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Effects of economic growth, foreign direct investment and internet use on child health outcomes: empirical evidence from South Africa

Mohammad Salahuddin[a,b,c], Nick Vink[d], Nicholas Ralph[b] and Jeff Gow[b,d]

[a]Trent University, Peterborough, Canada; [b]University of Southern Queensland, Toowoomba, Australia; [c]George Brown College, Toronto, Canada; [d]Stellenbosch University, Stellenbosch, South Africa

ABSTRACT

This study examines the effects of economic growth and foreign direct investment (FDI) on child health outcomes measured by Infant Mortality Rate (IMR) and Child Mortality Rate Under 5 (CMRU5) with several control variables such as corruption, inequality and HIV among others. It analyzes South Africa's annual time series data for the period 1985–2016. As variables were found with mixed order of integration, Autoregressive Distributed Lag (ARDL) model is applied to determine cointegration and estimate short-run and long-run coefficients.

Results indicate that economic growth and FDI have negative significant effects on both indicators of child health outcomes in both the short run and the long run. This implies that both economic growth and FDI contribute towards reducing IMR and CMRU5 in South Africa and thus help improve child health outcomes. Toda and Yamamoto (TY) causality test confirms causal association between these variables. Policy implications are discussed.

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ARDL; IMR; CMRU5; economic growth; FDI; South Africa

1. Introduction

There is a long-standing debate on the association between the macroeconomic performance and child health outcomes of a country. A predominant view that 'wealthier is happier' came from a seminal publication in the area (Pritchett and Summers 1996) who argued strongly that economic prosperity is good for health as a result of economic growth improving the living conditions of people of a country. This is likely to improve the overall health system also. This makes child health care more accessible and more affordable for people. However, some scholars (e.g. Cole 2019) contend that the benefits of economic growth on health outcomes are grossly exaggerated and they may be trivial, fluctuating or even adverse.

Another potential macroeconomic determinant of child health outcomes is foreign direct investment (FDI). FDI may have positive or negative effect on health outcomes of a nation. It is generally believed to boost economic growth through technology spill-overs, skill transfer, knowledge externalities, local employment generation and through other channels. Also FDI may potentially lead to increase in wages and better working conditions in low- and middle-income countries (Burns et al. 2017; Blouin, Chopra, and van der Hoeven 2009). However, there is some empirical evidence (e.g. Jorgenson 2009a, 2009b) that show a negative association between FDI and health outcomes. Findings from these studies indicate that FDI is responsible for detrimental effects such as increased levels of pollution, higher consumption of tobacco and unhealthy foods. Results from these studies (Jorgenson 2009a; 2009b) indicate that FDI stimulates pollution and causes health hazards leading to increased infant and child mortality. FDI may even have no effect on infant and child mortality (Burns et al. 2017). Therefore it is evident that the relation between FDI and health outcomes is ex-ante ambiguous.

The infant mortality rate (IMR) is a key measure of health outcomes (Burns et al. 2017; Bokhari, Gai, and Gottret 2007; Anyanwu and Erhijakpor 2009). It is considered the single most exhaustive indicator of health in a society (Jiménez-Rubio 2011). It reflects children's health and pregnant women's health, in addition to the overall development of the health sector of a country. The child mortality rate under 5 (CMRU5) is also used as an alternative indicator of health outcomes (Burns et al. 2017).

South Africa is an upper middle-income country but has a poorly functioning health system characterized by systemic failures in the public sector which services about 85% of the population and a fully functioning private sector that is only available to about 15% of the population due to its high cost (van den Heever 2016).

CONTACT Jeff Gow gowj@usq.edu.au

The country has poor health outcomes compared to its level of economic development. Its high mortality levels have resulted from a unique disease burden, first described in the First National Burden of Disease study in 2000, of epidemics of HIV/AIDS, TB and Malaria. It has a relatively high child mortality rate: IMR was 44.6 in 1990 and increased to 49.3 in 2004 before falling to 34.2 by 2016 (United Nations Inter-agency Group for Child Mortality Estimation 2017). The primary reason for the increase in IMR was the uncontained HIV/AIDS epidemic which saw the HIV prevalence increase dramatically from 2% in the early 1990s to over 25% in the early 2000s before the introduction of and wide availability of anti-retroviral drug treatment (ARVs) (Gow and Desmond 2007).

Pillay-van Wyk et al. (2016) attributed the poor health status to the country's history of colonialism and apartheid, which was reflected negatively in almost every aspect of life ranging from racial segregation, exploitation of the working class and high levels of poverty. In 2013, 45% of the population were below the national poverty line (Statistics South Africa 2014a) and the adult unemployment rate was 35% (Statistics South Africa 2014b) and income inequality is extreme as evidenced by its very high 2013 Gini coefficient of 0.625 which is the second highest in the world (World Bank 2018).

Economic growth in the post-apartheid era since 1994 has been higher and more stable than before, despite the dismal development data on poverty, unemployment and income inequality (Oosthuizen 2016; Salahuddin and Gow 2016). This growth has allowed South Africa to increase health expenditures with a view to reducing the wide racial disparities in health care access. Through the implementation of better sanitation and infrastructure in poorer areas, free medical care for pregnant women and young children and providing fourth-generation vaccinations, South Africa has made considerable progress with respect to reducing the prevalence of many of the major risk health factors (Blecher et al. 2012). Although its IMR is still high especially compared to many low- and middle-income countries as data from the Eastern and Sothern Africa region attests where IMR was 101 in 1990 before falling to 46.9 by 2004 and to 43.1 in 2016 (United Nations Inter-agency Group for Child Mortality Estimation 2017).

FDI inflows as a percentage of GDP using 5-year averages since 1994 has never surpassed 2% (South African Treasury 2017). Between 2009 and 2013, FDI inflows to GDP fluctuated between 1.0% and 2.6% (Wocke and Sing 2013) and it has one of the lowest contributions of FDI to GDP when compared to similar countries like Chile (7.0%) and Malaysia (4.3%) (Wocke and Sing 2013).

The main objective of this study is to empirically gauge the effects of economic growth and FDI on child health outcomes as proxied by the IMR and the CMRU5 for South Africa. Although the effects of economic growth and FDI on health outcomes have been widely studied in different contexts, such an empirical exercise is absent for South Africa. It is one of the few countries ranked as a middle-income country in Southern Africa and it will be quite interesting to assess the role played by economic growth and FDI on its health outcomes.

The rest of the paper is structured as follows. Section 2 examines the literature. Section 3 outlines the methodology and data. Section 4 showcases the results and a detailed discussion of the findings occurs in Section 5 as are policy implications. Conclusions are made in Section 6.

2. Literature review

2.1 Infant mortality, child mortality and economic growth

The effects of economic growth and its absence (recession) on mortality have been widely studied in different contexts. In developed countries, most studies find that economic recessions are associated with reduced mortality [Dehejia and Lleras-Muney 2004; Miller et al. 2009; Stevens, Miller, and Page 2015; Ruhm 2015, on the United States (US); Tapia-Granados 2005; Gerdtham and Ruhm 2006, on Europe]. However, studies on less developed countries show opposite findings. Recent empirical evidence also suggests that such straight linear association may not always apply in less developed countries.

Gonzalez and Quast (2010) compared Mexican states with differential levels of development and showed that mortality rates during economic contractions tend to decrease in more developed states and to increase in less developed states. A large volume of literature on the effects of economic fluctuations on health outcomes measured by IMR have evolved recently (a comprehensive review is in Ferreira and Schady 2009). The empirical findings are mixed.

There are also country-specific studies that focus on the impacts of economic recessions on child mortality and morbidity in middle- and low-income countries (Cutler et al. 2002 on Mexico; Costa et al. 2003 on Brazil; Paxson and Schady 2005; Aguero and Valdivia 2010 on Peru; Miller and Urdinola 2010 on Columbia). Cutler et al. (2002) found an increase of 0.06% in IMR during the 1995/1996 economic crisis in Mexico. Likewise, the recession that occurred in Peru at the end of the 1980s led to a rise in the IMR (Paxson and Schady 2005).

Aguero and Valdivia (2010) suggest that a reduction of 1% in GDP per capita is associated with an increase in the rate of infant mortality ranging from 0.3 to 0.39% in Peru during the same period. This finding was in contrast with another study that provided evidence in support of the hypothesis that economic recessions reduced IMR in Brazil (Costa et al. 2003), as well as in Columbia, where infant and child survival actually improved during an economic recession (Miller and Urdinola 2010). Fernandez and Lopez-Calva (2010) focused on five middle-income South and Central American countries: Argentina, Brazil, Jamaica, Mexico and Peru. They applied a difference–indifference approach, fixed effects models and instrumental variables, depending on each country's past economic crises. They observed that economic downturns are related to increases in child mortality.

Only a couple of studies to date focused on African countries (Hoddinott and Kinsey 2001 on Zimbabwe; Yamano, Alderman, and Christiansen 2005 on Ethiopia). Some other studies focused on Asian countries (Rukumnuaykit 2003; Block et al. 2004 on Indonesia; Lin 2006; on Taiwan and Bhalotra 2010 on India). Rukumnuaykit (2003) shows that the 1997 financial crisis in Indonesia had adverse impacts on IMR in both urban and rural areas. Bhalotra (2010) observes that state-level income and infant mortality are negatively correlated in rural Indian households. The study further argues that the income effect on infant mortality is stronger in relatively poorer states. Apart from these country-specific time-series studies, a few cross-sectional and panel data studies dealt with developing countries to investigate such association (Houweling et al. 2005; Fernandez and Lopez-Calva 2010; Schady and Smitz 2010; Anderson, Axelson, and Tan 2011; Baird, Friedman, and Schady 2011; Renton, Wall, and Lintott 2012).

Schady and Smitz (2010) used a sample of 17 diverse countries: 11 middle-income countries and 6 low-income countries, for the period 1977–2007. This study shows that in five countries of their sample, the average year on year decline in IMR is larger when growth is positive than when it is negative. This is not the case, however, for the other 12 countries, where IMR increased more during recessions than during expansions. It is only when shocks to GDP are large and sustained that they are consistently associated with higher IMR.

Anderson, Axelson, and Tan (2011) use descriptive analysis to assess how economic shocks affect the poor in Asian countries over the period 2000–2010. The analysis focused particularly on vulnerable children in 13 middle-income and 6 low-income countries. They argue that while there has been much progress in Asia, some very significant problems of infant mortality and morbidity remain. The inability to reduce these levels despite rapid economic growth in recent decades makes them exposed to slower progress during a future global recession.

Baird, Friedman, and Schady (2011) study the impact of short-term fluctuations in GDP per capita on IMR using a dataset of 36 middle-income countries and 23 low-income countries for the period 1975–2004 using fixed-effects models. They suggest that infants and especially girls have a higher mortality rate when there is a negative economic shock, especially when these shocks are severe. The main finding of their work is that there is a negative and robust relationship between GDP per capita and IMR. Renton, Wall, and Lintott (2012) point out that in the poorest countries economic growth may be regarded as essential for health improvements to be made. They analyzed the relationship between economic growth and some health indicators, including the IMR. They examined 63 middle-income countries and 39 low-income countries over the period 1970–2000 at 5-year intervals using a random-effects model.

Erdogan, Ener, and Arica (2013) empirically investigated the relationship between economic growth and IMR for the period 1970–2007 for a sample of 25 high-income OECD countries. The empirical evidence reveals that there is a significant and negative relationship between the IMR and real per capita GDP in some of the countries. It was concluded that the IMR of the countries decreased as countries GDP grew with more potential resources being available to address child health.

Cavalieri and Ferrante (2016) showed in an Italian study that a higher degree of fiscal autonomy of sub-national governments could improve health outcomes as measured by IMR and CMRU5. In Italy, responsibilities for healthcare have been decentralized to regions, though the central government still plays the key role in committing to providing all citizens with uniform health services throughout the country. A linear fixed-effects regression model was employed for a panel of 20 regions over the period 1996–2012. The findings suggest that a higher proportion of tax revenues raised and/or controlled locally as well as a lower transfer dependency on the central government, consistently reduced IMR. However, fiscal decentralization failed to reduce IMR for China (Brocka, Jinb, and Zenga 2015). Pérez-Moreno, Blanco-Arana, and Bárcena-Martín (2016) examine the effects of economic growth and recession periods on IMR in low-income countries during the period 1990–2010. The empirical evidence suggests that a decrease in GDP per capita causes a significant rise in IMR, whereas an increase in GDP does not affect IMR significantly.

2.2 Infant mortality, child mortality and FDI

FDI potentially generates more income through the creation of new employment opportunities in the host country. This is likely to increase demand for better and improved health services which would eventually stimulate higher private and public expenditures on better quality health services as well as increased demand for healthier food, clean water and education. In addition, through skill and technology transfer and knowledge spill over, the health sector of a country is likely to improve significantly.

FDI may also have negative effects on population health by encumbering income inequality. It may be responsible for increasing income disparity between skilled and unskilled workers in both developed and developing countries. In countries with FDI as a significant share of GDP, the skill premium is expected to increase in both the source and host countries (Feenstra and Hanson 1996a; 1996b). FDI may have even no effect on infant and child mortality of a country or region (Burns et al. 2017).

Taylor and Driffield (2005) argue that multinational companies are typically more competitive, more productive, very skill-intensive and enjoy more market power than their domestic counterparts. These firms engender a rise in the demand for highly skilled labor resulting in an upward pressure on local wages for skilled labor. Thus FDI may contribute towards increasing wage inequality in the host countries.

Two recent empirical studies (Herzer and Nunnenkamp 2012; Herzer, Hühne, and Nunnenkamp 2014) examine the effect of FDI on population health. Herzer and Nunnenkamp (2012) find that FDI is associated with lower life expectancy in the recipient country. However, this study is restricted to a small sample of just 14 highly developed host countries. The study concludes that FDI has a positive effect on health at low levels of income, but the effect decreases and even becomes negative at higher levels of income. In another study, the same authors (Herzer, Hühne, and Nunnenkamp 2014) examined the relationship between FDI and population health for a sample of 179 countries for the period 1980–2011. The study observes a non-linear effect of FDI on population health proxied by IMR. The effect of FDI on population health is positive at lower levels of per capita income, but it decreases with per capita income, then the effect is opposite, becoming increasingly negative at higher levels of income.

3. Methods

3.1 Data, outcome and predictor variables

Table 1 presents data sources along with the description of variables and summary statistics. Two health outcome variables: infant mortality rate which is defined as the number of deaths of children less than 1 year old, expressed per 1000 live births and child mortality rate under 5 (CMRU5) which is defined as the number of deaths of children less than 5 years old expressed per 1000 live births were used to investigate their relationship with economic growth and FDI. Economic growth is proxied by per capita GDP calculated at constant 2010 US$ while FDI is taken as FDI inflow as % share of GDP. Data for all these variables were sourced from World Development Indicators Data base of the World Bank (World Bank 2018).

3.2 Other covariates

A number of control variables were included in the estimable as these covariates were expected to influence

Table 1. Data sources and summary statistics.

Source	Definition	Variables	Obs.	Mean	Std. Dev.	Min.	Max.
WDI (2019)	Logarithm of mortality rate, infant (per 1000 live births)	lnIMR	33	3.83	0.18	3.40	4.15
WDI (2019)	Logarithm of mortality rate, under-5 (per 1000 live births)	lnCMRU5	33	4.16	0.22	3.65	4.44
WDI (2019)	Logarithm of GDP per capita (at 2010 US$)	lnGDPPC	33	8.31	0.38	7.65	8.99
WDI (2019)	FDI inflow (% of GDP)	FDI	33	1.00	1.33	−0.65	5.98
WDI (2019)	Logarithm of GINI (income inequality)	lnINIEQ	33	4.11	0.03	4.06	4.17
Freedom House (2019)	Institutional quality (civil liberty index)	INSTQ	33	2.97	1.53	2.00	6.00
Transparency International (2019)	Logarithm of corruption perception index	lnCOR	33	3.91	0.10	3.71	4.04
WDI (2019)	Prevalence of HIV, total (% of population aged 15-49)	HIV	33	10.67	7.39	0.60	18.90
The Quality of Government Institute (2019) & WDI (2019)	Public Health expenditure (% of GDP)	PHE	33	3.41	0.53	2.86	4.33
Global Rise of Education (2019)	National average of years spent in education	EDU	33	7.98	1.41	5.21	9.89
Global Rise of Education (2019)	Square of national average of years spent in education	SQEDU	33	65.62	21.53	27.14	97.81
WDI (2019)	Urban population (% of total)	lnURB	33	4.04	0.09	3.89	4.18
The Quality of Government Institute (2019) & WDI (2019)	Logarithm of Improved water source (% of population with access)	lnWAT	33	4.46	0.05	4.38	4.54
The Quality of Government Institute (2019) & WDI (2019)	Improved sanitation facilities (% of population with access)	lnSAN	33	4.05	0.10	3.91	4.21

Source: Own calculations.

FDI, economic growth as well as the outcome variables (IMR and CMRU5). In other words, these variables have a confounding effect on economic growth, FDI, IMR and CMRU5. These control variables are corruption (COR), income inequality (INIEQ), HIV prevalence (HIV), urbanization (URB), institutional quality (INSQ), education (EDU), public health expenditure (PHE), access to improved water (WAT) and access to improved sanitation (SAN).

Data on corruption is extracted from the most commonly used corruption perception index (CPI) constructed by Transparency International (2019). Data on income inequality which is literally taken to mean the difference in income distribution and demonstrated by Gini coefficient based on a cumulative frequency graph popularly known as Lorenz curve are obtained from WDI of the World Bank (World Bank 2018). The graph depicts the cumulative share of total income. It ranges from 0 to 1, meaning perfect equality and perfect inequality, respectively (Goldthorpe 2010; Leigh, Jencks, and Smeeding 2009). The variables of urbanization (measured by urban population as % total population), public health expenditure (measured by total public health expenditure as % of GDP), HIV prevalence (measured by % of total population aged 15–49 affected by HIV), improved water source (measured by % of population with access to improved water source) and improved sanitation (measured by % of population with access to improved sanitation) are also sourced from WDI (World Bank 2018). Institutional quality data proxied by civil liberty index are obtained from Freedom House (2019). Civil liberty index is considered as a good measure of institutional and governmental quality (Burns et al. 2017). Data on education (national average of years spent in education) measured by Barro and Lee (2013) and used by Burns et al. (2017) are available from Roser and Ortiz-Ospina (2019).

3.3 Expected association of covariates with the outcome and predictor variables

3.3.1 Corruption

Corruption is generally believed to undermine macroeconomic stability by generating uncertainty in an economy. It is likely to make the investment climate of a country vulnerable by destroying state institutions. Investors do not feel comfortable to pour money in an uncertain market. Thus corruption is widely regarded as an impediment towards economic growth and investment. Though not exhaustive, economists have detected three potential transmission channels through which corruption affects economic growth and investment.

First, it affects the accumulation of physical capital (Mauro 1995; Wei 2000). Second, corruption affects the motivation of investors by its negative impact of uncertainty on their expected returns. Thus both domestic investment and FDI are likely to be negatively affected. Third, corruption is likely to lead to underutilization and wastage of government resources through inefficient allocation of resources (d'Agostino, Dunne, and Pieroni 2016a, 2016b). By distorting public funds, corruption is likely to undermine the public health system of a country also. However, despite a negative notion about corruption towards economic growth and investment, health outcomes, empirical evidence on its role in an economy are inconclusive.

3.3.2 Income inequality

Income inequality is expected to have a negative effect on economic growth, FDI and the health outcomes of a country. High-income inequality is likely to be inversely associated with health outcomes (Detollenaere et al. 2018; Pickett and Wilkinson 2015).

Most of the empirical studies supported the hypothesis that greater differences in income are associated with lower standards of population health. Also, higher income inequality is associated with higher IMR (Siddiqi, Jones, and Erwin 2015).

The effect of income inequality on economic growth varies; it could be positive (e.g. Rubin and Segal 2015; Yang and Greaney 2017), negative (e.g. Majumdar and Partridge 2009; Nissim 2007) or even mixed (e.g. Huang et al. 2015). Barro (2000) found its negative growth effect for low-income countries while positive effect for high-income countries. Effect of income inequality on FDI is expected to be conditioned on its effect on economic growth and macroeconomic stability. Lack of income mobility from rising income inequality has significant implications for macroeconomic stability (Babu, Bhaskaran, and Venkatesh 2016). The level of inward FDI may vary depending on such macroeconomic conditions of an economy. Therefore, it is difficult to suggest *a priori the* sign of the effect of inequality on FDI.

3.3.3. Urbanization

Urbanization is a hallmark for economic growth and it facilitates better education, better transport and better health services especially for developing countries (Zheng and Walsh 2019). Thus urbanization is assumed to affect health outcomes of a country positively. It is also likely to attract FDI since, with increased urbanization, better infrastructure, and other facilities conducive for foreign investors become available. Urbanization may promote economic growth through increase in productivity also (Rosenthal and Strange 2004). However, the way urban concentration affects economic growth depends on the specificities of the urban process

(Castells-Quintana 2017). In other words, positive association between urbanization and economic growth is conditioned upon heterogeneous capacities of cities to provide urbanites with basic services such as urban infrastructures, environment and protection from congestion diseconomies.

3.3.4 Education

Education is the backbone of a nation and does spur economic growth and FDI through increase in productivity resulting from enriched human capital. An educated labor force is equipped with better skills and is likely to contribute towards enhancing productivity. Education is likely to improve health outcomes of a country as well. However, the empirical evidence on the effect of education on health outcomes is mixed (e.g. Ma, Nolan, and Smith 2018; Dursun, Cesur, and Mocan 2018). This study expects a non-linear (quadratic) effect of education on health outcomes.

3.3.5 HIV prevalence

HIV/AIDS is one of history's most deadly pandemics with a devastating havoc on health outcomes. HIV prevalence affects child health outcomes by causing infant and child deaths through vertical transmission of HIV from mothers to infants (Mofenson 2010; Gow and Desmond 2007). High prevalence of HIV also weakens economic growth and FDI since it affects human health and subsequently labor productivity (Asiedu, Jin, and Kanyama 2015). Widespread transmission and long-lasting effects of this disease are likely to cause negative economic repercussions (Augier and Yaly 2013).

3.3.6 Public health expenditure

Although higher level of public health expenditure is likely to positively affect public health outcomes by reducing IMR and CMRU5 as better health equipment and treatments are expected to come along with higher level of public health expenditure, empirical evidence on such association is mixed (e.g. Akinlo and Sulola 2018; Bernet, Gumus, and Vishwasrao 2018). Higher expenditure on public health is also expected to improve human capital that in turn is likely to affect labor productivity eventually promoting economic growth and investment in a country. Thus increased public health expenditure may be considered as a stimulant of economic growth and investment in an economy.

3.3.7 Water and sanitation

Lack of access to water and sanitation are detrimental to health and education (Ortiz-Correra, Filho, and Dinar 2016). Infants and children are more prone to diseases caused by the lack of safe drinking water and poor sanitation. Diarrhea – a waterborne disease is the leading cause of child mortality (WHO 2009). Most of the diarrhea cases are attributed to unsafe water, inadequate sanitation or insufficient hygiene (Augsburg and Rodríguez-Lesmes 2018). Safe water and improved sanitation are *sine qua non* for developing countries to reduce mortality associated with water and sanitation-related diseases (Alagidede and Alagidede 2016). Lack of safe water and sanitation are likely to affect human capital and productivity negatively and may thus impede economic growth and FDI of a country.

Table 1 reports summary statistics for all the variables in order to determine the nature of data distribution. The data of all the series are normally distributed as the values of the standard deviations of these distributions are within a reasonable range which implies that the application of standard estimation techniques is not likely to provide spurious findings. Also, the data are immune to the threat of multicollinearity as demonstrated through the Variance Inflation Factor (VIF) results presented in Table 2.

3.4 Models

While assessing the empirical relationship of economic growth and FDI with health outcomes for South Africa, it is imperative to acknowledge the potential reverse causality among them that may result in a so-called endogeneity problem. Such an endogeneity issue may arise due to the fact that a better health system positively affects human capital which is likely to stimulate productivity in an economy that would in turn boost economic growth and attract more FDI. In other words, a bidirectional causality between the outcome variables and the predictors cannot be ruled out. The application of simple regression techniques to models plagued with such endogeneity problems is likely to lead to spurious and biased regression coefficients and erroneous standard errors. To circumvent this potential threat, this

Table 2. Variance inflation factor (VIF).

Variable	VIF	1/VIF
EDU	2.33	0.429
lnSAN	2.12	0.472
HIV	1.88	0.532
lnGDPPC	1.80	0.554
FDI	1.73	0.578
PHE	1.70	0.587
INSTQ	1.66	0.602
lnURB	1.52	0.658
lnCOR	1.48	0.674
lnINIEQ	1.32	0.756
lnWAT	1.29	0.775
Mean VIF	1.71	

study applies Autoregressive Distributive Lag (ARDL) model that takes it into account for the estimation of data.

Two models are used to investigate the impact of economic growth and FDI on health outcomes in this study. Model 1 examines the effects of economic growth and FDI on health outcomes proxied by IMR with a number of controls in place. Model 2 examines the impact of economic growth and FDI on health outcomes proxied by child mortality rate under five (CMRU5) with the same controls. The models are specified in Equations (1) and (2).

3.4.1. Models 1 and 2

To achieve the objective of the study and based on two dependent and set of independent variables, two econometric baseline models of the following form are estimated:

$$\begin{aligned} HO_{IMR(t)} = {} & \beta_0 + \beta_1 GDPPC_t + \beta_2 FDI_t + \beta_3 INIEQ_t \\ & + \beta_4 INSTQ_t + \beta_5 COR_t + \beta_6 HIV_t + \beta_7 PHE \\ & + \beta_8 EDU_t + \beta_9 SQEDU_t + \beta_{10} URB_t \\ & + \beta_{11} WAT_t + \beta_{12} SAN_t + \varepsilon_t, \end{aligned} \tag{1}$$

$$\begin{aligned} HO_{CMRU5(t)} = {} & \beta_0 + \beta_1 GDPPC_t + \beta_2 FDI_t + \beta_3 INIEQ_t \\ & + \beta_4 INSTQ_t + \beta_5 COR_t + \beta_6 HIV_t \\ & + \beta_7 PHE + \beta_8 EDU_t + \beta_9 SQEDU_t \\ & + \beta_{10} URB_t + \beta_{11} WAT_t + \beta_{12} SAN_t + \varepsilon_t. \end{aligned} \tag{2}$$

All variables but FDI, HIV, HEP and EDU were then transformed into natural logs. This transformation was intended to reduce heteroscedasticity in the model. The reason for non-transformation of some variables into logs is that such transformation might result in negative values for them as they are too small. After the transformation, the estimable models stand as

$$\begin{aligned} HO_{IMRt} = {} & \beta_0 + \beta_1 \ln GDPPCt + \beta_2 FDI_t + \beta_3 \ln INIEQ_t \\ & + \beta_4 \ln INSTQ_t + \beta_5 \ln COR_t + \beta_6 HIV_t \\ & + \beta_7 PHE + \beta_8 EDU_t + \beta_9 SQEDUt + \beta_{10} \ln URB_t \\ & + \beta_{11} \ln WAT_t + \beta_{12} \ln SAN_t + \varepsilon_t\ , \end{aligned} \tag{3}$$

$$\begin{aligned} HO_{CMRU5t} = {} & \beta_0 + \beta_1 \ln GDPPCt + \beta_2 FDI_t + \beta_3 \ln INIEQ_t \\ & + \beta_4 \ln INSTQ_t + \beta_5 \ln COR_t + \beta_6 HIV_t \\ & + \beta_7 PHE + \beta_8 EDU_t + \beta_9 SQEDUt + \beta_{10} \ln URB_t \\ & + \beta_{11} \ln WAT_t + \beta_{12} \ln SAN_t + \varepsilon_t. \end{aligned} \tag{4}$$

3.4.2 Estimation procedures

3.4.2.1 Unit root tests. Recognizing the possibility of the presence of a structural break in data, if any, we employ Zivot and Andrews (2002) unit root test in this study which can accommodate a single structural breakpoint in the data. If a series is considered as *X*, then the structural tests take the following forms:

$$\Delta X_t = \Omega + \Omega X_{t-1} + \mathrm{c}t + \mathrm{d}D_t + \mathrm{d}DT_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t, \tag{5}$$

$$\Delta X_t = a + aX_{t-1} + bT + kP_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t, \tag{6}$$

$$\Delta - -X_t = \beta + \beta X_{t-1} + kt + bPT_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t, \tag{7}$$

$$\Delta X_t = \gamma + \gamma X_{t-1} + \mathrm{k}t + \mathrm{d}PT_t + \sum_{j=1}^{k} d_j \Delta X_{t-j} + \varepsilon_t, \tag{8}$$

where *P* is a dummy variable and shows the mean shift at each point and PT_t is a trend shift variable. The null hypothesis of this test is $k = 0$ which is the presence of unit root in the absence of structural break against the alternative that the series is trend stationary with an unknown time break. Then, this unit root test selects that time break which reduces the one-sided *t*-statistic to test $k(=k–1) = 1$.

3.4.2.2 Cointegration test: ARDL bounds testing approach to cointegration. Since unit root test results unpack a mixed order of integration among the variables of interest, this study employs ARDL bounds testing approach which takes into account this issue (Pesaran, Shin, and Smith 2001). ARDL has some other advantages also over traditional time series estimation techniques. First, it addresses low power and other problems associated with traditional cointegration approaches such as Johansen (1988), Engle and Granger (1987). Second, the ARDL approach involves the use of a simplified single equation system. Third, this method provides reliable estimates even for a small sample size as in our case ($n = 33$). Fourth, it simultaneously estimates the short-run dynamics and the long-run equilibrium within a dynamic unrestricted error correction model (UECM) and finally, the ARDL procedure allows the variables to have different optimal lags.

The empirical formulation of ARDL equations for the two models is specified as follows:

$$\Delta lnHO_{IMR(t)} = \beta_0 + \beta_1 lnHO_{IMR}t-1 + \beta_2 lnGDPPC_{t-1} + \beta_3 FDI_{t-1} + \beta_4 lnINIEQ_t + \beta_5 lnINSTQ_t + \beta_6 lnCOR_t + \beta_7 HIV_t t-1 + \beta_8 PHE_{t-1} + \beta_9 EDU_{t-1} + \beta_{10} SQEDU_t + \beta_{11} lnURB_t + \beta_{12} lnWAT_t + \beta_{13} lnSAN_t + \sum_{i=1}^{n} \beta_{1i} \Delta lnHO_{IMRt-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnGDPPC_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnINIEQ_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnINSTQ_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnCOR_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta HIV_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnPHE_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{10i} \Delta SQEDU_{t-i} + \sum_{i=0}^{n} \beta_{11i} \Delta lnURB_{t-i} + \sum_{i=0}^{n} \beta_{12i} \Delta lnWAT_{t-i} + \sum_{i=0}^{n} \beta_{13i} \Delta lnSAN_{t-i} + \mu_{1t}, \quad (9)$$

$$lnHO_{CMRU5(t)} = \beta_0 + \beta_1 lnHO_{CMRU5t-1} + \beta_2 lnGDPPC_{t-1} + \beta_3 FDI_{t-1} + \beta_4 lnINEQ_t + \beta_5 lnINSTQ_t + \beta_6 lnCOR_t + \beta_7 HIV_t t-1 + \beta_8 PHE_{t-1} + \beta_9 EDU_{t-1} + \beta_{10} SQEDU_t + \beta_{11} lnURB_t + \beta_{12} lnWAT_t + \beta_{13} lnSAN_t + \sum_{i=1}^{n} \beta_{1i} \Delta lnHO_{CMRU5t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnGDPPC_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnINIEQ_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnINSTQ_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnCOR_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta HIV_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnPHE_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{10i} \Delta SQEDU_{t-i} + \sum_{i=0}^{n} \beta_{11i} \Delta lnURB_{t-i} + \sum_{i=0}^{n} \beta_{12i} \Delta lnWAT_{t-i} + \sum_{i=0}^{n} \beta_{13i} \Delta lnSAN_{t-i} + \mu_{1t}, \quad (10)$$

where HO_{IMR} and HO_{CMRU5} are health outcomes measured by IMR and CMRU5 respectively, β_{1i}–β_{13i}, *and* β_1–β_{13} are short-run and long-run coefficients respectively, β_0 is a constant and μ_{1t} is the white noise error term.

Next, the error correction model for models 1 and 2 are specified as follows:

$$\Delta lnHO_{IMR(t)} = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnHO_{1MRt-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnGDPPC_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnINEQ_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnINSTQ_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnCOR_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta HIV_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnHEP_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{10i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{11i} \Delta SQEDU_{t-i} + \sum_{i=0}^{n} \beta_{12i} \Delta lnURB_{t-i} + \sum_{i=0}^{n} \beta_{13i} \Delta lnACW_{t-i} + \sum_{i=0}^{n} \beta_{14i} \Delta lnSAN_{t-i} + \mu_{1t}, \quad (11)$$

$$\Delta lnHO_{CMRU5(t)} = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnHO_{1MRt-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnGDPPC_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnINIEQ_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnINSTQ_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnCOR_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta HIV_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnPHE_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{10i} \Delta EDU_{t-i} + \sum_{i=0}^{n} \beta_{11i} \Delta SQEDU_{t-i} + \sum_{i=0}^{n} \beta_{12i} \Delta lnURB_{t-i} + \sum_{i=0}^{n} \beta_{13i} \Delta lnWAT_{t-i} + \sum_{i=0}^{n} \beta_{14i} \Delta lnSAN_{t-i} + \mu_{1t}. \quad (12)$$

To examine the cointegrating relationship, a Wald Test or the F-test for the joint significance of the coefficients of the lagged variables is performed with the null hypothesis of no cointegration against the alternative hypothesis in favor of cointegration between variables. *F* statistics are computed to compare the calculated upper and lower bounds with critical values provided by Pesaran, Shin, and Smith (2001). Next, the short-run, long-run and the ECT (error correction term) coefficients are estimated.

3.5 Toda–Yamamoto (TY) causality test

Next, this study examines the causal direction among key variables. Since, the variables in this study are integrated with mixed order of integration, traditional Granger causality test (Granger 1969) is not ideal for determining such causality as this test is sensitive to the order of integration among variables. Therefore, this study conducts a TY causality test to assess causal association among variables, if any. To conserve space, mathematical derivations of this test are skipped (for detailed mathematical derivations, please refer to Toda and Yamamoto 1995).

4. Results

Table 3 reports results from Zivot and Andrews (2002) structural break unit root test which shows that the variables child mortality rate under 5, FDI, income inequality, HIV and urbanization are stationary at levels while the rest of the variables are first difference stationary. The break years detected through this test are 1992, 1993, 1995, 1997, 1998, 2000 and 2006. This implies that throughout the 1990s, most of these variables pertaining to South Africa experienced some instability but later in the 2000s, they seemed to settle down.

Table 4 reports results from ARDL cointegration. The *F* statistics for models 1 and 2 are 4.427 and 7.240 respectively. Both are statistically significant at 1% level of significance. The calculated *F* statistics is compared to the Pesaran, Shin, and Smith (2001) critical values and is found greater than the upper critical bounds (UCB) implying a cointegrating relation among the variables. The presence of a cointegrating association among variables enable ARDL procedures to continue to estimate the short-run and long-run coefficients. But before such

Table 3. Zivot and Andrews unit root test.

	Levels			1st Difference		
Variables	*t*-statistic	Time break	Decision	*t*-statistic	Time break	Decision
lnIMR	−2.191	2007	Unit root	−5.765***	2006	Stationary
LnCMRU5	−5.135**	2007	Stationary			
lnGDPPC	−4.286	2003	Unit root	−6.201***	2003	Stationary
FDI	−6.008***	2010	Stationary			
lnINIEQ	−12.536	2006	Stationary			
INSTQ	−3.282	1994	Unit root	−6.820***	1998	Stationary
lnCOR	−3.732	2000	Unit root	−7.743***	1997	Stationary
HIV	−6.299***	1992	Stationary			
PHE	−3.660	2008	Unit root	−5.762***	2000	Stationary
EDU	−4.190	1990	Unit root	−6.359***	1992	Stationary
lnURB	−5.301**	2011	Stationary			
lnWAT	−4.547	1991	Unit root	−7.660***	1995	Stationary
lnSAN	−2.761	1998	Unit root	−8.527***	1993	Stationary

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

Table 4. ARDL cointegration results and critical values.

Models	Independent variables	Function		*F*-statistic		Cointegration status	
1	lnIMR	F(lnGDPPC, FDI, lnINIEQ, INSTQ, lnCOR, HIV, HEP, EDU, lnURB, lnACW, lnSAN)		4.427***		Cointegrated	
2	lnCMRU5	F(lnGDPPC, FDI, lnINIEQ, INSTQ, lnCOR, HIV, HEP, EDU, lnURB, lnACW, lnSAN)		7.240***		Cointegrated	
Assyptotic Critical Values (unrestricted intercept and no trend)							
Pesaran, Shin, and Smith (2001:300) critical values (Table CI(iii) Case III)		10%		5%		1%	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
		2.62	3.35	2.26	3.79	3.41	4.68

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

estimation, *a priori* information is required about the optimal lag length for each of the variables. Thus the optimal lag is selected based on Bayesian Information Criteria (BIC), which is believed to produce more reliable results than the Akaike Information Criteria (AIC) based models. The optimal lag lengths selected for Models 1 and 2 are ARDL (2, 1, 0, 3, 0, 1,2,2,1, 2, 3, 1) and ARDL (2, 3, 1, 1, 1, 1,0,1,4, 2, 0,1) respectively.

The long-run and short-run coefficients for Models 1–2 are presented in Tables 5A and 5B respectively. The regression results obtained from Model 1 and presented in Table 5A show that economic growth and FDI reduce infant mortality both in the short run and long run. Findings from the estimation of Model 2 and reported in Table 5B indicate that both economic growth and FDI have a negative significant long-run effect on child mortality under 5. However, their short-run effects are insignificant. Therefore, it is evident that economic growth and FDI both contribute towards improving South Africa's health outcomes measured by both infant mortality rate and child mortality rate under 5 in the long run.

Among control variables, corruption, HIV, public health expenditure, urbanization and education all have statistically significant effects with expected signs on both indicators of health outcomes. As expected, education has non-linear negative effects on both infant mortality and child mortality. Corruption and HIV lead to increase in infant and child mortality in South Africa. The effects of other control variables are insignificant. The error correction-coefficients ECM (−1) for models 1 and 2 are 1.01 and 0.2 respectively. Both of them are reported to be statistically significant.

Figure 1 demonstrates plots of CUSUM and CUSUMSQ for Models 1 and 2. The graphical plots of CUSUM and CUSUMSQ as depicted in panels 1A, 1B, 2A and 2B

Table 5A. ARDL results for Model 1.

Dependent variable = lnIMR			
	Long-run analysis		
Variables	Coefficient	Standard error	**t-statistics[Prob]**
Constant	0.73	0.75	0.98[0.35]
lnGDPPC	−0.16	0.03	−4.68[0.00]
FDI	−0.01	0.00	−3.55[0.01]
lnINIEQ	0.23	0.16	1.48[0.17]
INSTQ	−0.04	0.03	−1.51[0.17]
lnCOR	−0.31	0.08	−3.83[0.00]
HIV	0.07	0.01	7.06[0.00]
HEP	−0.13	0.03	−3.97[0.00]
EDU	0.03	0.02	1.47[0.18]
SQEDU	−0.12	0.04	−3.18[0.01]
lnURB	−27.48	3.03	−9.07[0.00]
lnWAT	−0.38	2.33	−0.16[0.88]
lnSAN	−2.35	1.48	−1.58[0.15]
R^2	0.978		
Adj R^2 0.953			
Short-run analysis			
Variables	**Coefficient**	**Standard Error**	**T-statistics [Prob]**
Constant			
ΔlnGDPPC	−0.13	0.01	−12.32[0.00]
ΔFDI	−0.01	0.00	−7.82[0.00]
ΔlnINIEQ	−0.32	0.15	−2.09[0.05]
ΔINSTQ	0.00	0.00	−1.00[0.35]
ΔlnCOR	−0.17	0.02	−7.89[0.00]
ΔHIV	0.07	0.00	22.19[0.00]
ΔHEP	−0.04	0.01	−4.06[0.00]
ΔEDU	0.01	0.00	2.49[0.03]
ΔSQEDU	−0.09	0.01	−12.50[0.00]
ΔlnURB	−27.74	2.98	−9.30[0.00]
ΔlnACW	−1.69	0.63	−2.67[0.02]
ΔlnSAN	−4.77	3.06	−1.56[0.14]
ECMt-1	−1.01	0.03	−29.34[0.00]
R^2	0.977		
Adj R^2	0.965		
F-statistic	25.15[0.000]		
D. W	2.20		
Short-run diagnostic tests			
Test	***F*-statistic**	**Prob. value**	
χ^2SERIAL	0.955	0.344	
χ^2ARCH	7.012	0.013	
χ^2RAMSEY	0.502	0.489	

Table 5B. ARDL results for Model 2.

Dependent variable = lnCMRU5			
Long-run analysis			
Variables	**Coefficient**	**Standard error**	***t*-statistics[Prob]**
Constant	−0.14	0.08	−1.75[0.10]
lnGDPPC	−0.01	0.06	−0.12[0.90]
FDI	−0.02	0.01	−2.65[0.02]
lnINIEQ	−5.94	2.43	−2.45[0.02]
INSTQ	−0.01	0.02	−0.59[0.57]
lnCOR	1.34	0.58	2.30[0.03]
HIV	0.03	0.01	2.81[0.01]
PHE	−0.16	0.05	−2.97[0.01]
EDU	0.05	0.03	1.58[0.14]
SQEDU	0.10	0.07	1.56[0.14]
lnURB	−2.41	0.89	−2.71[0.02]
lnWAT	−12.46	5.47	−2.28[0.04]
lnSAN	−1.99	3.29	−0.60[0.56]
R^2	0.911		
Adj R^2 0.902			
Short-run analysis			
Variables	**Coefficient**	**Standard Error**	**t-statistics[Prob]**
Constant			
ΔlnGDPPC	−0.01	0.03	−0.36[0.72]
ΔFDI	0.00	0.00	−1.40[0.18]
ΔlnINIEQ	0.50	0.34	1.49[0.16]
ΔINSTQ	−0.01	0.01	−0.46[0.65]
ΔlnCOR	0.31	0.12	2.52[0.03]
ΔHIV	0.10	0.02	5.32[0.00]
ΔPHE	−0.12	0.04	−3.24[0.00]
ΔEDU	−0.08	0.03	−2.66[0.02]
ΔSQEDU	0.09	0.07	1.30[0.22]
ΔlnURB	0.40	1.17	0.34[0.74]
ΔlnWAT	−1.48	2.32	−0.64[0.53]
ΔlnSAN	−1.10	1.12	−0.98[0.34]
ECMt-1	−0.20	0.07	−2.80[0.01]
R^2	0.989		
Adj R^2	0.972		
F-statistic	10.94[0.000]		
D. W	2.70		
Short-run diagnostic tests			
Test	***F*-statistic**	**Prob. value**	
χ^2SERIAL	1.898	0.183	
χ^2ARCH	3.872	0.063	
χ^2RAMSEY	0.187	0.688	

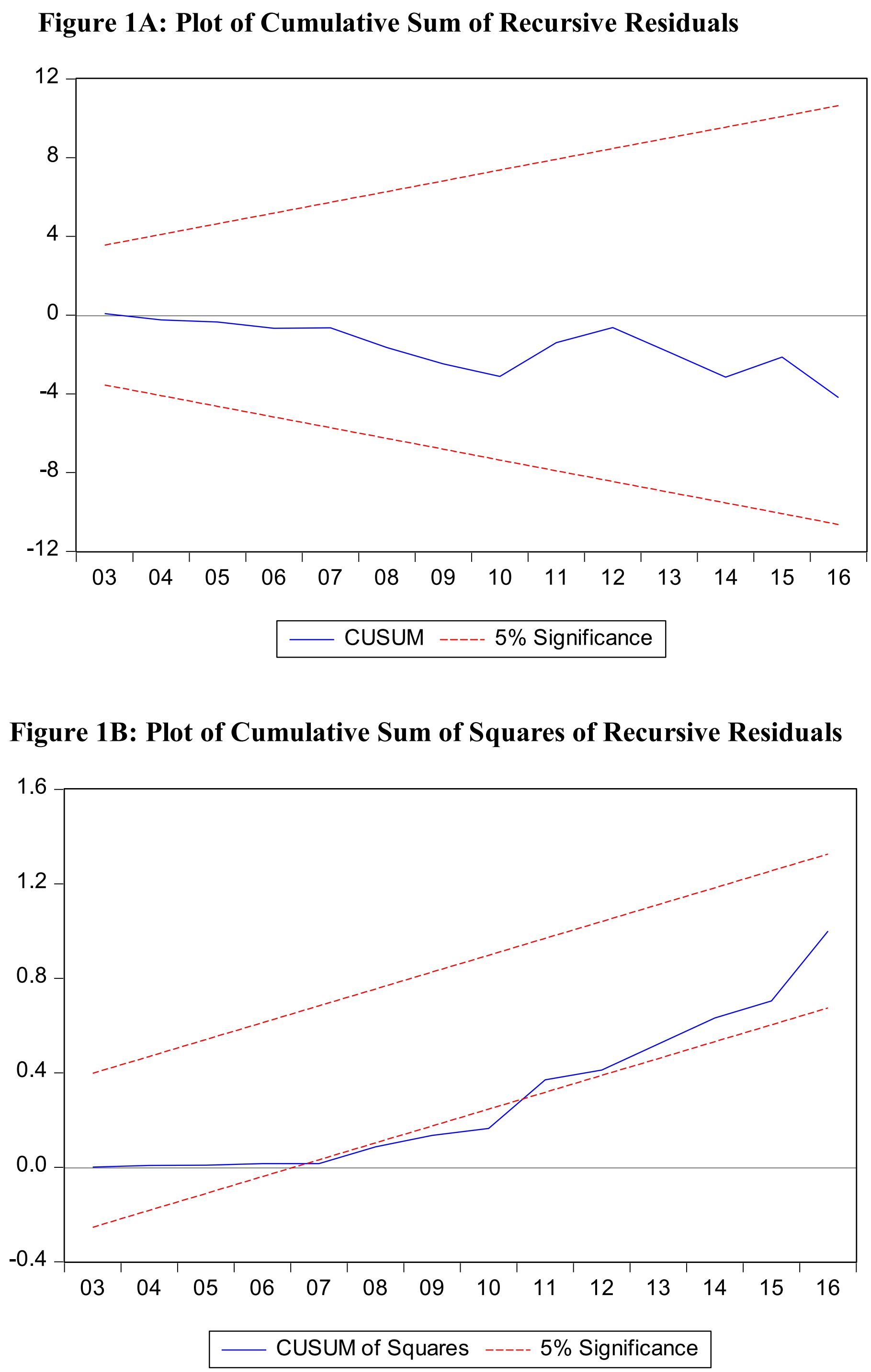

Figure 1 . (A) Plot of cumulative sum of recursive residuals and (B) plot of cumulative sum of squares of recursive residuals.

show that ARDL parameters in both models are stable at 5% level of significance.

Toda–Yamamoto causality results are reported in Table 6. It shows that both economic growth and FDI have causal link with both indicators of health outcomes. Also bidirectional causality is observed between economic growth and FDI. This is evident from the fact that the null hypothesis of no causality could not be rejected in these cases based on *p* values.

Results from the variance decomposition analysis are reported in Tables 7A and 7B. Findings from both models suggest that FDI is likely to have significant effect on both indicators of health outcomes in near future. Variation of 33% in infant mortality and over 10% variation

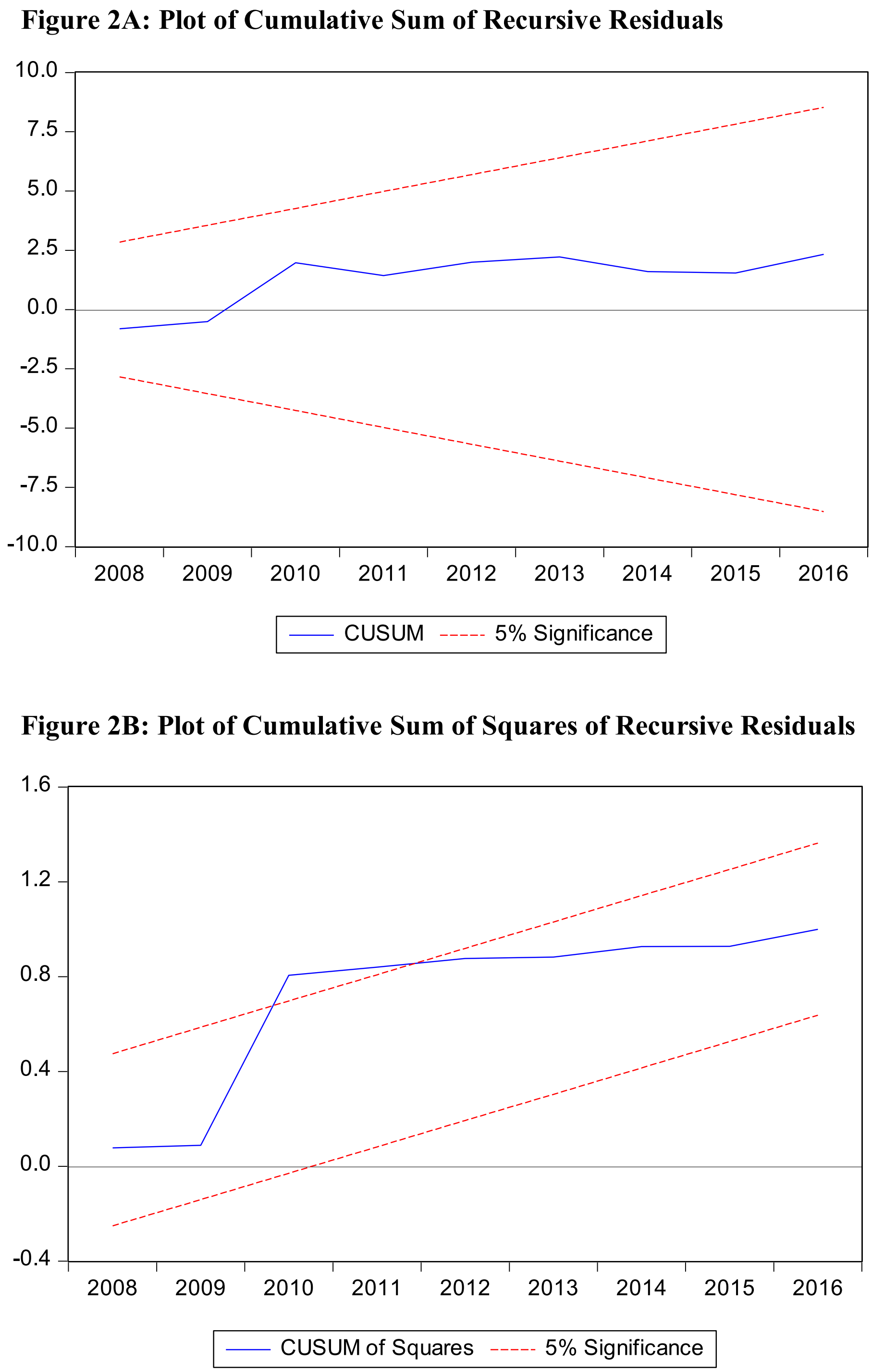

Figure 2 . (A) Plot of cumulative sum of recursive residuals and (B) plot of cumulative sum of squares of recursive residuals.

Table 6. Toda–Yamamoto causality test results.

	Chi-sq.	Prob.		Chi-sq.	Prob.
ΔlnCMRU5→ΔlnIMR	7.480	0.113	ΔlnIMR→ΔlnCMRU5	23.911	0.000
ΔlnGDPPC→ΔlnIMR	1.615	0.806	ΔlnIMR→ΔlnGDPPC	0.232	0.994
ΔFDI→ΔlnIMR	4.018	0.404	ΔlnIMR→ΔFDI	3.553	0.470
ΔlnGDPPC→ΔlnCMRU5	1.854	0.763	ΔlnCMRU5→ΔlnGDPPC	1.408	0.843
ΔFDI→ΔlnCMRU5	3.815	0.432	ΔlnCMRU5→ΔFDI	2.519	0.641
ΔFDI→ΔlnGDPPC	5.701	0.223	ΔlnGDPPC→ΔFDI	2.647	0.619

Table 7A. Variance decomposition of lnIMR.

Period	lnIMR	lnGDPPC	FDI
1	100.000	0.000	0.000
2	96.694	1.474	1.832
3	83.319	1.004	15.677
4	81.051	0.965	17.984
5	74.650	1.198	24.153
6	71.948	1.359	26.693
7	68.813	1.461	29.725
8	67.097	1.532	31.372
9	65.776	1.592	32.633
10	65.023	1.641	33.336

Table 7B. Variance decomposition of lnCMRU5.

Period	lnCMRU5	lnGDPPC	FDI
1	100.000	0.000	0.000
2	99.339	0.603	0.058
3	97.935	1.299	0.766
4	96.713	1.496	1.791
5	95.367	1.345	3.288
6	94.004	1.137	4.859
7	92.641	0.962	6.396
8	91.357	0.831	7.813
9	90.142	0.731	9.127
10	89.006	0.658	10.337

in child mortality are likely to be explained by FDI in case of South Africa over the period of the next 10 years.

5. Discussion and policy implications

The main objective of this study was to estimate the effects of economic growth and FDI on child health outcomes as proxied by the IMR and the CMRU5 for South Africa. Although the effects of economic growth and FDI on health outcomes have been widely studied in different contexts, such an empirical exercise has been until now absent for South Africa.

The results of this study are robust and consistent with *a priori* expectations and stable across different econometric methods. A good fit of data is observed with the application of ARDL for both models with adjusted R squared statistics of 95% and 96% respectively observed after performing both long-run estimations.

The long-run positive effects of economic growth and FDI in reducing IMR and CMRU5 are not unexpected as South Africa has almost overcome the problem of being influenced by the institutionalized racial discrimination that prevailed for much of its history prior to 1990 and which led to unfortunate disparities in child and adult morbidity and mortality during the apartheid era. The introduction of large-scale social programs, including the implementation of better sanitation and infrastructure in poor areas and free medical care for pregnant women and young children was aimed at reducing many of the major risk factors responsible for increasing infant mortality.

The positive effects of economic growth in reducing infant mortality occur through a number of channels. Due to stable and higher levels of economic growth in the post-apartheid era, South Africa is currently experiencing a demographic dividend (Oosthuizen 2016). The transition from high fertility and high child mortality, to low fertility and low child mortality as a result of a series of health reforms especially supporting poor people has resulted in a generational reduction in the dependency ratio (Oosthuizen 2016). This decline in the dependency ratio increases resources available to the health and other sectors.

South Africa's IMR was substantially driven by the HIV epidemic during the 1990s and early 2000s (Gow and Desmond 2007). Its public health care system is funded through general taxes. Higher tax revenue generation is likely to stimulate health expenditures. In order to combat HIV spread, South Africa recently introduced modern fourth-generation vaccinations that are contributing significantly towards reducing IMR and CMRU5.

As one of the biggest economies in Africa, South Africa has experienced rampant corruption, income inequality, poor governance and high prevalence of HIV in recent times. These factors can potentially negatively affect the performance of the health system of a country.

The findings of this study have a number of important policy implications for South Africa. South Africa has achieved a post-apartheid stable economic growth path characterized by mostly three factors, fiscal stability of government due to low levels of public debt (33.8% of GDP in 2011/12); the presence of fiscal space (i.e. budgetary flexibility that allows a government to provide resources for a desired purpose regardless of government's financial position); and the political priority for fiscal decentralization to improve maternal and child health. Despite a poorly functioning public health system characterized by systemic failures, it has made some progress in reducing IMR and CMRU5 (van den Heever 2016). However, these improvements in health outcomes are not necessarily attributable to the introduction of new vaccines only but also to the improvements in HIV prevention of mother-to-child transmission and HIV/AIDS treatment programs. Post-apartheid South Africa has also embarked on one of the largest subsidized housing programs in the world, constructing approximately 3.3 million new housing units since 1994. Because of better hygienic conditions, infant and child mortality are expected to be lower in the future.

South Africa still bears the scars of apartheid even after its demise over two decades ago. In spite of a post-apartheid stable and robust economic growth, it still encounters a number of challenges. It is one of the most unequal societies in the world with the second highest Gini coefficient. Poverty, income inequality and unemployment are the most pressing current challenges facing the country (Statistics South Africa 2014a; 2014b). In order to improve health outcomes and reduce IMR and CMRU5, these issues need further attention through more visionary fiscal relocation, fiscal decentralization in favor of improving local public services including health, improved law and order situation, aggressive investment in IT, more FDI induced investment in the health sector, higher budgetary allocation for vaccination roll out and more subsidized hygienic housing projects for the poor with access to improved water and improved sanitation.

Despite best possible efforts, this study suffers from a number of caveats. First of all, data on IMR and CMRU5 are very likely to be underreported since South Africa is a middle-income developing country. A second limitation is that only two indicators of health outcomes, IMR and CMRU5 are used as the predicted variables in the current study which means that the findings may not be robust across other measures of health outcomes. Third, the Granger causality test has limitations because it is a temporal understanding of causality. Other approaches to causality such as for example experimental methods would improve the robustness of the estimated variables. Finally, the long-run coefficients may not be robust across the application of other econometric estimation methods. These weaknesses need to be addressed in future research. Nonetheless, future research should also concentrate on establishing more detailed links between macro/aggregate fluctuations and health and education outcomes. Such research could inform public policy design and guide specific interventions to reduce IMR and CMRU5 in a middle-income country like South Africa.

6. Conclusion

This study examined the effects of economic growth and FDI inflows on two indicators of health outcomes as measured by IMR and CMRU5. The analysis also included several controls that included corruption (COR), income inequality (INIEQ), HIV prevalence (HIV), urbanization (URB), institutional quality (INSTQ), education (EDU), public health expenditure (PHE), access to improved water (WAT) and access to improved sanitation (SAN). Annual time series data for the period 1985–2015 for South Africa was used in the analysis.

Having found the variables integrated with mixed order through the ZA unit root test, ARDL methods of cointegration and subsequently short-run, long-run coefficient estimations are employed. Results indicate that there is a significant short-run and long-run relationship between FDI inflows and economic growth with both indicators (IMR and CMRU5) of health outcomes. Among control variables, corruption, HIV, public health expenditure, institutional quality have expected long-run significant effects on both IMR and CMRU5. As expected, education has a negative non-linear effect on health outcomes. Effects of other control variables are, however, insignificant. The TY causality test revealed that both economic growth and FDI have causal association with both measures of health outcomes.

Disclosure statement

No potential conflict of interest was reported by the authors.

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