THE FDI-GROWTH NEXUS IN SOUTH AFRICA:
A RE-EXAMINATION USING QUANTILE REGRESSION APPROACH

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Abstract. This study sought to contribute to the growing empirical literature by investigating the effects of FDI on per capita GDP growth for South Africa using time series data collected between 1970 and 2016. Compared to the majority of previous studies, we use quantile regressions which investigates the effects of FDI on economic growth at different distributional quantiles. Puzzling enough, the empirical results show that FDI has a negative influence on welfare at extremely low quantiles whereas at other levels this effect turns insignificant. Contrary, the effects of domestic investment on welfare is positive and significant at all levels. Collectively, these results have important implications for policymakers in South Africa.

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1. Introduction

Since the financial liberalization era of the 1980's and 1990's, when economies worldwide began to be increasingly integrated into the global economy, the relationship between foreign direct investment (FDI) and output growth became subjected to intense research. FDI is perceived as a major factor in enhancing economic growth, especially in developing countries where the savings rates are relatively low. In particular, FDI contributes to the integration of developing countries into the world economy as it provides not only capital but also technology and management know-how necessary for restructuring firms in the host countries (Keho, 2015). Nevertheless, the empirical evidence regarding the empirical links amongst FDI and economic growth remains mixed due to different methodologies employed, different data usage and different country specifics.

Following the global financial crisis of 2007-2008, many economies worldwide are still recovering from the aftereffects of the global recessionary period of 2009-2010 and the Euro debt crisis of 2010 which ensued afterwards. Many economies across the globe witnessed major declines in output, employment and trade. GDP growth worldwide declined drastically in 2009, dropping from slightly over 4 percent to 0.9 percent between 2007 and 2009. Moreover, approximately 34 million jobs worldwide were lost during the 2009 recession while world trade volumes plummeted by more than 40 percent in 2008, collapsing at rate that outpaced the fall of aggregate output (Alfaro and Chen, 2011). According to the World Economic Forum, in order for the world to recover from its decline in growth, the global economy needs an injection of new FDI to reach US$ 3 trillion annually (approximately 4% of current world gross domestic product, GDP). Hence there has been a recent rejuvenation of empirical interest concerning the effects of FDI on economic growth.

Nevertheless, we notice two major shortcomings associated with a majority of previous empirical studies addressing the subject matter. Firstly, most studies do not take into consideration the possible effect of the financial crisis on the FDI-growth relationship. Secondly, studies suffer from the methodological shortcoming of relying on OLS and other linear estimating techniques hence assuming that the effects of FDI on economic growth are uniform across all levels of FDI. In reality, this assumption does not hold true. In our study we take into consideration these identified flaws by making a case study for the South African economy over the period of 1970 to 2016. South Africa is often regarded to be the gateway to the Sub-Saharan Africa (SSA) region, as well as being one of the prominent FDI recipients in terms of national resources, traditional oil as well as minerals. However, prior to the first democratic elections in 1994, when international sanctions were imposed on the state between the 1980's and the early 1990's, South Africa's FDI had been close to zero as the country become increasing isolated from the global economy during that period. Nevertheless, following the termination of the apartheid regime in the early 1990's, the new democratic South Africa government changed the focus of it's economic development and growth strategy towards deeper global integration, developing stabilizing macroeconomic policies as well as attracting increasingly higher numbers of foreign investors.

Over the past two decades, South Africa has become an important global economic player. In 2012, the country was considered one of the largest recipients of FDI in Africa with over US$3 billion. According to the United Nations Conference on Trade and Development (UNCTAB, 2013), South Africa has been receiving a bulk majority of it's FDI (i.e. approximately 89%) from the European Union, while other major contributing countries include the UK with 75.8% and other minor contributors include Germany with 6% and other developing countries an overall of 4% of FDI to South Africa, of which 2.5% is generated by Asian economies alone.

In our study we rely on the quantile regression methodology of Koenker and Bassett (1978). The primary advantage of quantile regression over least-squares regression is its flexibility for modelling data with heterogeneous conditional distributions. Therefore, in comparison to other linear estimation techniques commonly used in the literature, quantile regression provides a more complete covariate picture of the covariate effect when a set of percentiles is modelled, and makes no distributional assumption about the error term in the model (Koenker and Hallock (2001). Our contribution to the ilterature is as follows. Firstly, to the best of our knowledge, we become the first study in the literature to employ the quantile regression in investigating the FDI-growth nexus and as by-product the first to examinine possible nonlinearities for the case of South Africa. Secondly, we go beyond the exising literature and examine the effects of the global financial crisis on the FDI-growth relationship for South Africa.

Against this background, we structure of the remainder of the paper as follows. The next section of the paper will review the literature concerned with the effects of FDI on economic growth. The third section will present the econometric model and this will be followed by the data and empirical analysis which are presented in section four. Section five will conclude the study and provide recommendations based on the research findings.

2. Literature review

Theories of FDI

Theories of FDI began to more prominently emerge in the post- World War II era. Even though theories of FDI are wide spread, for convenience sake, we restrict the reviewed mainstream theories of FDI to those classified under imperfect markets which can further be categorized into four main theories. Firstly, there is the industrial organization approach of Hymer (1968 and 1970) and extended upon by Kindelberger (1969) which is consider one of the earliest explanations of investment flows in an oligopolistic market situations. According to this theory, when a multinational corporations (MNC's) establish a subsidiary in a foreign country it faces several disadvantages in competing with local firms such as culture, language, legal system and consumers preferences. As initially argued in Kindelberger (1969), these disadvantages can be offset by some form of market power such as the possession of proprietary resources and unique capabilities such as differentiated products, proprietary technology, managerial skills, better access to capital and government

imposed market distortions confer MNCs with competitive advantage over indigenous firms in the host country and help them offset the disadvantages of operating in a foreign country (Nayyar,2014).

Under the second approach, the transaction cost approach or internalization theory, as popularized in the works of Buckley and Casson (1976) and Williamson (1979) and yet having its roots embedded in the seminal works of Coase (1937), FDI is viewed as an organizational response to market imperfections faced by MNC's. In particular, the internalization theory hinges on three postulates i) firms maximize profits in a market that is perfect ii) When markets in intermediate products are imperfect, there is an incentive to bypass them by creating internal markets iii) internalization of markets across the worlds leads to MNC's (Nayak and Choudhury, 2014). Since intangible assets, such as technology, marketing ability and consumer goodwill, based largely on proprietary information, they cannot be exchanged at across borders for a variety of reasons rising from the economics of information as well as from the economics of public goods (Morck and Young, 1992). The firm thus overcomes these market imperfections by creating an internal market and this internalization of markets is an on-going process which continues until the marginal benefits and marginal costs are equal.

The last theory of FDI we discuss the eclectic paradigm of international production as pioneered by Dunning (1973). In essence, the theory integrates both the internalization and oligopolistic theories and adds a third dimension in the form of location theory to explain why firm opens a foreign subsidiary (Nayak and Choudhury, 2014). The theory asserts that, at any given moment of time, the extent and pattern of international production will be determined by the configuration of three sets of forces; namely, i) the net competitive *ownership* MNc's possess vis-à-vis foreign firms ii) the extent to which firms perceive it to be in their best interests to *internalize* the markets for the generation and/or the use of these assets; and by so doing add value to them; and iii) the extent to which firms choose to *locate* these value-adding activities outside their national boundaries (Nayyar,2014). Combining these three factors, namely, ownership (O), internalization (I) and location (L) provides MNC's a three-tier framework to use when deciding to invest in a foreign country.

Theories of economic growth

Dynamic models of economic growth were formally introduced in the seminal work of Harrod (1939) and Domar (1946) and later refined as the neo-classical model by Solow (1965). A major contribution by the neo-classical growth economists is the distinction of different growth factors; namely, capital accumulation or gross fixed capital formulation, growth in the labour force and technological progress. Within the neo-classical model, which typically operates via a Cobb-Douglas production technology, the savings rate is a key determinant of the level of capital intensity and thus the start of any dynamic movement within the economy. The role of FDI can be envisioned as a channel through which technology exerts spillover effects such that MNC's contribute to sectoral production (Rudy, 2012).

Following the neo-classical era, came the construction of a class of growth models in which the keys determinants of growth were endogenous to the model (Romer (1986) and Lucas (1988)). Endogenous growth theories describe economic growth as a process generated by factors within the production process, for example; economies of scale, increasing returns or induced technological change; as opposed to outside (exogenous) factors such as increase in population, and growth in neo-classical models depends on the rate of return on capital (Solow, 1994). The role of FDI in influencing economic growth is more pronounced because unlike the neo-classical model, technological advances are treated as the heart of economic growth (Seyoum et al., 2014). Nevertheless, there are two major contentions on the role of FDI in these growth models. Firstly, whilst dynamic growth models tend to indicate that FDI has numerous advantages for economic growth, it can also have a negative impact mainly through the crowding out of domestic investment i.e. displacement effect. Secondly, these models, by design, are particularly suited for advanced economies which tend to put FDI flows to more productive use in comparison to FDI flows to developing or emerging economies. Nevertheless, FDI has been successfully incorporated in dynamic endogenous growth theories in developing eonomies as is evidence in the works of Bende-Nabende and Ford (1998), Vu (2008) and Cleeve et al. (2015).

3. Empirical review

Industrialized economies

There has been a considerable debate on the role of FDI on economic growth in industrialized economics. A majority of the available empirical literature for industrialized economies is primarily focused on the EU region (Moudatsou (2003), Tang (2015)), the US (Alfaro (2003), Roy and van der Berg (2006)), Australia (Pandyal and Sisombat (2017), Portugal (Leitao and Rasekhi (2013)) and Central and East Europe countries (Popescu, 2014). Notably a vast majority of these empirical studies advocate for a positive relationship between FDI and economic growth (Moudatsou (2003), Alfaro (2003), Roy and van der Berg (2006), Leitao and Rasekhi (2013), Leitao and Rasekhi (2013) and Pandyal and Sisombat (2017)) with a sole exceptions provided in the works of Tang (2015) which fails to finds any evidence of a significant relationship between the variables for EU countries.

Developing and emerging economies

The empirical efforts dedicated towards examining the FDI-growth relationship in developing and emerging economies appears to be more extensive in comparison to other world regions. For convenience sake, the literature concerning developing and emerging economies and be further disseminated into those concentrating on Latin American countries (Bengoa and Sanchez-Robles (2003) for Latin American countries, Naguibi (2002) for Argentina, Dias et al. (2014) for Brazil), Asian countries

(Chakraborty and Basu (2002) for India, Khaliq and Noy (2007) and Velnampy et al. (2013) for Sri Lanka, Naz et al. (2015) for Pakistan, Rahman (2015) for Bangladesh, Najaf and Najaf (2016) for Pakistan and Afghanistan, Zhang (2001, 2006) and Hong (2014) for China) as well as for African countries (Seetanah and Khadaroo (2007) for 39 SSA countries, Esso (2010) for 10 SSA countries, Sakyi and Egyir (2012) for 45 African countries, Seyoum et al. (2015) for 23 African countries and Jugurnath et al. (2016) for 32 SSA countries).

In summarizing the results of these studies, we note that Zhang (2001, 2006), Bengoa and Sanchez-Robles (2003), Seetanah and Khadaroo (2007), Sakyi and Egyir (2012), Velnampy et al. (2013), Dias et al. (2014), Hong (2014), Naz et al. (2015), Seyoum et al. (2015), Jugurnath et al. (2016) and Najaf and Najaf (2016) all find a positive FDI-growth relationship, whilst Rahman (2015) finds a negative relationship and Naguibi (2002), Chakraborty and Basu (2002), Khaliq and Noy (2007) as well as Esso (2010) establish no significant relationship between the time series.

Mixed economies

There also appears to be a handful of empirical studies which have investigate the FDI-growth relationship for mixed economies. For instance, in a much earlier empirical study Borensztein et al. (1998) investigated the FDI-growth relationship for 69 developing countries and discovered a positive relationship of FDI on productivity growth only when the host country has a minimum threshold stock of human capital level such that sufficient absorptive capacity of the advanced technologies exists in the host country.

De Mello (1999) investigates the FDI-growth relationship for 15 OECD countries and 17 non-OECD countries and establishes a positive link between FDI and growth for both sets of data. On the other hand, Nair-Reichert and Weinhold (2001) also find a positive relationship between FDI and growth for 24 developed and developing countries even though the authors caution on the relationship being highly heterogeneous across countries. Choe (2003) investigates the FDi-growth relationship for 81 countries and despite finding a positive association between the time series, the author cautions that this finding does not necessarily indicate that FDI promotes economic growth.

Using a sample of 31 developing economies, Hansen and Rand (2006) found that FDI has a significant positive effect on economic growth via knowledge transfers and adoption of new technology. Similarly, Li and Liu (2005) investigated the impact of FDI on growth for a mixture of 84 developed and developing countries an identified a significant positive endogenous relationship existing from the mid-1980's. For a mixture of 71 developed and developing countries comprising of 20 OECD and 51 non-OECD countries, Alfaro et al. (2004) establish that the impact of FDI on economic growth is more pronounced the more developed the financial markets of the host country. On the other hand, in purely focusing on a cluster of 28 developing countries comprised mainly of African, Latin American and Asian countries, Herzer et al. (2008) found no clear association between FDI, per capita GDP growth and other growth determinants. In undertaking a comparative analysis for EU and ASEAN

countries, Moudatsou and Kyrkilis (2011) find that FDI has a positive influence on growth for both regional blocs even though this effect is more pronounced in ASEAN countries.

Previous South African studies

We also present a review of studies for South Africa and we consider this important as these studies are more closely related to our current study. To the best of our knowledge, the works of Fedderke and Romm (2006), Sridharam et al. (2009), Masipa (2014), Mazenda (2014), Agrawal (2015), Sakyi and Egyir (2017) and Sunde (2017) suffice as an exhaustive list of previous empirical studies conducted on the South African economy using econometric techniques.

Beginning with the study by Fedderke and Romm (2006) who use vector error correction models (VECM's) to investigate the FDI-growth relationship between 1960 and 2002. The authors establish a positive correlation between the FDI and growth even though the authors find evidence of FDI crowding our domestic investment in the short-run. Similarly, Sridharam et al. (2009) examined the FDI-growth relationship for South Africa as member of the BRICS countries using VECM technique between 1996 and 2007 and find a positive long-run relationship between FDi and growth for all BRICS countries under the period of investigation. Along the same lines, Masipa (2014) employs Johansen's (1991) cointegration procedure to also concluded that FDI is a conducive factor towards improving and sustaining long-run employment and economic growth.

Applying Johansen (1991) cointegration procedure and estimating an associated VECM model to South African time series collected between 1980 and 2010, Mazenda (2014) finds a significant and negative influence of FDI on economic growth whereas domestic investments exerts a significantly positive effects on economic growth. These results thus offer evidence in support of a crowding out effect of FDI on domestic investment. Conversely, Agrawal (2015) adopt panel cointegration techniques to instigate the FDI-growth relationship for BRICS countries and uncovers a positive relationship between FDI and economic in which increases in FDI lead to increases in economic growth. In a more recent study, Sunde (2017) applies the more robust autoregressive distributive lag (ARDL) model to model the tri-variate relationship between FDI, economic growth and exports in South Africa between 1990 and 2014. The empirical results support conventional theory by depicting a positive relationship between FDI and growth for the data.

4. Econometric model

Empirical studies assessing the impact of foreign direct investment (FDI) on economic growth typically assumes the following econometric framework:

$$Y_t = \alpha f di/g dp_t + \beta X_t + e_t \tag{1}$$

Where Y_t is the per capita GDP growth rate, fdi/gdp_t is the share of FDI in economic growth, X_t represents a vector of conditioning variables and e_t is a well-behaved error term. In deviating from the traditional OLS methodology and other linear estimation techniques used in previous South African case studies (Fedderke and Romm (2006), Sridharam et al. (2009), Masipa (2014), Mazenda (2014), Agrawal (2015), Sakyi and Egyir (2017) and Sunde (2017)), we examine the impact of FDI on the conditional distribution of economic growth. In particular, our empirical quantile regression (QR) can be specified as:

$$Y_t = \alpha(q)fdi/gdp_t + \beta(q)X_t + e(q)_t \tag{2}$$

Where $\alpha(q)$ and $\beta(q)$ represent unknown parameters associated with the qth quantile, $q \in (0, 1)$. As q increases monotonously from 0 to 1, we can investigate the influence of FDI on the whole conditional distribution of economic growth. In particular, the qth conditional quantile function of Y_t can be formulated as:

$$Q(q/F_{t-1}) = \alpha(q)fdi/gdp_t + \beta(q)X_t + e(q)_t \tag{3}$$

In further creating a vector $x_t = (1, Y_{t-1},...,Y_{t-p})$ and denoting β_τ as the regression quantiles, equation (3) can be re-specified as:

$$Q(\tau/F_{t-1}) + e_t = x_t'\beta_\tau + e_t \tag{4}$$

And β_τ are estimated as:

$$\beta_\tau{}^* = \text{arg}_{\beta \in R^{P+1}} \min\square \sum_{t=1}^{T} \rho_\tau(Y_t - x'_t\beta) \tag{5}$$

Where ρ_τ (.) is the quantile loss function which is a tilted absolute value function yielding the qth sample quantile as its solution i.e. $\rho_\tau(u) = u[q - I.(u < 0)]$. Equation (5) can be solved straightforward using linear programming methods.

5. Data and empirical results

Empirical data

All data used in our empirical analysis has been collected between from the World Bank database on an annual basis for a span of 47 years, dating from 1970 to 2016. The dataset consists of the per capita gdp growth rate ($gdp.capita_t$), the share of FDI in GDP (fdi/gdp_t), the share of gross fixed capital accumulation in GDP (inv_t/gdp), CPI inflation rate (π_t), population growth ($population_t$) and terms of trade (tot_t). The descriptive statistics of these variables are reported in Table 1, the correlation matrix amongst the time series are reported in Table 2 whereas the plot of the time series are presented in Figure 1.

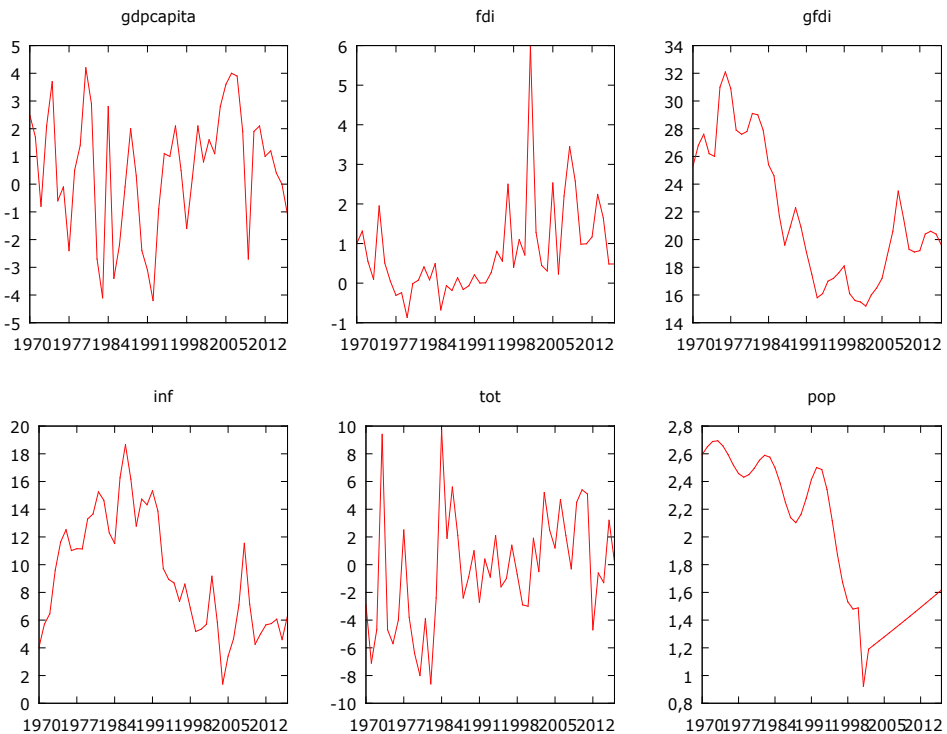## Table 1: Summary statistics of the time series variables

	mean	s.d.	skewness	kurtosis
$gdp.capita_t$	0.53	2.23	-0.42	-0.64
fdi/gdp_t	0.80	1.21	2.04	5.66
inv/gdp_t	21.79	4.91	0.47	-1.02
π_t	9.37	4.19	0.25	-0.99
pop_t	1.99	4.19	-0.23	-1.52
tot_t	-0.29	4.19	0.23	-0.20

Note: Authors own computation

Table 2: Correlation matrix of the time series variables

	$gdp.capita_t$	fdi/gdp_t	inv/gdp_t	π_t	pop_t	tot_t
$gdp.capita_t$	1.00	0.26	-0.11	0.43	-0.28	0.04
fdi/gdp_t		1.00	-0.31	-0.43	-0.58	-0.09
inv/gdp_t			1.00	0.44	0.70	-0.37
π_t				1.00	0.63	-0.18
pop_t					1.00	-0.36
tot_t						1.00

Note: Authors own computation

Figure 1: Time series plot of the variables

As can be observed from the summary of descriptive statistics reported in Table 1, the skewness and kurtosis statistics particularly hint that the time series may not be normally distributed. This observation provides a genuine case for the use of quantile regression over traditional OLS estimates. Also note some of the linear dependences between the variables as depicted by the correlation matrices presented in Table 2, are in contradiction to what is dictated by conventional growth theory, for instance, the negative relationship between FDI and per capita GDP growth as well as the positive correlation between inflation and per capital GDP growth. This further provides a plausible reason for further econometric analysis that would paint a broader picture than that presented by linear estimates. In this sense, quantile regression present a suitable alternative methodology.

Unit root tests

Before we can estimate our empirical QR model, we first perform unit root and cointegration tests in order to avoid the possibility of spurious regressions in our empirical estimates. The concept of a unit root within a time series can be demonstrated by specifying the following autoregressive (AR) model of a time series, y_t, i.e.

$$y_t = \alpha y_{t-1} + e_t \tag{6}$$

Where $e_t \sim$ iid. From regression (6)., the series y_t is said to be stationary if $|\alpha| < 1$ and the series contains a unit root process if $\alpha = 1$. Dickey and Fuller (1979) extend equation (5) to accommodate ARMA structure through the following test regression:

$$y_t = \beta' D_t + \phi y_{t-1} + \sum_{i=1}^{p} \delta_j \Delta y_{t-i} + e_t \tag{7}$$

Where the vector D_t is a vector of deterministic trends. The hypotheses tested are formally given as:

$$H_0: \phi = 1, y_t \sim I(1) \tag{8}$$
$$H_1: \phi = 1, y_t \sim I(0) \tag{9}$$

And the test statistic used to test the above hypothesis is computed as:

$$ADF_{\phi=1} = \frac{\acute{\phi}* - 1}{SE(\acute{\phi}*)} \tag{10}$$

Where $\phi*$ and $SE(\phi*)$ are the least squares estimate of ϕ and the standard error estimate, respectively. The critical values of the ADF tests statistics are reported in MacKinnon (1996). We perform the unit root tests on the levels as well as on the first differences of our time series variables and report the results in Table 3

below. Note that the unit root tests are performed with i) no constant, ii) a constant and ii) a trend, with the maximum lag used in the ADF test based on the modified AIC (MAIC).

Table 3: ADF unit root tests results

time series	levels		first differences	
	drift	trend	drift	trend
gdp.capita$_t$	0.14	-3.51*	-5.83***	-5.83***
fdi/gdp$_t$	-0.46	-4.47***	-3.15**	-3.15
inv/gdp$_t$	-2.45	-5.43***	-2.93*	-2.93
π_t	-2.52	-4.11**	-2.84*	-2.84
pop$_t$	-1.22	-1.52	-5.40***	-5.37***
tot$_t$	-0.61	-0.31	-1.73*	-1.73

Notes: "***", "**","*" denote the 1%, 5% and 10% significance levels, respectively.

Based on the reported results, all observed time series fail to reject the unit root null in the levels of the variables when the tests are performed with a drift. However, when a trend is included the unit root null is rejected for the per capita gdp (10% statistical significance), FDI (significant at all critical levels), domestic investment (significant at all critical levels) and inflation (5% statistical significance) variables. In their first differences, all the time series reject the unit root null at significance levels of at least 10 percent when the test is conducted with a drift. When performed with a trend, only the gdp.capita and population variables reject the unit root null hence rendering the results of the unit root tests performed with a trend as being ambiguous. We therefore consider the results of the test run with only a drift and declare that all series are first difference I(1) variables, a condition which is indicative of cointegration amongst the time series. We thus formally test for cointegration relations within the series in the next section of the paper.

Cointegration tests

The concept of cointegration originated in the seminar work of Engle and Granger (1987). According to these authors, a pair of time series variables can be said to be cointegrated if the variables are mutually first difference variables and collectively produce a stationary error term. Their theorem particularly notes that such a condition will ensure that there exists a singular cointegration vector between the time series over the long-run. Johansen (1991) extend upon Engle and Granger

(1987) by allowing for multiple cointegration vectors or relations for a vector of time series. In particular, Johansen (1991) devised two likelihood ratio tests for cointegration. The first, the lambda-maximum test, is based on the log-likelihood ratio Ln[Lmax(r)/Lmax(r+1) and is conducted sequentially for r = 0, 1, …, k-1. The second test, the trace test, is based on the log-likelihood ratio Ln[Lmax(r)/Lmax(k) and is conducted sequentially for r = k-1, …, 1, 0. Seeing that we have previously found our time series to be difference stationary variables, we are enabled to test for multivariate cointegration vectors amongst the time series. The results of Johansen's (1991) cointegration tests as performed on our time series are found in Table 3 and based on the obtained test statistics for both Eigen and trace cointegration tests, we are compelled to render that there are two cointegration vectors amongst the observed variables.

Table 4: Johansen's test for cointegration

Rank	Eigen statistic	p-value	Trace statistic	p-value
0	175.04	0.00***	75.40	0.00***
1	99.64	0.00***	38.74	0.00***
2	60.90	0.00***	38.15	0.00***
3	22.75	0.27	11.87	0.57
4	10.89	0.22	8.79	0.31
5	2.09	0.15	2.09	0.15

Notes: "***", "**","*" denote the 1%, 5% and 10% significance levels, respectively.

QAR regression estimation results

The quantile regression estimates of our empirical model are reported in Tables 5, and has been executed for nine quantiles (i.e. 10th quantile, 20th quantile, 30th quantile, 40th quantile, 50th quantile, 60th quantile, 70th quantile, 80th quantile and 90th quantile). The plots of coefficients from the quantile functions for each of the time series regressors are provided in Figure 2. Also note that for comparative sake, the OLS estimates of the long-run regression are also reported in Table 1. As can be observed, the OLS estimates indicate a surprisingly negative and significant coefficient on FDI and yet a produces a positive and significant coefficient on domestic investment. Note that these results concur with that obtained from the study of Mazenda (2014) for South Africa and Rahman (2015) for Bangladesh, albeit using different econometric techniques. Other results reported in Table 1 include a correct negative yet insignificant coefficient on inflation, a negative and insignificant coefficient on population and a negative and significant coefficient on terms of trade.

However, the estimates from our quantile regression indicate that the OLS esteems may be depicting an incomplete picture of the actual relationship. For instance, for the FDI variable, we find a negative and significant estimates at the 10th and 40th quantile whereas at the remaining quantiles, the coefficients are negative and insignificant. The insignificant effect of FDI on economic growth has been previously found in the studies of Tang (2015) for EU countries, Naguibi (2002) for Argentina, Chakraborty and Basu (2002) for India, Khaliq and Noy (2007), Herzer et al. (2008) for developing countries as well as Esso (2010) for SSA countries. Concerning the domestic investment, we note positive and significant impact of domestic investment on economic growth at all quantiles with the effect being more pronounced as one moves up the quantiles. In turning to the inflation variable, we note a negative and highly significant coefficients at the lower quantiles (i.e. 10th, 20th, 30th and 40th) as well as at the 90th quantile whilst at other quantiles the coefficients turn insignificant. The coefficients on the population variable remain insignificant throughout the quantiles albeit being positive up to the 30th quantile and turn negative thereafter. Finally, the quantile coefficient estimates on the terms of trade variable are more puzzling, being negative and significant at the 10th and 40th quantiles, positive at the 20th quantile and turning positive and insignificant at all other quantiles.

Table 5: QAR regression estimates on original time series

q	fdi/gdp$_t$		inv/gdp$_t$		π_t		pop$_t$		tot$_t$	
	estimate	p-value	estimate	p-value	estimate	p-value	estimate	p-value	estimate	p-value
ols	-0.43	0.03**	0.36	0.00***	-0.06	0.74	-0.24	0.15	-1.57	0.15
0.1	-0.41	0.00***	0.19	0.00***	-0.23	0.00***	0.21	0.42	-0.12	0.00***
0.2	-0.03	0.26	0.17	0.00***	-0.36	0.00***	0.01	0.79	0.40	0.00***
0.3	-0.08	0.60	0.17	0.02**	-0.29	0.04**	0.48	0.53	-0.10	0.32
0.4	-0.18	0.02**	0.22	0.00***	-0.20	0.00***	-0.14	0.64	-0.15	0.00***
0.5	-0.52	0.27	0.39	0.05**	0.10	0.77	-2.24	0.32	-0.31	0.29
0.6	-0.52	0.26	0.39	0.04**	0.10	0.76	-2.24	0.31	-0.31	0.28
0.7	-0.50	0.15	0.41	0.00***	-0.10	0.67	-1.73	0.28	-0.19	0.36
0.8	-0.24	0.33	0.38	0.00***	-0.24	0.20	-1.09	0.34	-0.13	0.39
0.9	-0.24	0.18	0.38	0.00***	-0.24	0.08*	-1.09	0.20	-0.13	0.24

Notes: "***", "***", "*" represent the 1%, 5% and 10% significance level, respectively.
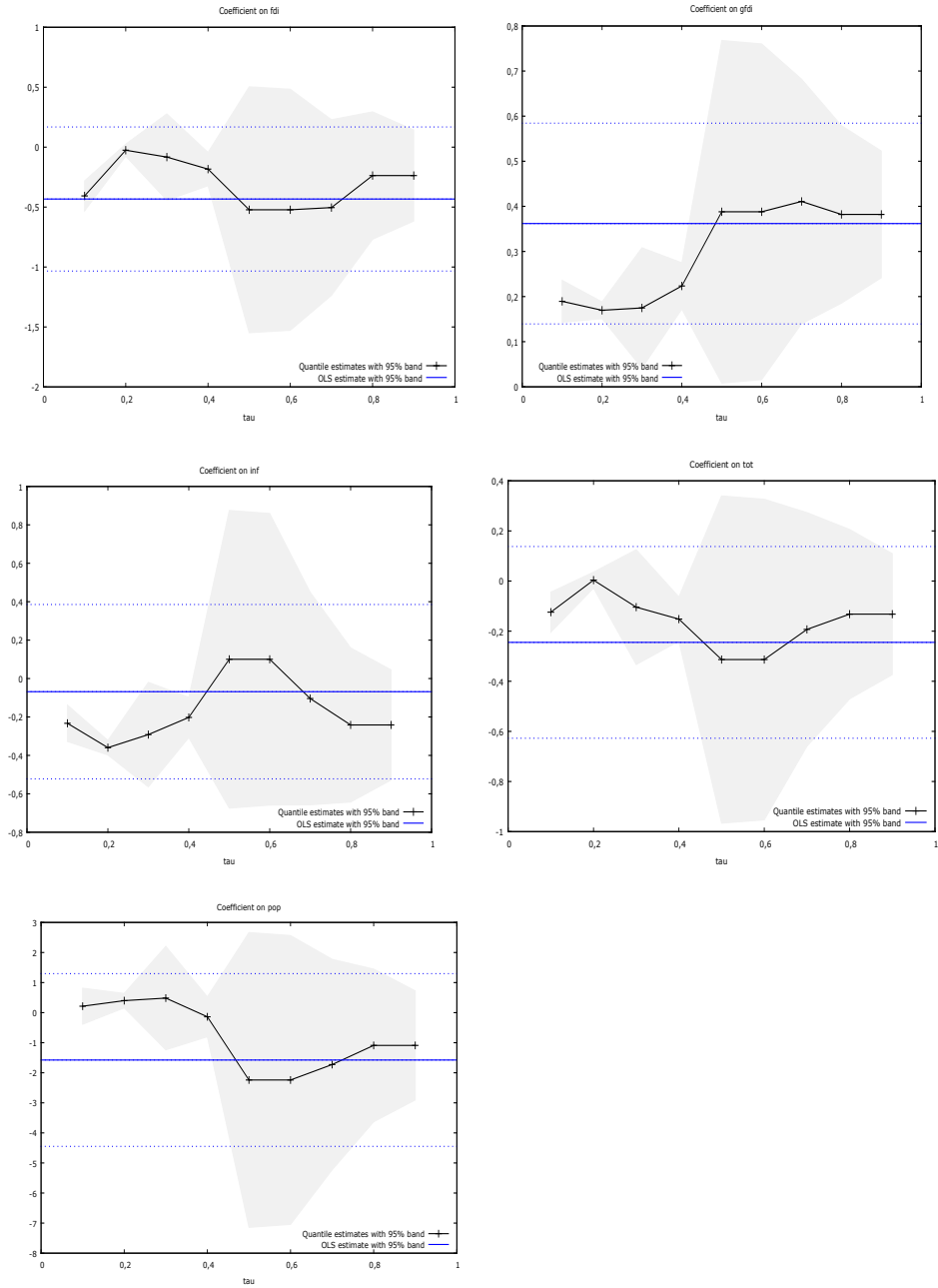
Figure 2: Plots of coefficients from different quantiles

Sensitivity analysis

Notwithstanding, the encouraging results obtained from our initial quantile estimates, we feel it is important to perform sensitivity analysis on our estimated regressions. A significant yet often overlooked factor that would distort the FDI-growth relationship overt time would be the structural break caused by the 2007 global financial crisis. Thus, we conduct our sensitivity analysis as means of ensuring that our estimates are not biased, we segregate our data into two sub-periods corresponding to the pre-crisis (1970-2006) and post-crisis (2007-2016) periods and performed our empirical quantile estimates on the theses sub-samples. In being aware of the danger posed by the low number of observations particular associated with post-crisis period, we interpolate our data from annual to quarterly frequencies as a means of increasing the observations numbers available for empirical use. The results of this empirical exercise are reported in Table 6 with the associated plots of coefficients from the quantile functions for the pre-crisis and post-crisis periods are plotted in Figures 3 and 4, respectively.

In quickly browsing through the OLS estimates, we note that all obtained coefficients are insignificant in both sub-sample periods with the exception of the inflation coefficient in the pre-crisis which produces the correct negative and significant regression estimate. We also summarize the findings of our quantile estimates as follows. For the FDI variable, we note that coefficient estimate is negative and significant at the 60th and 80th quantile and in the 10th, 20th and 90th quantiles in the post-crisis. We also find significant positive coefficient estimate on the domestic investment variable at the 10th and 90th quantile for both pre-and-post crisis periods, the 40th, 60th, 70th and 80th quantile in the pre-crisis periods and the 20th quantile in the post-crisis period. Inflation is also found to have a negative and significant in both sub-sample periods at the 90th quantile whereas the coefficient estimates are negative and significant at all other quantiles for the pre-crisis periods whereas they turn negative and insignificant in the post-crisis data. On the other hand, population is negative and significant at the 60th and 80th quantiles for the pre-crisis period and at the 10th, 20th and 90th quantiles in the post-crisis whereas the remaining coefficient estimates as negative and insignificant. Lastly, terms of trade coefficients are negative and significant at the 60th and 80th quantiles in the pre-crisis and at the 10th, 20th and 90th quantile for the post-crisis period. All-in-all, we observe a change in regression results when account for the global financial crisis, note only for the quantile regressions but also for the OLS estimates.

Table 6: QAR regression estimates on logs of variables

q		fdi/gdpt		inv/gdpt		πt		popt		tott	
		estimate	p-value	estimate	p-value	estimate	p-value	estimate	p-value	estimate	p-value
ols	Pre-crisis	0.33	0.21	0.13	0.22	-0.24	0.00***	-0.15	0.89	0.05	0.60
	Post-crisis	-1.06	0.67	1.19	0.48	-0.53	0.61	-12.30	0.49	-0.20	0.60
0.1	Pre-crisis	-0.03	0.71	0.17	0.00***	-0.36	0.00***	0.40	0.30	0.01	0.94
	Post-crisis	-4.95	0.00***	2.49	0.00***	0.07	0.84	-29.54	0.00***	-0.57	0.00***
0.2	Pre-crisis	-0.03	0.90	0.17	0.12	-0.36	0.09*	0.40	0.73	0.01	0.98
	Post-crisis	-4.95	0.00***	2.49	0.02**	0.07	0.88	-29.54	0.00***	-0.57	0.02**
0.3	Pre-crisis	-0.03	0.90	0.17	0.11	-0.36	0.08*	0.40	0.72	0.01	0.98
	Post-crisis	-0.61	0.62	1.02	0.24	-0.40	0.44	-11.23	0.23	-0.25	0.22
0.4	Pre-crisis	-0.08	0.48	0.17	0.02**	-0.29	0.02**	0.48	0.43	-0.10	0.21
	Post-crisis	0.37	0.73	0.68	0.36	-0.50	0.29	-7.10	0.37	-0.18	0.30
0.5	Pre-crisis	-0.08	0.74	0.17	0.15	-0.29	0.19	0.48	0.71	-0.10	0.53
	Post-crisis	-0.33	0.85	1.31	0.28	-0.85	0.26	-13.11	0.30	-0.13	0.63
0.6	Pre-crisis	-0.76	0.00***	0.50	0.00***	0.32	0.00***	-3.74	0.00***	-0.40	0.00***
	Post-crisis	-1.35	0.54	2.22	0.17	-1.37	0.17	-21.88	0.20	-0.05	0.89
0.7	Pre-crisis	-0.19	0.35	0.30	0.02**	-0.61	0.01**	0.70	0.50	0.05	0.68
	Post-crisis	-1.35	0.54	2.22	0.17	-1.37	0.17	-21.88	0.20	-0.05	0.89
0.8	Pre-crisis	-0.19	0.01**	0.30	0.00***	-0.61	0.00***	0.70	0.03**	0.05	0.14
	Post-crisis	-1.38	0.48	2.25	0.12	-1.32	0.13	-22.36	0.14	-0.05	0.87
0.9	Pre-crisis	-0.19	0.36	0.30	0.02**	-0.6	0.01**	0.70	0.50	0.05	0.69
	Post-crisis	-1.38	0.00***	2.25	0.00***	-1.32	0.00***	-22.36	0.00***	-0.05	0.08*

Notes: "***", "***", "*" represent the 1%, 5% and 10% significance level, respectively.
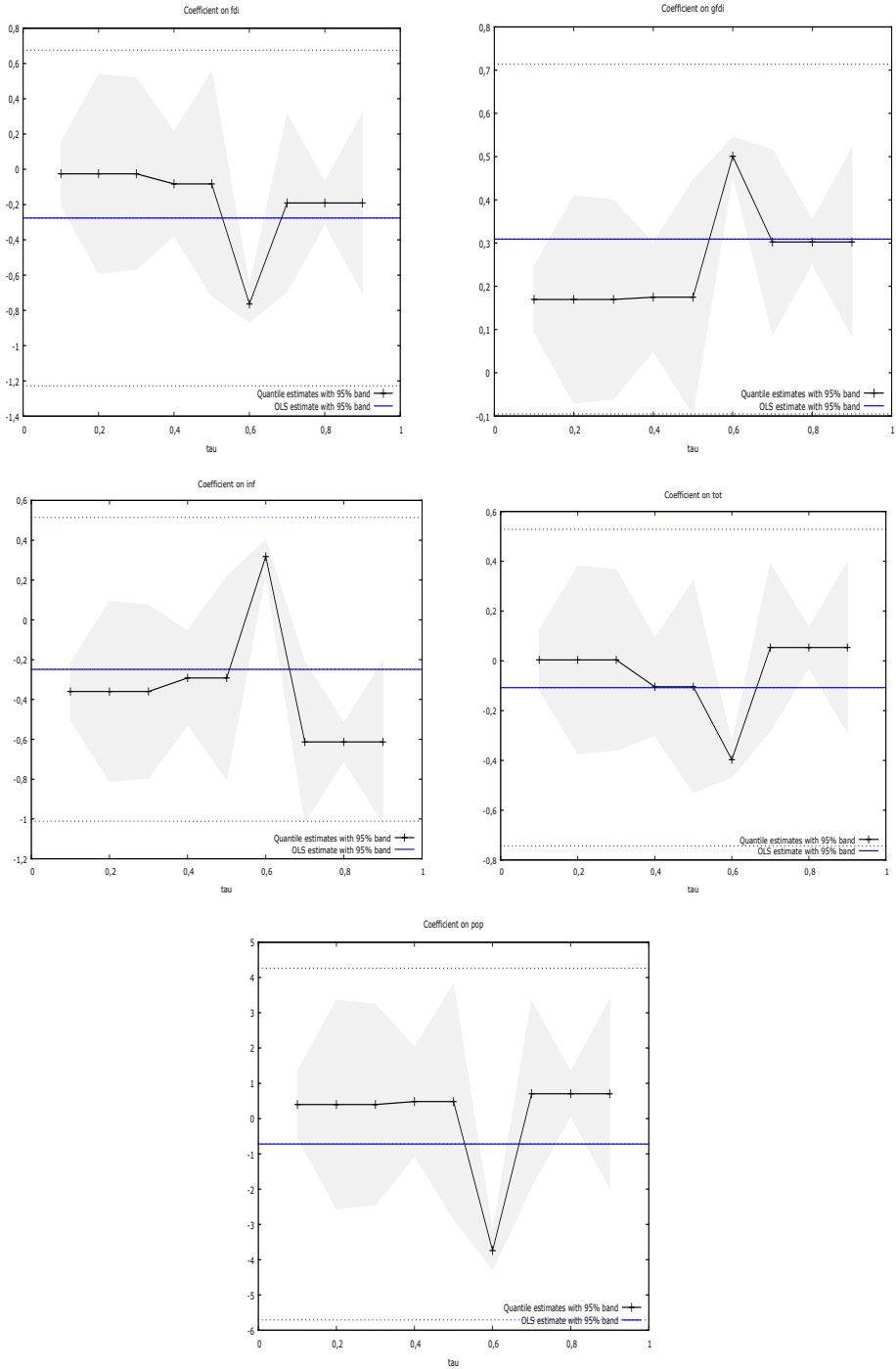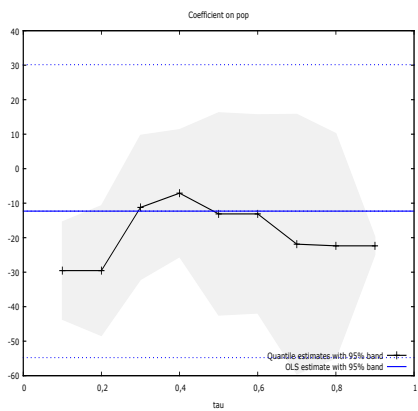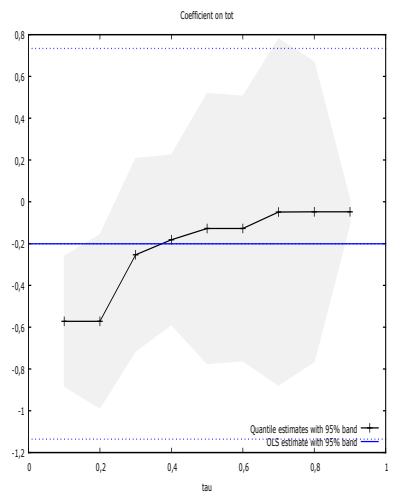
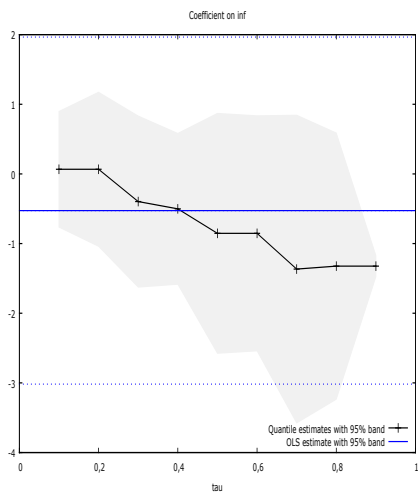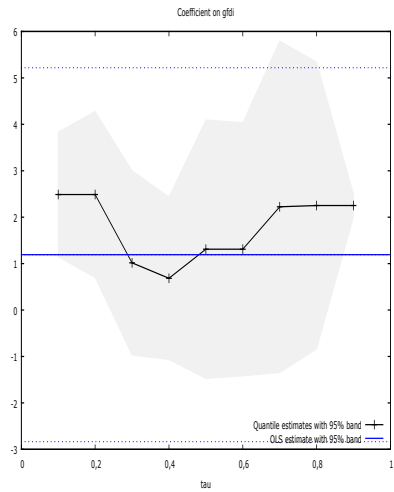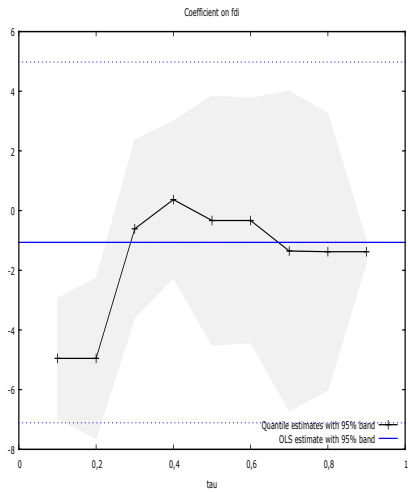**Figure 3: Plots of coefficients from different quantiles (pre-crisis)**

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Figure 4: Plots of coefficients from different quantiles (post-crisis)

6. Conclusion

Much debate has been cast on the relationship between FDI and growth more prominently so during the post 2008-recession era. It is widely believed that FDI is an important component in assisting the world economy recovering from the recessionary period, more specifically so for developing regions. We contribute to the on-going literature by presenting an empirical analysis of the effects of FDI on growth in South Africa, one of the largest recipients of FDI in the Sub-Saharan Africa (SSA) region. In differing from previous South African case studies we use quantile regression approach as opposed to restrictive OLS technique and carry out our analysis using data collected from 1970 to 2016. As part of our sensitivity analysis, we accounted for the global financial crisis as a break period and perform a comparative analysis thereafter.

Concerning the FDI-growth relationship, our results indicate that FDI negatively affects economic growth welfare at lower extreme quantiles more prominently so during the post-crisis period. At other levels, FDI insignificantly influences welfare. Conversely, we find that domestic investment positively affects per capita GDP growth in a majority of quantiles regardless of the observed sample period. Collectively, a plausible policy implication which can be drawn from our analysis is that FDI may be crowding out domestic investment in the aftermath of the global financial crisis via a displacement effect. Our results thus caution policymakers to not only dedicate efforts towards attracting more levels of FDI but should more importantly focus on developing strategies and channels through which FDI can be directed at improving economic welfare in South Africa. Identifying the channels through which FDI can possible influence economic welfare without crowding out domestic investment would thus pose as the main challenge to policymakers. Considering the limited scope of this current study, we are unable to provide answers concerning the channels through which FDI can affect growth and can only speculate on channels such as instituional quality and urbanization. Investigating the possible 'transmission' channels can be empirically reserved for future research analysis.

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