
PDG does not homogeneously cause FTE	1.9432	−0.46867	0.6393	$FTE \Rightarrow PDG$
FTE does not homogeneously cause PDG	5.69958 **	4.04391 ***	5.2×10^8	

*** shows significance at 1 percent, ** and * indicate significance at 5 percent and 10 percent, respectively. Source: Authors' compilation.

Using female primary school enrolment (FPE) as a proxy, we reject the null hypothesis that PDG does not cause FPE and accept the hypothesis that FPE does not cause PDG. Therefore, there is a unidirectional relationship flowing from PDG to FPE. Likewise, using female secondary enrolment (FSC) as a proxy, we accept the null hypothesis that PDG does not cause FSC and reject the hypothesis that FSC does not cause PDG. Hence, there is a unidirectional relationship flowing from FSC to PDG. Finally, using female tertiary school enrolment (FTE) as a proxy, we accept the hypothesis that PDG does not cause FTE and reject the hypothesis that FTE does not cause PDG, and indicate that there is a unidirectional relationship flowing from FTE to PDG.

This result raises interesting policy implications, despite the insignificance of the factor accumulation and productivity channels in the long- and short-run analyses. In this sense, the human capital development index for women's empowerment may be stimulated to foster and complement productivity in the SADC.

5. Conclusions

This study adds to the empirical literature by providing new insights into the effect of the productivity channels on human capital in the Southern African Development Community (SADC) using female human capital data sets. This becomes necessary because the SADC's economy has recently been growing at a slower rate than that of the rest of the continent. The problem attributed to this is, among others, inadequate productivity growth. Similarly, women are the backbone of many African economies and they play an important role in the economy of all SADC member states. Evidence from official statistics also show that women account for more than half of the poor in SADC and that poverty can only be addressed through initiatives (such as education) that specifically target the poor. Based on this, two hypotheses for the individual effects and combined effects of 'factor accumulation channel' and 'productivity channel' on women's empowerment productivity growth in SADC in SADC were tested, first for short and long implications and second for causal impacts. We examined the long- and short-run effects of female human capital productivity channels using the novelty CS-ARDL and the causality effect using the Dumitrescu-Hurlin approach. Evidence from the CS-ARDL results shows that women's empowerment via education in the SADC has not significantly benefited from either the factor accumulation channel or the productivity channel of human capital. Evidence from the Dumitrescu-Hurlin causality approach shows that there is a unidirectional relationship

flowing from productivity growth to government expenditure on female education at the higher level; there is a unidirectional relationship flowing from female tertiary school enrolment to productivity growth. Finally, there is a unidirectional relationship flowing from female secondary enrolment to productivity growth. The crucial way for policy to boost productivity in the SADC is to improve investment in female education and to ensure that human capital is aligned towards and matching the economy's dynamic demands.

Based on the findings, the study suggests that development of relatively high skills through investment in the productive channels of human capital becomes extremely relevant in SADC; this will enhance the ability of industries and labour to adopt improved techniques or innovate more to boost productivity in the long-run. However, the factor accumulated channel indicators are insignificant. At the elementary level, skills and personality traits play a critical role in ensuring sustainable economic performance in the long-run. In this regard, SADC needs to shift attention in order to improve female education during the developmental years with the aim of promoting productivity through this channel in the middle age.

In addition, better management leadership skills focusing on promoting the optimum utilization of investment in female job training through effective investment in research and development in order to advance female employees' skills at work is essential. Finally, a framework should be developed to ascertain, from time to time, the marginal benefits of investment in female education compared to the marginal costs, both at the levels of the factor accumulation channel and the productivity channel. The economy is dynamic; therefore, identifying SADC female human capital formation needs to be done on a periodic basis; this should include a change in the structure of government expenditure on female education to meet the desired needs of the economy. One way to achieve this is by establishing or introducing a workforce development strategy that focuses on the human capital challenges of women in the SADC.

The main aim of this work is to give new insights into the assessment of productivity channels of human capital in the Southern African Development Community from the perspective of women's empowerment. To a large extent the study focused on the macroeconomic indicators and the formal sector, which are relevant in formulating policy to improve the aggregate welfare of women in the Southern African Development Community. Official statistics have shown that women participate in both the formal and informal sectors. To this end, we recommend that future studies should pay more attention to the informal section of women's empowerment in the Southern African Development Community.

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