FDI AND POVERTY REDUCTION IN BOTSWANA: A MULTIVARIATE CAUSALITY TEST

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Abstract

In this study, the causal relationship between foreign direct investment (FDI) inflows and poverty reduction is investigated in Botswana from 1980 to 2014. The study has used a trivariate causality model; and economic growth has been included as the intermittent variable between poverty reduction and foreign direct investment. In addition, three proxies of poverty have been used: 1) household consumption expenditure; 2) infant mortality rate; and 3) life expectancy. The study has used the autoregressive distributed lag (ARDL) bounds testing approach to cointegration and the ECM-based causality test to examine this linkage. The empirical results show that there is a distinct unidirectional causality from FDI to poverty reduction, but only in the short run, when household consumption expenditure is used as a proxy for poverty reduction. When infant mortality rate is used, the study finds bidirectional causality between FDI and poverty reduction – both in the short run and the long run. However, when life expectancy is used as a poverty reduction proxy, no causal relationship is found to exist, irrespective of the time considered. Based on the results from this study, it can be concluded that the causal relationship between poverty reduction and FDI is sensitive to the proxy used to measure the level of poverty reduction and to the time-frame considered.

Key Words: Botswana; Household consumption expenditure; Life expectancy; infant mortality rate; Granger-causality

JEL Classification: F21; I32.

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1. Introduction

The causal relationship between poverty reduction and FDI has received little coverage in the literature. The majority of studies have mainly dwelt on the dynamic impact of FDI on poverty reduction, and only a few studies have taken the analysis further in order to establish a causal relationship between the two. Further, some of the studies have used cross-sectional data to investigate the causal relationship between FDI and poverty reduction, an approach that has known limitations. In addition, the few studies that have attempted to establish causality between FDI and poverty reduction have used a bivariate framework, although this is now known to suffer from limitations (see Solarin and Shahzab, 2013). To address some of the limitations of these studies, the causal relationship between FDI and poverty reduction is investigated in a trivariate framework, and gross domestic product (GDP) has been selected as an intermittent variable. The inclusion of a third intermittent variable can alter the direction of causality and the magnitude of the results (Loizides and Vamvoukas, 2005; Odhiambo, 2009b).

The few studies that have analysed the causal relationship between FDI and poverty reduction have found mixed results. Some studies have found unidirectional causality between FDI and poverty reduction (see Gohou and Soumare, 2012). Other studies have found a bidirectional causal relationship between the two variables (see, for example, Soumare, 2015). There are yet further studies that have found no causality between FDI and poverty reduction (see Ogunniyi and Igberi, 2014). The results from studies that have investigated the causal relationship between FDI and poverty reduction have varied depending on the poverty proxy used, sample period, and methodology employed, making generalisation of the findings across all countries inappropriate.
The current study aims to establish the causal relationship between FDI and poverty reduction in Botswana between 1980 and 2014 using the Granger-causality test. The study differs from other studies in several ways. First, the ARDL bounds testing approach to cointegration that has been used in this study has a number of advantages. For instance, the ARDL bounds approach to cointegration is robust in small samples (see Odhiambo, 2008; Solarin and Shahbaz, 2013). Second, the study analyses the causal relationship between FDI and poverty reduction in a trivariate framework. This overcomes the limitations of a bivariate framework that has been employed in some studies with omission-of-variable-bias (see Solarin and Shahzab, 2013). Third, the study investigates the causal relationship between FDI and poverty reduction using three poverty reduction proxies: household consumption expenditure (Pov1), infant mortality rate (Pov2), and life expectancy (Pov3). Unlike previous studies that have relied on one poverty reduction proxy, the inclusion of three poverty reduction measures gives another angle on the causal relationship between FDI and poverty reduction.

Botswana was among the nations that signed the United Nations’s Millennium Development Goals (MDGs) declaration in 2000 and the Sustainable Development Goals 2030 in 2015 (United Nations, 2000; United Nations, 2017). Apart from international collaboration, Botswana has also implemented poverty reduction policies through the National Development Plans and Vision 2016. The National Development Plan 10 aims to accelerate the achievement of Vision 2016, a long-term vision for Botswana, which was initiated in 1996. Pillar 3, which focuses on building a compassionate, just, and caring nation has included poverty reduction, and increased access to health, education, and employment among other important poverty alleviation initiatives. The National Strategy for Poverty Reduction, launched in 2003, has taken initiatives to broaden and
deepen programmes aimed at poverty alleviation. Government strategy on poverty reduction can be viewed as a three-pronged approach: (i) stimulating economic growth, economic diversification, employment creation, and income generation capacity and empowered as ways of drawing the poor from poverty trap; (ii) development of infrastructure to increase government capacity in service provision; and (iii) provision of social safety nets to capture those without access to economic development opportunities. There has been a positive response to poverty reduction policies, as shown by a reduction in poverty from 30.6% in 2002/3 to 19.6% in 2009/10 (Statistics Botswana, 2013). Although a reduction in poverty was registered over this period, variations in poverty levels across sex and household head and at district level were noted (Statistics Botswana, 2013).

Government has also implemented policies in support of investment from both domestic and foreign sources, and the policies have been enshrined in the National Development Plans (NDP). Government policy on FDI is enshrined in Pillar 2 in the NDP 10 that strives to build a prosperous, productive and innovative nation. The Ministry of Trade and Industry (MTI) spearhead internal and external mobilisation of funds for economic growth, among other key economic roles. Government policies focused on attracting FDI included exchange control reforms, building a stable and sound macroeconomic environment, regulatory reforms, trade agreements, regional integration, investment incentives and building of special economic zones, among other policy initiatives aimed at building an environment conducive to investment. The government has also made a concerted effort to channel diamond proceeds towards building and stimulating economic development, which is important for investment. Botswana received modest FDI inflows from
1980 to 2000, with an average of 2.5%, and a gradual increase was recorded from 2000 to 2014, with an average of 4.5% -- although characterized by huge fluctuations.

This study investigates the causal relationship between FDI and poverty reduction in Botswana because it is an African country with a low population and it receives a fair share of FDI inflows among other African countries (Organisation of Economic Cooperation and Development (OECD), 2014; World Bank, 2016). An investigation of the causal relationship prevailing in Botswana will assist policy makers in making informed decisions on which economic variable to target in order to achieve a reduction in poverty. To our knowledge, this may be the first study of its kind to examine in detail the causal relationship between FDI and poverty reduction using modern time-series techniques.

The rest of the paper is divided as follows: Section 2 provides a brief review of literature; Section 3 outlines estimation techniques, covering variable definition, specification of the models and data sources; Section 4 discusses the results of the study; and Section 5 concludes the study.

2. Empirical Literature Review

The literature on the causal relationship between FDI and poverty reduction is still scant. Further, the results of the few studies that have attempted to analyse this relationship are inconclusive. Some studies have found unidirectional causality between FDI and poverty reduction; other studies have found bidirectional causality between these variables; while another set of studies have found no causal relationship between FDI and poverty reduction. The causal relationship between these variables varies depending on the domain, poverty measure, and sample period. Lack of
consistency in the results makes generalisation of the causality results from one study to another unsuitable.

Gohou and Soumare (2012) investigated the causality between FDI and poverty in five regional economic communities and five customs and monetary unions in Africa. Using the Human Development Index (HDI) as a measure of welfare, a unidirectional causal relationship was found running from FDI to HDI. Fauzel et al. (2015) carried out a causality study on selected African countries and, employing Granger-causality analysis, found unidirectional causality running from FDI to poverty reduction. In a separate study, Soumare (2015) studied the causal relationship between FDI and poverty in North Africa between 1990 and 2011. Using the Granger-causality test, unidirectional causality was found running from FDI to HDI in Egypt, Morocco, Tunisia, and Mauritania.

Besides studies that have found unidirectional causality, other studies have found a bidirectional causal relationship between FDI and poverty reduction. Gohou and Soumare (2012) investigated the causal relationship between FDI and poverty in five regional economic communities and five customs and monetary unions in Africa from 1990 to 2007. In their study, GDP per capita was used as a poverty proxy and the Granger-causality test was employed. A bidirectional relationship between GDP per capita and FDI was found in the whole region. In a study on North African countries from 1990 to 2011, Soumare (2015) employed the Granger-causality test and found bidirectional causality between FDI and HDI in Algeria. In the same study, when real per capita GDP was used as poverty proxy, bidirectional causality was found in all countries with the exception of Libya.
Conversely, other studies have found no causal relationship between FDI and poverty reduction. Ogunniyi and Igberi (2014) investigated the causal relationship between FDI and standard of living in Nigeria between 1980 and 2012. Using per capita income as a standard of living proxy and employing the Granger causality test, they found no causality between FDI and poverty. Thus, empirical findings on the causal relationship between FDI and poverty are inconclusive.

3. Estimation Techniques

In this study, the autoregressive distributed lag (ARDL) bounds test to cointegration and ECM-based causality testing were employed. The tests were selected because of numerous advantages. The ARDL approach to cointegration is robust in small samples (see Odhiambo, 2009a; Solarin and Shahbaz, 2013). While other conventional approaches to cointegration have a restrictive assumption on the order of integration of variables, the ARDL-bounds test can be used even when series have a different order of integration (Pesaran et al., 2001: 290; Solarin and Shahbaz, 2013). Another advantage of using the ARDL approach to cointegration is that it provides unbiased estimates of the long-run model, even in cases where some variables are endogenous (see Odhiambo, 2009a). The ARDL approach also uses a reduced form single equation, while other conventional cointegration methods employ a system of equations (Pesaran and Shin, 1999). Given these advantages, the study uses the ADRL-bounds testing approach to cointegration. To determine cointegration, the null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration. The calculated F-statistic is compared to the critical values provided by Pesaran et al. (2001). If the calculated F-statistic falls above the critical value, the null
hypothesis of no cointegration is rejected. Alternatively, if the F-statistic falls below the lower bound, we conclude that there is no cointegration. However, if the F-statistic falls between the upper and the lower bound, the results are inconclusive.

After confirming the existence of a long-run relationship, the next step is to establish the direction of causality. The presence of cointegration only indicates the presence of a long-run relationship and the existence of causality at least in one direction (Narayan and Smyth, 2004). The causal relationship between poverty reduction and FDI is investigated using the ECM-based approach in a trivariate framework. The intermittent variable that has been selected in this study is gross domestic product (GDP). This provides a trivariate causality framework consisting of poverty reduction, FDI, and GDP. This approach addresses the weakness of a bivariate framework wherein the results may suffer from omission-of-variables-bias (among others, see Odhiambo, 2008).

A number of poverty reduction proxies have been used in the literature, including household consumption expenditure, GDP per capita, and poverty indices, among other poverty reduction proxies. Due to limited time-series data and the need to capture the multidimensional aspects of poverty reduction, household consumption expenditure (Pov1), infant mortality rate (Pov3), and life expectancy (Pov3) were employed. Model 1a investigates the causality between FDI and household consumption expenditure (Pov1), Model 1b investigates the causality between FDI and poverty reduction proxied by infant mortality rate, and Model 1c analyses the causality between FDI and poverty reduction proxied by life expectancy (Pov3).

### 3.1 Cointegration
Following Narayan and Smyth (2008) and Odhiambo (2008), the ARDL-bounds specification for Models 1a-c is presented in Equations 1-9.

**ARDL Model Specification for Model 1a (Pov1, FDI, and GDP)**

\[
\Delta Pov1_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov1_{t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \beta_1 Pov1_{t-1} + \beta_2 FDI_{t-1} + \beta_3 GDP_{t-1} + \mu_{1t} \tag{1}
\]

\[
\Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov1_{t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \beta_1 Pov1_{t-1} + \beta_2 FDI_{t-1} + \beta_3 GDP_{t-1} + \mu_{1t} \tag{2}
\]

\[
\Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov1_{t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \beta_1 Pov1_{t-1} + \beta_2 FDI_{t-1} + \beta_3 GDP_{t-1} + \mu_{1t} \tag{3}
\]

*Where* \( \alpha_0 \) *is a constant, \( \alpha_1 - \alpha_3 \) and \( \theta_1 - \theta_3 \) *are regression coefficients, and \( \mu_{1t} \) is an error term.*

**ARDL Model Specification for Model 1b (Pov2, FDI, GDP)**

\[
\Delta Pov2_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov2_{t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov2_{t-1} + \theta_2 FDI_{t-1} + \mu_{2t} \tag{4}
\]

\[
\Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov2_{t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov2_{t-1} + \theta_2 FDI_{t-1} + \mu_{2t} \tag{5}
\]
\[
\Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{2t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov2_{t-1} + \theta_2 FDI_{t-1} + \theta_3 GDP_{t-1} + \mu_{2t} \] 
\[
+ \theta_2 FDI_{t-1} + \theta_3 GDP_{t-1} + \mu_{3t} \] 
\[
(6) 
\]

Where \(\alpha_0\) is a constant, \(\alpha_1 - \alpha_3\) and \(\theta_1 - \theta_3\) are regression coefficients, and \(\mu_{2t}\) is an error term.

\[
\Delta Pov_{3t} = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{3t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov3_{t-1} + \theta_2 FDI_{t-1} + \theta_3 GDP_{t-1} + \mu_{3t} \] 
\[
(7) 
\]

\[
\Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{3t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov3_{t-1} + \theta_2 FDI_{t-1} + \theta_3 GDP_{t-1} + \mu_{3t} \] 
\[
(8) 
\]

\[
\Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{3t-i} + \sum_{t=0}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=0}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 Pov3_{t-1} + \theta_2 FDI_{t-1} + \theta_3 GDP_{t-1} + \mu_{3t} \] 
\[
(9) 
\]

Where \(\alpha_0\) is a constant, \(\alpha_1 - \alpha_3\) and \(\theta_1 - \theta_3\) are regression coefficients, and \(\mu_{3t}\) is an error term.

### 3.2 A Granger-Causality Model Specification

The ECM-based Granger-causality models are specified for Models 1a-c. The introduction of the lagged error correction term reintroduces the long-run relationship that could have been lost with differencing (see Odhiambo, 2009a) The ECM-based causality test also enables analysis of
causality in both the short and long run. The F-statistics obtained from the variable deletion test or the Wald-test give the short-run causality, while the long-run causality is given by the t-statistic on the lagged error correction term.

**ECM-based Granger-causality for Model 1a (Pov1, FDI, GDP)**

The ARDL Granger-causality model specification for Model 1c is given in Equations 10-12.

\[
Pov_{1t} = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{1t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 ECM_{t-1} + \mu_{1t} \]

\[
\Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{1t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_2 ECM_{t-1} + \mu_{2t} \]

\[
\Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{1t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_3 ECM_{t-1} + \mu_{3t} \]

Where \( \alpha_0 \) is a constant, \( \alpha_1 - \alpha_3 \) and \( \theta_1 - \theta_3 \) are regression coefficients, and \( \mu_{1t} - \mu_{3t} \) are the error terms.

**ECM-based Granger-causality for Model 1b (Pov2, FDI, GDP)**

The ARDL Granger-causality model specification for Model 1b is given in Equations 13-15.

\[
\Delta Pov_{2t} = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{2t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 ECM_{t-1} + \mu_{1t} \]

\[
\Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{2t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_2 ECM_{t-1} + \mu_{2t} \]

\[
\Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov_{2t-i} + \sum_{i=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_3 ECM_{t-1} + \mu_{3t} \]
\[ \Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov2_{t-i} + \sum_{t=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_2 ECM_{t-1} + \mu_{2t} \] ... (14) 

\[ \Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov2_{t-i} + \sum_{t=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_3 ECM_{t-1} + \mu_{3t} \] ... (15)

Where \( \alpha_0 \) is a constant, \( \alpha_1 - \alpha_3 \) and \( \theta_1 - \theta_3 \) are regression coefficients, and \( \mu_{1t} - \mu_{3t} \) are the error terms.

ECM-based Granger-causality for Model 1c (Pov3, FDI, GDP)

The ARDL Granger-causality model specification for Model 1c is given in Equations 16-18.

\[ \Delta Pov3_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov3_{t-i} + \sum_{t=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_1 ECM_{t-1} + \mu_{1t} \] ... (16)

\[ \Delta FDI_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov3_{t-i} + \sum_{t=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_2 ECM_{t-1} + \mu_{2t} \] ... (17)

\[ \Delta GDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta Pov3_{t-i} + \sum_{t=1}^{n} \alpha_2 \Delta FDI_{t-i} + \sum_{t=1}^{n} \alpha_3 \Delta GDP_{t-i} + \theta_3 ECM_{t-1} + \mu_{3t} \] ... (18)

Where \( \alpha_0 \) is a constant, \( \alpha_1 - \alpha_3 \) and \( \theta_1 - \theta_3 \) are regression coefficients, and \( \mu_{1t} - \mu_{3t} \) are the error terms.
Data Sources

The study used time series data from 1980 to 2014 to investigate the dynamic causal relationship between poverty reduction and FDI. The data employed in this study was obtained from the World Bank development indicators. The data was analysed using Microfit 5.0.

4. Empirical Analysis

The Unit Root Tests

The ARDL approach to cointegration does not require pretesting of variables for stationarity. In this study, unit root tests were carried out on Pov1, Pov2, Pov3, FDI, and GDP to confirm if the variables were integrated of at most order 1 [I (1)]. The ARDL approach is only applicable if variables are integrated of order 0 [I (0)], order [I (1)], or fractionally integrated (Pesaran et al., 2001). The results of Dickey-Fuller generalised least squares (DF-GLS), Phillip-Perron (PP root) and Perron unit root tests (PPU root test) are presented in Table 1.
Table 1: Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF-GLS Test</th>
<th>PP Test</th>
<th>PPU(root) Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stationarity of Variable in Levels</td>
<td>Stationarity of Variable in First Difference</td>
<td>Stationarity of Variable in Levels</td>
</tr>
</tbody>
</table>

Note: *, ** and *** denote stationarity at 10%, 5% and 1% significance levels, respectively.
The variables are stationary in levels and in first difference, with a variation from one unit root test to the other. Unit root test results presented in Table 1 confirm that all the variables are integrated of at most one [I (1)]. Therefore, the ARDL approach to cointegration and causality analysis can be employed in this study.

*Bounds Testing Approach to Cointegration*

The cointegration results are presented in Table 2.

**Table 2: Bounds F-test for Cointegration: Model 1a-c**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Function</th>
<th>F-Statistic</th>
<th>Cointegration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Model 1a</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pov1</td>
<td>F(Pov1</td>
<td>FDI, GDP)</td>
<td>1.331</td>
</tr>
<tr>
<td>FDI</td>
<td>F(FDI</td>
<td>Pov1,GDP)</td>
<td>4.186*</td>
</tr>
<tr>
<td>GDP</td>
<td>F(GDP</td>
<td>Pov1, FDI)</td>
<td>1.773</td>
</tr>
<tr>
<td><strong>Panel B: Model 1b</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pov2</td>
<td>F(Pov2</td>
<td>FDI, GDP)</td>
<td>4.5696*</td>
</tr>
<tr>
<td>FDI</td>
<td>F(FDI</td>
<td>Pov2,GDP)</td>
<td>4.6656*</td>
</tr>
<tr>
<td>GDP</td>
<td>F(GDP</td>
<td>Pov2, FDI)</td>
<td>1.7665</td>
</tr>
<tr>
<td><strong>Panel C: Model 1c</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pov3</td>
<td>F(Pov3</td>
<td>FDI, GDP)</td>
<td>1.981</td>
</tr>
<tr>
<td>FDI</td>
<td>F(FDI</td>
<td>Pov3,GDP)</td>
<td>4.618**</td>
</tr>
<tr>
<td>GDP</td>
<td>F(GDP</td>
<td>Pov3, FDI)</td>
<td>1.321</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Asymptotic Critical Values (unrestricted intercept and no trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesaran et al. (2001:300) critical values (Table CI(iii), Case III)</td>
</tr>
<tr>
<td>I(0)</td>
</tr>
<tr>
<td>5.15</td>
</tr>
</tbody>
</table>

*Note:* *, ** and *** denote stationarity at 10%, 5% and 1% significance levels respectively.
The results in Table 2 confirm cointegration between poverty reduction proxies (i.e. Pov1, Pov2 and Pov3), FDI, and GDP, although the results are sensitive to the poverty reduction proxy used. The F-statistics confirm the existence of cointegration between poverty reduction proxies (Pov1, Pov2 and Pov3), FDI, and GDP. The presence of cointegration in any one of the equations in Model 1a, Model 1b, and Model 1c indicates the presence of causality in at least one direction (see Granger, 1988; Narayan and Smyth, 2008). The direction of causality is obtained by running an ECM-based Granger-causality test.

**ECM-Based Causality Testing**

After establishing the existence of cointegration between poverty reduction – Pov1, Pov2, Pov3 – FDI, and GDP, an ECM was included as an additional variable in the Granger-causality analysis for those equations where cointegration was confirmed. For those equations where no cointegration was confirmed, Granger-causality was performed on the variables without an ECM. From the cointegration result presented in Table 2, ECM was developed for the following equations: F (FDI|Pov1, GDP), F (Pov2|FDI, GDP), F (FDI|Pov2, GDP) and F (FDI|Pov3, GDP). Short-run causality was determined by the F-statistics on the explanatory variables given by the variables deletion test, and the long-run causality was determined by the significance of the lagged error correction term using the t-statistic (see Narayan and Smyth, 2008; Odhiambo, 2009a). The results of the ECM-based causality test are reported in Table 3.
Table 3: ECM-Based Causality Results

<table>
<thead>
<tr>
<th>Panel A: Model 1a</th>
<th>Dependent Variable</th>
<th>F-Statistics</th>
<th>ECM t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔPov2</td>
<td>ΔFDI</td>
<td>ΔGDP</td>
</tr>
<tr>
<td>ΔPov1</td>
<td>-</td>
<td>3.258**</td>
<td>9.211***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.083]</td>
<td>[0.006]</td>
</tr>
<tr>
<td>ΔFDI</td>
<td>0.006</td>
<td>-</td>
<td>9.386***</td>
</tr>
<tr>
<td></td>
<td>[0.938]</td>
<td></td>
<td>[0.005]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2.724]</td>
</tr>
<tr>
<td>ΔGDP</td>
<td>0.153</td>
<td>3.046**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>[0.699]</td>
<td>[0.093]</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Panel B: Model 1b</th>
<th>Dependent Variable</th>
<th>F-Statistics</th>
<th>ECM t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔPov2</td>
<td>ΔFDI</td>
<td>ΔGDP</td>
</tr>
<tr>
<td>ΔPov2</td>
<td>-</td>
<td>3.257**</td>
<td>1.0794</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.082]</td>
<td>[0.380]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[-1.849]</td>
</tr>
<tr>
<td>ΔFDI</td>
<td>8.606*</td>
<td>-</td>
<td>1.266</td>
</tr>
<tr>
<td></td>
<td>[0.007]</td>
<td></td>
<td>[0.270]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[-3.733]</td>
</tr>
<tr>
<td>ΔGDP</td>
<td>3.594*</td>
<td>1.6950</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>[0.038]</td>
<td>[0.204]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Model 1c</th>
<th>Dependent Variable</th>
<th>F-Statistics</th>
<th>ECM t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔPov3</td>
<td>ΔFDI</td>
<td>ΔGDP</td>
</tr>
<tr>
<td>ΔPov3</td>
<td>-</td>
<td>0.079</td>
<td>0.138</td>
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<tr>
<td></td>
<td></td>
<td>[0.781]</td>
<td>[0.714]</td>
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<tr>
<td>ΔFDI</td>
<td>0.296</td>
<td>-</td>
<td>7.058*</td>
</tr>
<tr>
<td></td>
<td>[0.591]</td>
<td></td>
<td>[0.013]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[-4.072]</td>
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<tr>
<td>ΔGDP</td>
<td>0.030</td>
<td>0.077</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>[0.865]</td>
<td>[0.784]</td>
<td></td>
</tr>
</tbody>
</table>

Note: *, ** and *** denote stationarity at 10%, 5% and 1% significance levels, respectively.
The results in Table 3, Panel A for Model 1a reveal that FDI Granger-causes poverty reduction in the short run. This is confirmed by a statistically significant F-statistic for ΔFDI in the Pov1 function. The results imply that FDI Granger-causes poverty reduction in the short run in Botswana. The results compare favourably with findings from other studies (see, for example, Fauzel et al., 2015; Soumare, 2015). However, no long-run causality is confirmed between FDI and poverty reduction (Pov1). When poverty reduction is measured by infant mortality rate (Pov2), bidirectional causality in both the long run and the short run is recorded between FDI and poverty reduction. The short-run Granger-causality is confirmed by statistically significant F-statistics for ΔFDI in the Pov2 function and a significant F-statistic for ΔPov2 in the FDI function. Long-run causality is confirmed by the error correction term in the Pov2 and FDI functions. The findings from this study suggest that FDI and poverty reduction Granger-cause each other. The results are consistent with findings from other studies (see Soumare, 2015). Results in Panel C for Model 1c confirm that no causal relationship exists between poverty reduction (Pov3) and FDI. Although not anticipated, Gohou and Somaure (2012) and Oggunniyi and Igberi (2014) found the same results.

When household consumption expenditure (Pov1) is used as a poverty reduction measure, there is (i) unidirectional causality from GDP to poverty reduction (Pov1) in the short run; (ii) a distinct unidirectional causality from GDP to poverty reduction in the short run; and (iii) bidirectional causality between GDP and FDI in the short run and unidirectional causality from GDP to FDI in the long run. When infant mortality rate (Pov2) is used as a poverty measure, there is (i) a distinct unidirectional causality from poverty reduction (Pov2) to GDP in the short run; and (ii) no causality between FDI and GDP in both the short run and the long run. Finally, when Pov3 (life
expectancy) is used as a poverty reduction proxy, there is (i) no causality between poverty reduction and GDP; and (ii) distinct unidirectional causality from GDP to FDI in both the short run and the long run. A summary of the Granger-causality results is given in Table 4.

<table>
<thead>
<tr>
<th>Model 1a (Pov1)</th>
<th>Causality</th>
<th>Long run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FDI → Pov1</td>
<td>No causality</td>
</tr>
<tr>
<td>Model 1b (Pov2)</td>
<td>Pov2 ↔ FDI</td>
<td>Pov2 ↔ FDI</td>
</tr>
<tr>
<td>Model 1c (Pov3)</td>
<td>No causality</td>
<td>No causality</td>
</tr>
</tbody>
</table>

Table 4: Summary of Causality Results

Notes: Pov1 = household consumption expenditure; Pov2 = infant mortality rate; Pov3 = life expectancy

5. Conclusion
This study investigated the causal relationship between poverty reduction and FDI in Botswana using data from 1980 to 2014. Gross domestic product was included as a third variable in a trivariate Granger-causality test. The intermittent variable was used to overcome the limitation of bivariate causality tests, whose results have been found to be weak due to the possibility of omission-of-variable bias. The study employed the autoregressive distributed lag (ARDL) bounds testing approach to cointegration and the ECM-based causality test to examine this linkage. The study used three poverty reduction proxies, namely, household consumption expenditure (Pov1), infant mortality rate (Pov2), and life expectancy (Pov3). When household consumption expenditure was used as a poverty reduction proxy, unidirectional causality from FDI to poverty reduction was confirmed in the short run but not in the long run. When infant mortality rate was used as a proxy, bidirectional causality was found to prevail both in the long run and in the short run. However, no causality was confirmed between FDI and poverty reduction when life
expectancy was used as a proxy for poverty reduction. This applied irrespective of whether the causality was estimated in the short run or in the long run. Other results revealed that i) there is short-run unidirectional causal flow from economic growth to poverty reduction when household consumption expenditure is used as a proxy for poverty reduction; ii) bi-directional causality between economic growth and FDI exists in the short run, and a unidirectional causal flow from economic growth to FDI exists in the long run when household consumption expenditure (Pov1) is used as a poverty reduction proxy; iii) there is a short-run unidirectional causality from poverty reduction to economic growth when infant mortality rate (Pov2) is used as a poverty reduction proxy; and iv) there is no causality between FDI and economic growth in the short run and the long run when infant mortality rate is used as a poverty reduction proxy; and v) there is a unidirectional causal flow from economic growth to FDI – both short-run and long-run – when life expectancy (Pov3) is used as a proxy for poverty reduction; and iv) no causality exists between economic growth and poverty reduction when the same proxy was used. Based on the findings from this study, it can be concluded that the causal relationship between FDI and poverty reduction is sensitive to the proxy used to measure the level of poverty reduction and to the time considered.

References


