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Full Length Research Paper

Mean-Gini portfolio selection: Forecasting VaR using GARCH models in Moroccan financial market

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This paper focuses on Mean-Gini (MG) method for optimum portfolio selection. The MG framework, introduced by Shalit and Yitzhaki, is an attractive alternative as it is consistent with stochastic dominance rules regardless of the probability distributions of asset returns. Therefore, a MG framework is similar to a corresponding Mean-Variance (MV) framework in that it also uses two summary statistics- the mean and a measure of dispersion to characterize the distribution of a risky prospect. The goal of this paper is to test MG strategy, based on Moroccan financial market data from turbulent market period of the years 2011, 2012, 2013 and 2014. In addition, those outcomes are explicitly tested in terms of Value-at-risque (VaR). The results show that MG strategy is profitable for investors. Moreover, we consider MG strategy to be safer in turbulent times.

Key words: Diversification, MG, mean-variance, Morrocan financial market, portfolio selection, value-at-risk.

INTRODUCTION

The early '50s marked the starting point for the development of modern finance theory, with the work of Markowitz (1952a, 1952b, 1959). The model is supposed to be a reference in efficient portfolio construction.

The investors have the ultimate goal of combining a set of assets with maximum return and a given level of risk amounts to the same thing, or what amounts the same minimal risk for a given level of return. However the application of MV optimization is questionable. In fact a MV optimization does not consider the direction of the

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price movement. Thus, optimizing the variance can prevent investor from losses in same manner as from gains. Moreover, Roll (1977, 1978, and 1979) firstly pointed out other weaknesses of the theory. This evidence forced several theorists to search for other more appropriate models to modelize the best possible return / risk relationship. For instance, Markowitz (1991), Fishburn (1977) and Bawa (1977) proposed mean-lower partial moment approach; Yitzhaki (1982) and Yitzhaki (1984) proposed MG portfolio selection model; Konno and Yamazaki (1991) proposed Mean-Absolute Deviation (MAD) approach; Uryasev (2000) proposed Mean-VaR (Mean-CVaR) type models.

The restrictive character of the variance as a risk parameter led us to choose MG method. The MG strategy uses Gini as a parameter of risk instead of variance. Concept of MG was proposed by Shalit and Yitzhaki (1984; 2005) in finance as an alternative method to the MV approach of Markowitz (1952) because it can outstrip normal assumptions of return distribution and utility function quadratic. Yitzhaki (1982) has shown that the Gini coefficient satisfies the second degree stochastic dominance, which makes the MG model compatible with the theory of expected utility.

In the last twenty years, alternative measures of market risk have been proposed in the literature. The VaR has attracted particular attention. VaR refers to a portfolio's worst outcome that is expected to occur over a predetermined period and at a given confidence level. VaR assumes that returns follow a normal distribution. Particularly, in the case of skewed and fat-tailed returns, the assumption of normality leads to substantial bias in the VaR estimation and results in an underestimation of volatility. Hence, other distributions, such as the student-t and the Generalized Error Distribution (GED), are applied instead.

The above models do not, however, incorporate the observed volatility clustering of returns, first noted by Mandelbrot (1963). The most popular model taking account of this phenomenon is the Autoregressive Conditional Heteroscedasticity (ARCH) process, introduced by Engle (1982) and extended by Bollerslev (1986).

The purpose of our paper is to implement GARCH (1.1) model to forecast quasi-analytic VaR under two different distributional assumptions of returns in order to estimate the 1, 5 and 10% one-day VaR for completely diversified portfolio composed only of assets from the MADEX index over a period of financial crisis on Moroccan financial market. Combined with higher moments using Cornish-Fisher expansion and the Johnson SU distribution, our basic idealization is that financial return series follow a stationary time series model with stochastic volatility structure.

Our study shows that GARCH combined with higher moments using Cornish-Fisher expansion and the Johnson SU distribution provide better estimators of VaR.

The rest of the paper is organized as follows: First, we present the framework of the two models: MV versus MG and value-at-risk estimation by GARCH (1.1) model. Hence we provide a comprehensive data and methodology. Finally, we apply MG model and calculate VaR estimation by GARCH (1.1) model with Cornish-Fisher expansion and the Johnson SU approximation; and we recall some definitions.

METHODOLOGY

Mean-variance

A portfolio is defined to be a list of weights x_i for assets $Si, i=1;.....;n$, which represent the amount of capital to be invested in each asset. We assume that one unit of capital is available and requires that capital to be fully invested. Thus, we must respect the constraint that $\sum_{i=1}^{n} x_i$ = 1. The return of portfolio (Rp), obtained by Rp = $\sum_{i=1}^{n} x_i r_i$ (xi is the amount invested in asset i, ri is the expected return of asset i per period).

In the traditional Markowitz portfolio optimization, the objective is to find a portfolio which has minimal variance for a given expected return. More precisely, one seeks such that:

$$\text{Min } \sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} W_i W_j \rho_{ij} \sigma_i \sigma_j$$

Subject to:

$$\begin{cases} R_p \geq \mu \\ \sum_{i=1}^{n} x_i \\ x_i \geq 0, 1 \leq i \leq n \end{cases} \quad (1)$$

Where σ_{ij} is the covariance between the returns of Si, Rp is the return of portfolio and Sj and μ are the minimal rate of return required by an investor.

Mean-Gini

The MG approach, consistent with stochastic dominance for decisions under risk, is ideal for portfolio analysis for a great variety of financial assets. The MG analysis introduced by Shalit and Yitzhaki (1984) in finance defines the Gini coefficient as an index of variability of a variable random.

The idea used by these authors assumes that the cumulative distribution corresponding to the observation with rank t is t/T.

Specifically, Dorfman (1979) and Shalit and Yitzhaki (1984) retain as a measure of the Gini coefficient :

$$\Gamma_p = 2\,\mathrm{cov}\left(R_p, F\left(R_p\right)\right)$$

Where Rp is the return of portfolio and F is the cumulative distribution function.

$$\Gamma_p = 2\,\mathrm{cov}\left(R_p, F\left(R_p\right)\right) = 2\sum_{i=1}^{n} x_j\,\mathrm{cov}\left(r_i, F\left(R_p\right)\right)$$

The MG mathematical model is presented as follows:

Minimize: Γ_p
Subject to:

$$\begin{cases} R_p \geq \mu \\ \sum_{i=1}^{n} x_i \\ x_i \geq 0, 1 \leq \mathrm{i} \leq \mathrm{n} \end{cases} \qquad (2)$$

Where Γ_p is the portfolio Gini, xi is the amount invested in asset Si, ri is the expected return of asset Si per period, μ is the minimal rate of return required by an investor (Cheung et al., 2007; Jaaman and Lam 2012).

Value-at-risk (VaR)

Value-at-risk is a measure of risk. It represents the maximum loss of the portfolio with a certain confidence probability $1-\alpha$, over a certain time horizon. Approaches to the estimation of VaR fall into one of four categories: the variance-covariance (or parametric or analytic) approach, historical simulation (or the non-parametric approach), Monte Carlo simulation, and the extreme value. The most widely used of these is variance-covariance approach, popularized by Morgan (1996). Formally, if the portfolio's price P(t) at time t is a random variable where S(t) represents a vector of risk factors at time t, then the value-at-risk (VaR_α) is implicitly given by the formula :

$$\Pr ob\left\{-P(t) + P(0) > VaR_\alpha\right\} = \alpha$$

In the case of normal distribution, the parametric VaR is calculated by:

$$VaR_\alpha = \bar{R} - \sigma \times z_\alpha$$

Where z_α is the quantile from a normal distribution.

Zangari (1996) and Favre and Galeano (2002) provide a modified VaR calculation that takes the higher moments of non normal distributions (skewness, kurtosis) into account through the use of a Cornish-Fisher expansion.

$$z_{\alpha f} = z_\alpha + \frac{\left(z_\alpha^2 - 1\right)S}{6} + \frac{\left(z_\alpha^3 - 3z_\alpha\right)K}{24} - \frac{\left(2z_\alpha^3 - 5z_\alpha\right)S^2}{36}$$

$$VaR_{CF} = \bar{R} - \sigma \times z_{\alpha f}$$

Where S is the skewness of R and K is the excess kurtosis of R.

The Johnson SU distribution we used here differs from the Cornish-Fisher approach. It transforms a random variable z in a standard normal variable x, and writing in general:

$$x = \xi + \lambda \sinh\left(\frac{z - \gamma}{\delta}\right)$$

Where z is a standard normal variable; ξ and λ shape parameters; γ the location parameter and δ scale parameter.

The Johnson SU value-at-risk is obtained by:

$$VaR_{JSU} = -\lambda \sinh\left(\frac{z_\alpha - \gamma}{\delta}\right) - \xi$$

GARCH (1.1) model

For the present study, volatility was estimated by fitting a GARCH (1.1) model to each portfolio. This is a familiar model in econometrics (Shephard, 1996; Hartzet, 2006: Alexander et al., 2013). If y_t denotes the observed series (in this case, the observed daily return) on day t, assumed standardized to mean 0, then the model represents y_t in the form:

$$y_t = \sigma_t \varepsilon_t ,$$

Where ε_t are i.i.d. N(0; 1) random variables, and the volatility σ_t is assumed to satisfy an equation of the form :

$$\sigma_t^2 = \alpha_0 + \alpha_1 y_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

Data and description statistics

This paper focuses on Moroccan financial market. We consider a portfolio constituted solely by assets from the MADEX index, over the period from January 1, 2011 to November 14, 2014 (Figure 1).

We use the first 714 daily returns, corresponding to the period from March 1, 2011 to November 12, 2013, to estimate the volatility

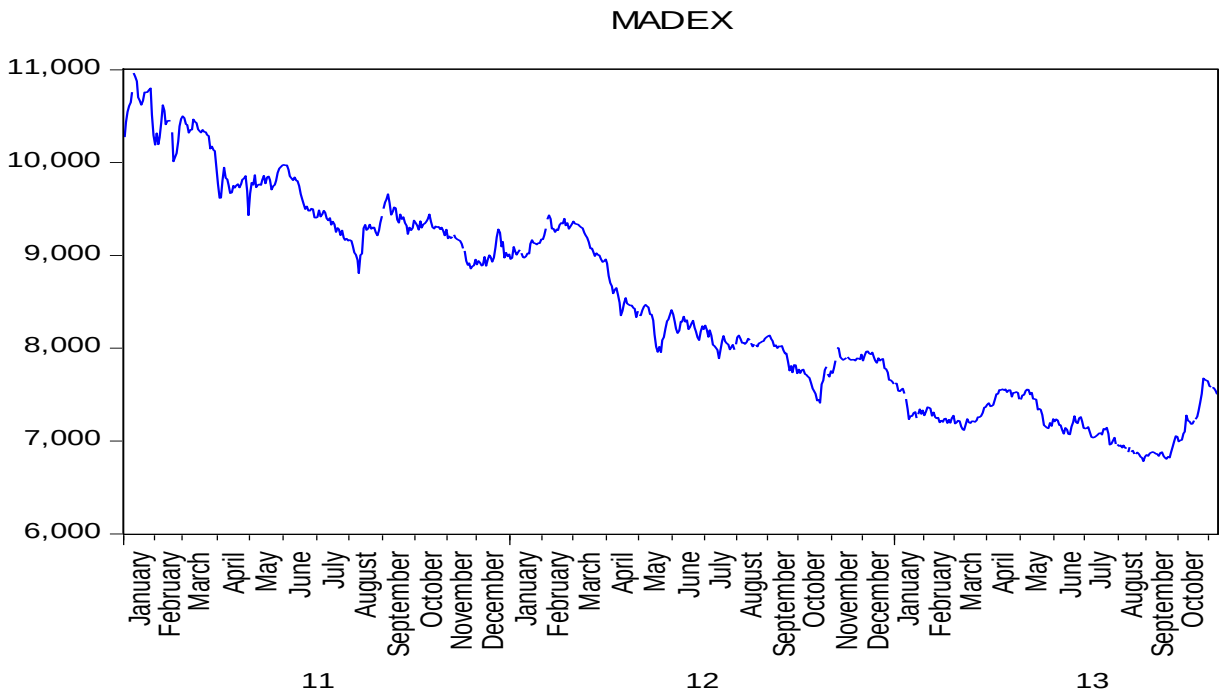

Figure 1. Evolution of MADEX.

using a GARCH model.

For the second period, from November 12, 2013 to November 14, 2014 (250 values), we estimated VaR at horizon h = 1 day and level α = 1, 5 and 10% using a GARCH (1, 1) on the first period, and kept this GARCH model for all VaR estimations of the second period. The estimated VaR and the effective losses were compared for the 250 data of the second period.

The six risky assets selected from are those most sensitive during this period: Addoha, Atlanta, BCP, Delta Holding, Mangem and Maroc Telecom. This study begins with an analysis of the characteristics of six selected assets that allows the construction of a portfolio using the MG strategy to determine the weights of the six assets. Figure 2 is plotted to illustrate stock returns and descriptive statistics are presented in Table 1.

The results of normality tests (Jarque-Bera) strongly for every stock led us to reject the null hypothesis of the normality test at 99% confidence level. These results are evidenced well-known property of financial data series, i.e. returns are usually not normally distributed. In addition, skewness and kurtosis, other properties of risky assets have been discovered that are true for our data. Since both problems are true to our data, we assume that, using the Mean- Gini strategy should end with the best portfolio, due to the fact that the Gini exceeds normal return distribution assumptions. Based on these results, we assume that in the context of our data, MG strategy must be better than the MV strategy.

After the resolution of optimization programs of the MG strategy, we obtained the optimum portfolio.

Table 2 presents percentage of stocks in optimal MG portfolio. Results show that the composition MG portfolio is diversified by combining all shares. BCP is the dominant share with 48. 90% of the funds invested in the MG portfolio that is due to the fact that its return is close to that required and risk is the smallest. While, Mangem is the smallest component of the MG portfolio (1. 19%).

Table 3 presents summary statistics of optimal portfolios obtained by the resolution of optimization programs (2). The return target for MG portfolio is -0.0002, higher than the MADEX index average return during this study period.

Table 4 presents the different tests of stationary, so we accept the alternative hypothesis that the series of returns of the two portfolios are stationary. The result of the test ARCH impels us to reject the null hypothesis. Therefore, it is assumed that the residual variance is not homoscedastic. So the prediction of VaR for MG portfolio will be made on a GARCH (1.1) model (Figure 3).

NUMERICAL RESULTS

The results of the goodness-of-fit tests for different models ARMA/GARCH show clearly that a combination

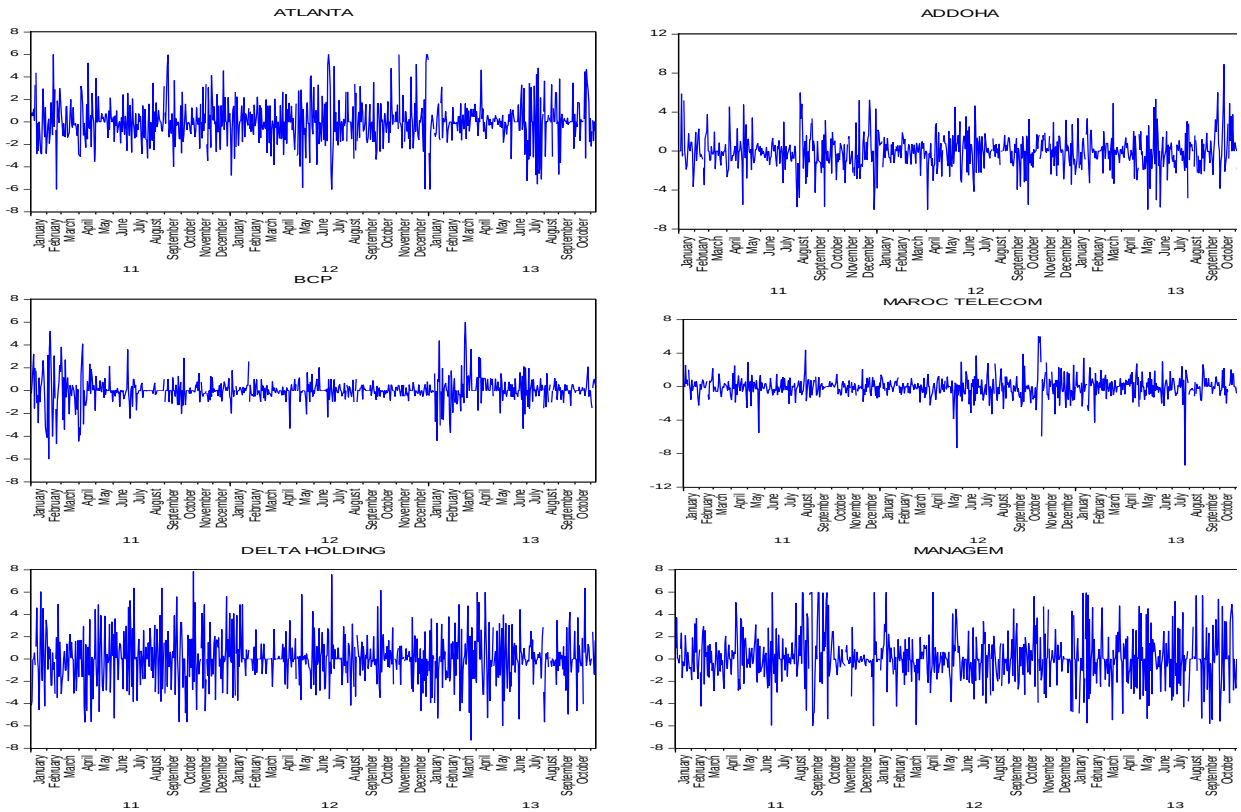

Figure 2. Evolution of returns of different assets.

Table 1**.** Descriptive statistics.

	Addoha	Atlanta	BCP	Delta Holding	Mangem	Maroc Telecom
Mean	-0.8228	0.0029	-0.0127	0.0607	0.1632	-0.0574
Std. Dev %	1.7076	1.9633	1.0677	2.1724	2.0231	1.2282
Gini %	0.0091	0.0106	0.0050	0.0118	0.0108	0.0061
Skewness	0.0087	0.3413	-0.4397	0.2658	0.4038	-0.0065
Kurtosis	4.9631	4.1469	9.8029	3.8739	4.5224	9.8548
Jarque-Bera	81.0994	37.4845	990.0570	22.0168	62.4877	988.7219

of AR (1)-GARCH (1.1) with Gaussian residuals and student-t residuals are the appropriate models from a statistical point of view for the portfolio.

The process used to estimate the parameters of the GARCH (1.1) model from historical data is known as the maximum likelihood method. This method involves choosing values for the parameters that maximize the likelihood of the data occurring. The problem is to estimate a variance of the returns from m observations of the variable when the underlying distribution is normal

Table 2. Percentage of stocks in optimal portfolios.

Addoha	5.98
Atlanta	6.32
BCP	48.90
Delta Holding	8.96
Mangem	1.19
Maroc Telecom	28.65

Table 3. Summary statistics of optimal portfolios.

Mean	-0.020
Median	-0.051910
Maximum	2.928983
Minimum	-3.178777
Std.Dev	0.779238
Gini	0.4112586
Skewness	-0.027186
Kurtosis	5.398.624
Jarque-Bera	121.1233

Table 4. Unit root tests of the series of returns.

Tests	MG	Test critical value : 1% level
ADF	-21.263317	-2.568790
KPSS	0.039752	0.739000
ERS	0.128421	1.99
ARCH	68.57045	

with zero mean (Tables 5 and 6).

Back-testing VaR estimates

We evaluate the accuracy of the proposed VaR estimates over 250 day using the now standard coverage tests of Christoffersen (1998). We combine the GARCH (1.1) model with two approximation methods, the Johnson SU distribution and the Cornish-Fisher expansion, and derive the VaR estimates for the portfolio for α = 10, 5 and 1%.

In the finance literature there are basically two test procedures to compare the performances of VaR: Unconditional and Conditional.

We make use of Kupiec's (1995) test to evaluate GARCH specifications for unconditional coverage and Christoffersen test to embrace both unconditional coverage and the independence of violations. Kupiec Test and Christoffersen test results for the portfolio are reported in Tables 7 and 8.

Table 5. Estimating parameters of GARCH (1.1) model with normal distribution.

Parameters	Coefficient	Probability
C	-0.084234	0.0929
α_0	0.046909	0.0000
α_1	0.136320	0.0001
β_1	0.769239	0.0000

Table 6. Estimating parameters of GARCH (1.1) model with student-t distribution.

Parameters	Coefficient	Probability
C	-0.099031	0.0362
α_0	0.040060	0.0102
α_1	0.156102	0.0000
β_1	0.770181	0.0000

Table 7. Unconditional coverage and conditional coverage of VaR.

Cornish-fisher vaR			
Significant level	**Coverage test**	**Normal**	**Student-t**
1%	N	0	0
	Rate	0	0
	LRuc	NA	NA
	LRind	NA	NA
	LRcc	NA	NA
5%	N	8	9
	Rate	0.032	0.036
	LRuc	1.90673	1 .10914
	LRind	NA	NA
	LRcc	NA	NA
10%	N	20	34
	Rate	0.08	0.136
	LRuc	1.14094	3.35613
	LRind	1.37955	3.97297
	LRcc	2.52049	7.32911

Tables 7 and 8 present the different tests of VaR. The results show the great accuracy for all significance levels that we considered for GARCH VaR forecasting. The results are better for this sample. None of the normal models and the student-t models are rejected in the

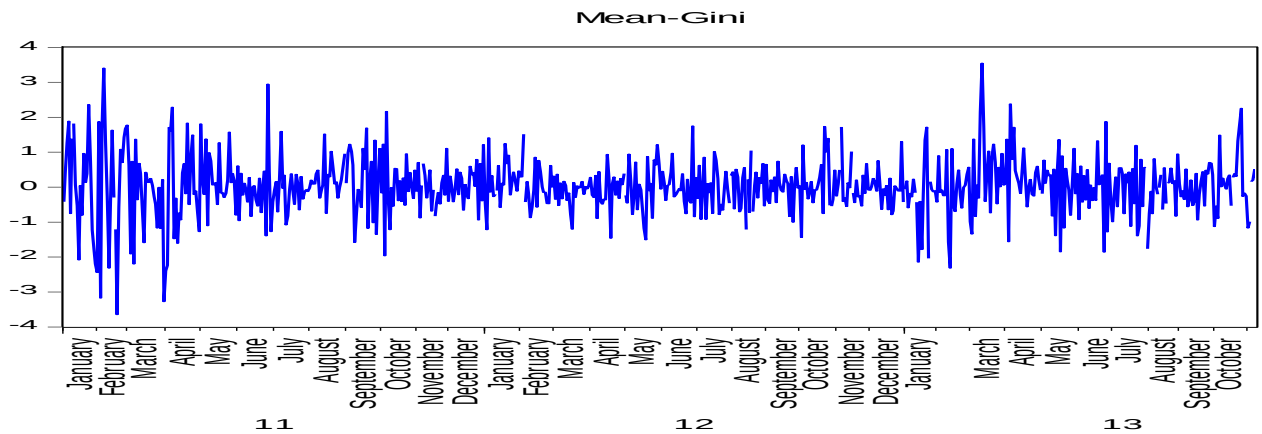

Figure 3. Evolution of MG portfolio.

Table 8. Unconditional coverage and conditional coverage of VaR.

	Johnson SU VaR		
Significant level	**Coverage test**	**Normal**	**Student-t**
	N	4	4
	Rate	0.016	0.016
1%	LRuc	0.78136	0.78136
	LRind	NA	NA
	LRcc	NA	NA
	N	10	9
	Rate	0.04	0.036
5%	LRuc	0.54257	1.10915
	LRind	NA	NA
	LRcc	NA	NA
	N	20	19
	Rate	0.08	0.076
10%	LRuc	1.14094	1.67769
	LRind	1.37955	1.80681
	LRcc	2.52049	3.48449

independence test, across all significance levels. Overall, the normal models perform slightly better than the student-t model for the Cornish-Fisher expansion and the opposite for the Johnson SU distribution.

The results obtained by combining the same GARCH model with different approximation methods are slightly better with the Johnson SU approximation in cases. Actually, the only GARCH model which yields better results when coupled with the Cornish-Fisher expansion than with the Johnson SU distribution is α = 1%.

Conclusion

In his paper, we intend to achieve two objectives. First, discuss and make a comparison in crisis periods of analytical results obtained with MG strategy on the Moroccan financial market where MV strategy is not expected to be appropriate because of its strict distributional requirements on asset returns. Second, demonstrate empirically that quasi-analytic GARCH VaR forecasts can be accurately constructed using analytic formula for higher moments of aggregated GARCH returns by using Cornish-Fisher expansion and the Johnson SU distribution.

Results show that the composition of MG method have the great accuracy for all significance levels (10, 5 and 1%); we considered GARCH VaR for forecasting. Our results are even more remarkable when we consider that the analysis is entirely out-of-sample and that the testing period (2011-2014) contains several years of excessively turbulent financial markets. At the end of this study, we identified the following findings:

Firstly, returns are not normal because their distribution are positively or negatively skewed and leptokurtic or platykurtic as in the case of our data. Second, the volatility is not stable in time for that the use of GARCH

models to take into account the volatility dynamics is crucial in predicting the value-at-risk. Finally, in financial crisis environment, it may be of critical importance to implement the best strategy which fits the investor's preferences as good as possible. In fact, MG strategy is the appropriate strategy for portfolio analysis and risk management.

Conflict of Interests

The authors have not declared any conflict of interest.

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Journal of Economics and International Finance

Full Length Research Paper

The role of foreign aid in reducing poverty: Time series evidence from Ethiopia[i]

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Driven by recent shifts in international financial flows towards poverty reduction and the concentration of previous studies on aid economic growth relationships, this study took a new metric to investigate aid's effectiveness, that is poverty reduction. Based on this objective, the study employed multivariate cointegration analysis to a time series data from Ethiopia over the period 1975-2010. The empirical results indicated that foreign aid has a significant effect on poverty reduction, by reducing infant mortality rate and increasing household consumption expenditure. On the other hand, its impact found to be negative when poverty is measured by gross primary enrollment ratio. Nonetheless, when augmented by macroeconomic policy index the impact turned to be positive. Furthermore the result indicated the presence of diminishing returns to the inflow of foreign aid. The results also revealed that economic growth has a significant contribution for poverty reduction, while poor quality of governance exacerbates poverty. Thus, to achieve the poverty reduction objectives, measures have to be taken in the area of aid allocation, quality of governance and macroeconomic policies that can ensure sustainable economic growth.

Key words: Foreign aid, poverty reduction, cointegration analysis, Ethiopia.

INTRODUCTION

Foreign aid first began as international post-war assistance in the late 1940s with the statement of the Marshal plan in which its purpose was to reconstruct the war- torn economy of Western Europe. The success of the Marshall plan in the post WWII period led to the development of more optimistic thinking about the role of foreign aid. As discussed in the gap models and the big push theory, this thinking proposes that, with such an access to transfer of resources, low income countries and/or the LDCs could come to the development track as Western Europe countries did. In addition to this, foreign aid was also set as an essential prerequisite for the economic advancement of developing countries by (which is low due to the vicious cycle of poverty) and

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JEL classification: F23; F36; F43; O16; O30

propelling the economy out of "low-level equilibrium trap"[1] (Hjertholm and White, 1998; United Nations, 2006).

Based on these general propositions the more affluent countries and international organizations have provided large amounts of aid targeted to be used in large scale investments to bring the desired level of economic growth and well being in the low income countries. Accordingly developing countries continued to receive large amounts of aid from both multilateral and bilateral sources. According to World Bank (1998) these financial flows have two broad objectives; promoting long term growth and poverty reduction in developing countries and promoting short-term political and strategic interests of donor countries.

Being one of the developing countries, Ethiopia has received large sum of development assistance and continued to be one of the major recipients of international aid in recent times also. Based on Organization for Economic Cooperation and Development - Development Assistance Committee (OECD-DAC) statistics, net ODA to Ethiopia amounted to USD 3.563 billion in 2011, making the country the largest non-war destroyed aid recipient among aid receiving developing countries. The World Bank database shows that net ODA as a percentage of gross national income (GNI) is still significant and high relative to many developing countries (13.43% on average from 2000-2010 reaching a peak of 19.15 in 2003). The share of ODA in total government expenditure is also very high accounting to more than 50% in 2000s.

Given the large volume of aid the country had received for decades several empirical studies, using periodic data, have been conducted on the impact of foreign aid (ODA). However, these research works tried to investigate aid's effectiveness in stimulating economic growth. Consequently they have concentrated only on macroeconomic variables - investment, saving, government spending - that determine economic growth (Siraj, 2002; Tadesse, 2011; Birrara, 2011; Siraj, 2012). Unlike these studies, this paper focuses on investigating aid's effectiveness on its ability to reduce poverty in Ethiopia.

With broader scopes a number of scholars had also analyzed the impact of foreign aid using a time series as well as a cross-country data for decades. However, the literature on the role of aid in poverty reduction is highly limited: which is mainly because studies with the main objective of investigating the effectiveness of foreign aid in reducing poverty began to emerge only recently. In addition to being limited and cross-country data based, the results of these studies have been also found to be contradictory. Studies conducted by Mosley et al. (2004), Gomanee et al. (2003), Asra et al. (2005), Masud and Yontcheva (2005) and Alvi and Senbeta (2011)….have shown that aid has resulted in poverty reduction in poor countries and thereby contributed significantly to their development progress. In contrast, opposing strand of literature argue that foreign aid has a negative impact on growth and even worsens poverty (e.g. Boone, 1996; Easterly, 2005; Magnon, 2012). The evidence brought to be on this contention is that many countries are still desperately poor after 50 years of assistance and that many parts of the developing world made rapid progress long before the advent of the official development assistance[2]. These critics further state that, international assistance may support governments who are pursuing policies that are obstructing development; and by increasing the power of government, assistance breeds corruption, inefficiency and tensions in the society which retards development and encourages irresponsible financial policies. They also mentioned that if the assistance is free (pure aid) there may be no incentive to use resources productively. Some even argue that if foreign aid were indispensable for emergency from poverty, the rich countries of today could not have developed because they did not receive foreign aid (Dorn, 2004; Niaz, 2011). Some scholars, again say it has a positive and significant impact in a good policy environment and relates aid's effectiveness with political sphere (Collier and Dollar, 1999; World Bank, 1998, 2002; Burnside and Dollar, 2000).

This controversy underscores the need to undertake a study at country level and investigate empirically whether aid have positive, negative or no relation (depends on other factors to be effective) with poverty reduction. Specifically the study has the following objectives:

a. The conditional effectiveness of aid on macroeconomic policy; whether the relationship between aid and poverty is conditional on macroeconomic policy stance.
b. The impact of aid when different measures of poverty are used. Does the measure matters?
c. Whether aid's effectiveness depend on its size or not.

MATERIALS AND METHODS

Sample selection and data

The study is conducted using a secondary country level macroeconomic and demographic data covering the period from 1974/75 to 2009/10. The time period is chosen based on the availability of relevant data. The data used in this study is collected from various sources which can be grouped into two main categories as data from government organizations and online databases. Accordingly, the first category includes National Bank of Ethiopia (NBE), Central Statistical Authority (CSA) of Ethiopia, Ministry of Finance and

[1] Low – level equilibrium trap refers to an economic condition where the change in capital labor ratio ($K\Delta/\Delta L$) is constant. This implies that the change in percapita income is zero (Subarata, 2005).

[2] Supporting this justification, Salmonsson (2007), stated that, "when foreign aid was introduced, the target was to reduce poverty with 50%within 10 years. After more than 50 years and more than a 2.3 trillion USD spent on foreign aid, more than 2 billion people still are living in extreme poverty situations"(pp-1).

Table 1. Description of variables.

Variable	Description	Measurement
IMR	Infant mortality rate	No of deaths before first birth day out of 1000 live births
GPI	Gross primary enrollment ratio	Out of 100 %
RHFCE	Real household final consumption expenditure	In millions of birr
RGDP	Real GDP	In millions of birr
ODA	Official development assistance	% of real GDP
PODA	Policy index interacted with ODA	ODA * policy index[ii]
GEOE	Government expenditure on education	% of gov't expenditure
GEOH	Government expenditure on health	"
ODA^2	Squared ODA	
GOV	Indicators of quality of governance[iii]	1-7

Economic Development (MoFED) and Ethiopian Economic Association (EEA) database (2012). The online data sources include United Nations Development Program (UNDP), World Bank (WB), Organization for Economic Cooperation and Development (OECD) and Freedom House databases.

Model specification

Poverty: being a multidimensional phenomenon it has no single stated unit of measurement. The Foster–Greer–Thorbecke (FGT) index (class of poverty measures) is one of the widely used measures of poverty in empirical works which enable the calculation of three indexes; poverty head count index, poverty gap index and poverty severity index using the following expression:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{Z-Yi}{Z}\right)$$

Where Y_i is real per-adult (per capita) household expenditure, Z is poverty line, N is the total population, and q is the number of poor. α takes the value of zero for the headcount index, 1 for the poverty gap index and 2 for the squared poverty gap (MoFED, 2012). However, the figures which are inputs to calculate this index are often collected from household surveys which are conducted in a four or five year intervals. Thus, this index is more favorable for panel data analysis and is not used in this study.

Among the monetary indicators of poverty (income and consumption), consumption expenditure is the widely used and accepted variable to measure poverty. Consumption rather than income is viewed as the preferred welfare indicator because consumption better captures the long-run welfare level than current income. Household income, for example, by its very nature could fluctuate widely while consumption could be smoothed out over time through various coping mechanisms (MoFED, 2012).

Consumption may also better reflect households' ability to meet basic needs. However, using consumption expenditure as an only measure of poverty to analyze the impact of foreign aid on poverty may end up with a poor proxy. This is due to the fact that poverty is associated not only with insufficient consumption but also with insufficient outcomes with respect to health, nutrition, and literacy, and with deficient social relations, insecurity, and low self-esteem and powerlessness (Coudouel et al., 2002).

Due to the problems with the above measures, a number of recent research works start the utilization of indices that take into account the human development or deprivation aspects of individuals (households) in addition to the conventional measures of poverty. Their use is based on the general argument that improvements or a reduction in these measures implies indirectly the wellbeing and the status of the people in that country. These measures include the Human Development Index, Human Poverty Index (introduced very recently), infant mortality rate, life expectancy, literacy rate, asset holdings, and percentage of the population with access to safe water and adequate sanitation as well as other non monetary measures (Nakamuray and McPhersonz, 2005; Gomanee et al., 2003; Morrissey et al., 2004; Moser and Ichida, 2001; Mapango, 2012; and Lamb, 2010).

Accordingly, this paper used infant mortality per 1000 live births and gross primary enrollment ratio with private consumption expenditure, as measures of poverty. Gross primary enrollment refers to the ratio between the total enrollment at a particular level of education regardless of age, and the population corresponding to the official age (5 to 9 years) at that level. As of Baluch and Shahid (2008), this ratio can be computed using the following formula:

$$GRE_{pt} = \frac{TEP_t}{TP_t}$$

Where, $GREp_t$ = Gross enrollment at primary level of education in year t, TEp_t = Total enrollment at primary level of education in year t (regardless of age) and TP_t = Total population of corresponding official age group (5-9 years) in period t.

Based on previous literatures and arguments on poverty reduction the following variables are identified as determinants of poverty reduction: economic growth, foreign aid, government expenditure on pro-poor sectors, and quality of governance (Table 1).

Based on the above description and related literatures, the general form of the model is structured as follows:

$$\text{Log (Poverty measure)}_t = \alpha + \beta_1 \log \text{RGDP}_t + \beta_2 \log \text{ODA}_t + \beta_3 \log \text{PODA}_t + \beta_4 \log \text{GE}_t + \beta_5 \log \text{GOV}_t + \beta_6 \log \text{LODA}^2{}_t + \varepsilon_t \ldots\ldots (1).$$

As noted above, poverty is measured by three different indicators, implying estimation of three models. Thus, the models are specified as follows:

Poverty measured by Infant Mortality Rate

$$\text{L(IMR)}_t = \alpha_1 + \beta_1 \text{LRGDP}_t + \beta_2 \text{LODA}_t + \beta_3 \text{LPODA}_t + \beta_4 \text{LGEOH}_t + \beta_5 \text{LGOV}_t + \beta_6 \text{LODA}^2{}_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2).$$

Poverty measured by Gross Primary School Enrollment Ratio

$$L(GPI)_t = \alpha_2 + \gamma_1 LRGDP_t + \gamma_2 LODA_t + \gamma_3 LPODA_t + \gamma_4 LGEOH_t + \gamma_5 LGEOE_t + \gamma_6 LGOV_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3).$$

Poverty measured by Real Household Final Consumption Expenditure

$$L(RHFCE)_t = \alpha + \delta_1 LRGDP_t + \delta_2 LODA_t + \delta_3 LPODA_t + \delta_4 LGOV_t + \delta_5 LODA^2{}_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4).$$

Except in the first model, poverty reduction is indicated by improvement (increment) in the values of the poverty indicators. Accordingly, all the explanatory variables except the governance indicator are expected to contribute positively in the two models. With regard to the first model, when infant mortality declines it can be said that poverty is reduced. Thus, in this model, except that of governance indicator, all coefficients on the explanatory variables are expected to have negative signs.

Observed from previous studies (Lensink and White, 2001; Asra et al., 2005), the impact of aid on poverty reduction is found to depend on the size of aid rather than being constant. Thus, to examine the existence of nonlinear relationship between aid and poverty reduction, the variable ODA^2 is incorporated in the above models. Accordingly, the coefficient on $LODA^2$ is expected to be positive in the first model and negative in model 3[3], implying that aid (ODA) improves the poverty condition but too much aid might not have a proportional effect in reducing poverty.

Estimation technique

Since the data used is time series, preliminary tests have to be conducted before proceeding to estimation. The first test is unit root test which helps to insure that the mean and variance are the same for all t =1, 2... T, and the auto covariance, $\gamma_s = Cov(Y_t, Y_{t-s})$, depends on s but not on t, where s subscripts individual observation and t proxies time (Nielsen, 2007). This is important since stationarity of the variables used in a regression is crucial for the properties of standard estimation and inference. In this paper, unit root test is conducted using the Augmented Dickey-Fuller (ADF) and Philips- Perron tests. ADF test has an advantage over the other tests for it takes care of error autocorrelations by including lagged values which is, for instance, not applicable in Dickey-Fuller tests.

Cointegration test

If the variables found to be non-stationary at level it became necessary to check the presence of long run relationships (cointegration) between the variables considered. One method of cointegration test is by using the maximum likelihood estimator from the Johansen maximum likelihood procedure. This method allows for testing the presence of more than one cointegrating vector and also gives asymptotically efficient estimates of the cointegrating vectors (the_β's) and of the adjustment parameters (the_α's). To conduct a test for co-integration in a multivariate framework using Johansen's maximum likelihood procedure, first a general VAR (Vector Autoregressive) model has to be formulated. Considering k lags, a general VAR (k) model is formulated as:

$$Y_t = A_1\ Y_{t-1} + A_2\ Y_{t-2} + \cdots + A_k\ Y_{t-k} + \mu + \varphi D_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots 5$$

Where Y_t is an (nx1) vector of stochastic I (1) variables, Ai (i=1...k) is (nxn) matrix of parameters, μ is a vector of deterministic component (i.e., a constant and trend), D is a vector of dummies and ε_t is a vector of normally and independently distributed disturbances with zero mean and non-diagonal covariance matrixes (vector of white noise disturbance terms).

However, as noted by Granger (1981) and Engle and Granger (1987), cited in L¨Utkepohl and Kr¨Atzig (2004), if cointegrating relations are present in a system of variables, the VAR form is not the most convenient model setup. In that case, it is useful to consider specific parameterizations that support the analysis of the cointegration structure. The models that can capture such relationships are known as the vector error correction models (VECMs) or vector equilibrium correction models.

By subtracting Y_{t-1} from both sides of equation 5 and rearranging terms, the general form of VECM can be formulated as:

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \mu + \varphi D_t + \varepsilon_t \ldots 6$$

In a simplified from,

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{j=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \mu + \varphi D_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where, $\Pi = -\left[I - \sum_{i=1}^{k} Ai\right]$ $\Gamma i = -\left[I - \sum_{j=1}^{i} Aj\right]$……with i=1,2,…..k-1 and I an identity matrix.

The long run relationship among the variables is captured by the term $\prod Y_{t-1}$ and the Γ_i coefficients estimate the short run effects of shocks on ΔY_t. According to the Johansen (1988) procedure, determining the rank of Π (i.e. the maximum number of linearly independent stationary columns in Π) provides the number of cointegrating vector between the elements of Y.

The other issue related with cointegration analysis is that of identifying the endogenous and exogenous variables in the model. This is because the VAR analysis treats all variables in the model as they are endogenous. This can be done by applying the weak exogeneity test. As stated in Juselius (2006), weak exogeneity test with the null hypothesis of, "a variable has influenced the long-run stochastic path of the other variables in the system, while at the same time has not been influenced by them", gives an indication for treating that variable as endogenous or not. According to kurita (2006) also, Weak exogeneity allows to model a partial/ conditional system alone, instead of a full system, for the purpose of making efficient statistical inferences about parameters of interest, i.e. if a variable is weakly exogenous, then it appears on the right hand side of the VAR model and its error correction term does not appear in the error correction model implying that the dynamic equation for that variable contains no information concerning the long run relationship in the system. Test for weak exogeneity is conducted by imposing zero restriction on the relevant α-coefficients, and failing to reject the null hypothesis implies the variable is weakly exogenous.

Short run dynamic model

As to the above discussion, two variables that are non-stationary in levels might have a stationary linear combination which implies that the two variables are cointegrated. Existence of cointegration allows for the analysis of the short run dynamic model that identifies adjustment to the long run equilibrium relationship through the error correction model (ECM) representation.

Given that the cointegrating rank, endogenous as well as exogenous variables are identified, using the lagged first difference

[3] $Loda^2$ – is excluded from model 2 for the sake of statistical simplicity and model robustness.

Table 2. Trends of national poverty.

National poverty indices over time					Percentage change		
Index	1995/96	1999/00	2004/05	2010/11	1999/00 over1995/96	2004/05 over 1995/96	2010/11 over 2004/05
Headcount	0.455	0.442	0.387	0.296	- 2.9	-12.4	-23.5
Poverty gap	0.129	0.119	0.083	0.078	-7.76	-30	-5.5
Poverty severity	0.051	0.045	0.027	0.031	-11.8	-39.8	14.4

Source: MoFED, Interim report on poverty analysis study 2010/11.

of the endogenous variable Y_t, the current and lagged first differences of the weakly exogenous variables and the error correcting term, the Error Correction Model (ECM) can be formulated as:

$$\Delta Y_t = \alpha + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{k} \theta \Delta X_{jt-i} + \delta ECT_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots 8$$

Where, ΔY_{t-i} is the lagged first differences of the endogenous variable, ΔX_{jt-i} is the current and lagged first differences of the explanatory variables and ECT_{t-1} is the error correcting term whose coefficient measures the speed at which prior deviations from equilibrium are corrected.

The short run dynamic model is estimated using the above ECM specifications. In order to arrive at a parsimonious model the general to specific modeling strategy, which allows step by step elimination of insignificant regressor (starting from the highly insignificant one) is applied. All the empirical estimations are conducted by using the econometric soft ware packages PC Give 10 and STATA 11.

RESULTS AND DISCUSSION

Trends of poverty indicators

Despite the good economic performance - measured by growth rate of real GDP - the country has experienced in the past decade, poverty is still pervasive in Ethiopia. Continuous internal and external conflicts, famines, back ward production system which led to low agricultural production, low non-farm income, low education and poor health, high population growth and weak institutional structures have been mentioned as the constraints that kept the country in mass poverty (Enquobahrie, 2004; Niaz, 2011). According to world development indicators report, Ethiopia was ranked 174th out of 187 countries in 2011 by human development index with a value of 0.363, a value which is much lower than the SSA average of 0.463. Based on the recently developed poverty measure, the multi-dimensional poverty index[4], Ethiopia was ranked 174th again out of 187 countries having 56.2 % of its total population in multidimensional poverty (UNDP-HDR, 2011).

Although, international comparisons show how Ethiopia is poor, encouraging progress has recently been realized in reducing national poverty. Table 2 shows the trends of the overall poverty.

As shown in the table, the proportion of total population below the national poverty line in the country was 29.6% in 2010/11, declining significantly from 45.5% in 1995/96. The poverty gap index has also experienced a decline by 39.5% within the period 1995/96-2010/11, reaching 7.8% in 2010/11. Similarly, the national level poverty severity index stood at 3.1% in 2010/11 from 5.1% in 1995/96.

The non income dimensions of poverty, including those stated in the MDGs have also shown substantial improvements, implying how promising the country's prospect is in meeting the MDGs on time. The decline in the infant and maternal mortality rates together with the increasing trends in life expectancy and primary school enrollment ratios can be mentioned as indicators of the improvements (Table 3).

According to the analysis conducted by MoFED and CSA (2012 and 2013) on poverty reduction, the development and implementation of the various development policies and strategies in a way that accounted the MDGs, helped at large to the reductions in the national poverty level as well as the improvements in the indicators of human development. The increasing emphasis given to the pro-poor sectors, health and education, has also been stated as another significant factor.

Official development assistance (ODA) flows to Ethiopia

Official development assistance is one way of transferring resources to poor countries in the form of grants and concessional loans. Consequently, being one of the poor countries, Ethiopia had received a large amount of aid from different sources beginning from the end of WWII.

According to OECD data, Ethiopia has received 3,529 million USD in 2010 as official development assistance, making the country one of world's top five ODA recipient and the 1st from African countries. Table 4 shows the net ODA Ethiopia received under the study period. On

[4]Multidimensional Poverty Index - implies Percentage of the population that is multidimensionally poor adjusted by the intensity of the deprivations. It is computed by considering different aspects of deprivations- such as poor health, lack of education, inadequate living standards, lack of income, disempowerment, poor quality of work and treat from violence.

Table 3. Trends of poverty indicators.

Indicator	1990	1996	2000	2006	2011
Infant mortality rate Per 1000 live births	123	98	97	77	59
Maternal mortality rate per 100,000 live births	871	-	673	676	590
Life expectancy	46	49	52	55	59
Gross primary enrollment rate	31	35.5	58.9	91.6	95.9(2009/10)
Net enrollment ratio	-	19.4	33.8	-	86.5(2009/10)
Adult literacy rate	-	26	29.9	38	36 (2009/10)
Population with access to safe water	-	-	25.3	35	53.7
Population with toilet facility	-	-	19.1	38	62

Source: EDHS report 2000, 2005 and 2011; MoFED, 2010; PRSP, 2002.

Table 4. Net ODA Received from 1970-2010 (In million USD).

Year	1970-1979	1980-1989	1990-1999	2000-2010
Net ODA received	377	1,110	1, 292	2, 395
% of increment	-	194	16.4	85.4

Source: OECD 2012.

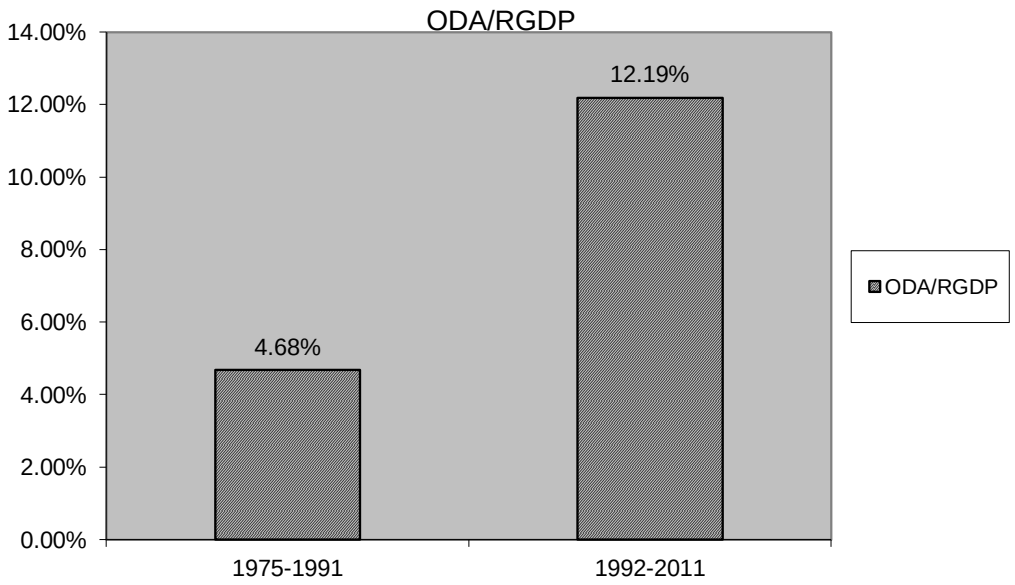

Figure 1. ODA as a percentage of RGDP. Source: own computation using data from MoFED (2012) and OECD (2013).

average, it experienced significantly increasing trends between 1970s and 1980s and in post 2000 period.

In line with this the share of ODA as a percentage of GDP has also increased substantially in the post 2000 period, implying the country's dependency on external finance.

As can be seen in Figure 1, ODA as a percentage of RGDP is higher in the current regime than it was in the military period, credited to the aforementioned reasons. Looking at the sectoral distribution, in the period 1997-2002, 19% of ODA went to the pro-poor sector which incorporated health, education and social development (UNDP, 2006). According to OECD data, of the total ODA that Ethiopia received in 2010, 34% has been committed to these three sectors. Due to lack of data on how much ODA is allocated for the pro-poor sectors it is not possible

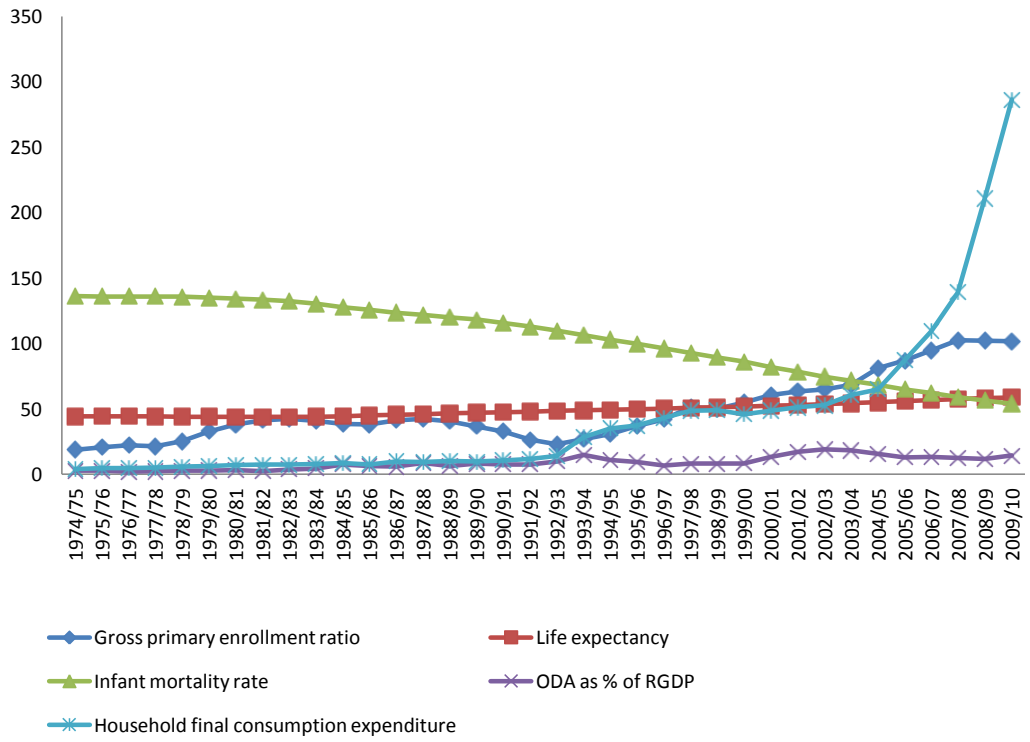

Figure 2. Trends of ODA as percentage of RGDP and indicators of poverty. Source: own computation using data from MoFED, 2012; OECD and UNDP 2013 databases.

to show whether the disbursement to these sectors have increased or not and contributed for the improvements in the poverty indicators, with the increase in total ODA. In spite of this fact, it is possible to see the trends in total ODA the country have received and the indicators of poverty, to have some insight about the relationship between poverty and ODA inflows.

Figure 2 shows the trends in total ODA as percentage of GDP and indicators of poverty in the study period. All indicators have experienced significant improvements reaching 69, 58 and 100% in 2010 from 139, 44 and 18.9% in 1974 for infant mortality, life expectancy and gross primary enrollment ratio, respectively, with a similar increase in ODA. The same is true for the real house hold final consumption expenditure too. Based on the general argument that ODA is planned for tackling poverty, these improvements might be related to the increasing ODA flows to the country. It is expected that more convincing pattern would emerge after testing the relationship empirically. The following section would take up these issues.

Unit root test results[5]

As can be seen from appendix A, the null hypothesis of unit root is not rejected for all series at their level. Since all the variables are non stationary at level, a regression analysis using ordinary least squares (OLS) may produce spurious results. However, all the series found to be stationary after differenced once. By taking first difference of these I (1) variables, OLS method can be used in regression analysis and estimation. However, there is a problem with this approach of differencing: the possibility of losing long-run information present in the variables (Malik, 2008). By applying cointegration technique such problems can be avoided, since this method considers the long-run relationship among the non stationary series.

Results of Johansen cointegration test[6]

By applying the Akaike information criteria (AIC), the Schwarz information criteria (SIC) and the Hannan-Quinn information criteria (HQIC) the optimal lag length for each model were selected to be 2, 1 and 1 for model 1, 2 and 3, respectively.

Using the selected optimal lag length for the three models, the Johansen cointegration test indicated the presence of one cointegrating equation in each model. As can be seen from appendix B, the null hypothesis of zero

[5] See appendix A

[6] See appendix B

cointegrating equation against one or more cointegrating equations is rejected at 1, 5 and 5% level of significance for model 1, model 2 and model 3, respectively. But, the null of one against two or more cointegrating equations failed to be rejected in all the three models.

Results of weak exogeneity tests[7]

Based on the likelihood ratio test the null hypothesis of weak exogeneity is rejected at 1 % for LIMR and at 5% for LPODA in the first model indicating that LIMR and LPODA are endogenous variables in the system. This implies the expected dependent variable in model one, LIMR, can be explained by the other variables and at the same time it explains the other endogenous variable LPODA. This enables one to analyze a single long run equation for LIMR conditional on the other variables in the system. Similarly in model 2 gross primary enrollment ratio found to be the only endogenous variable in the system at 1% level of significance and LRPFCE and $LODA^2$ found to be endogenous variables in the third model at 1 and 5% level of significance, respectively. Thus, based on the results of weak exogeneity test the three indicators of poverty can be used as endogenous variables in the specified models.

Having confirmed that the poverty indicators are endogenous variables in each model, it is possible to estimate the long run equations. Accordingly, the long run models with their respective interpretations are presented as follows.

Poverty measured by IMR

$$LIMR= -0.24LRGDP- 0.2LODA + 0.06LPODA – 0.01LGEOH + 0.54 LGOV + 0.02 LODA^2$$

P-values - [0.0000]*** [0.0000]*** [0.0014]*** [0.6668] [0.0000]*** [0.0039]***

In this model economic growth, aid, squared aid and governance are found to be statistically significant with the expected sign. Gomanee et al. (2003) and Asra et al. (2005) have found similar results except that these studies used panel data. However aid interacted with policy index is found to exacerbate infant mortality rate while government expenditure on health is statistically insignificant. Although it cannot be concluded that good macroeconomic performance exacerbates infant mortality, this finding creates a question on the relationship of macroeconomic policies and infant mortality rate in such models. The simple OLS regression resulted in a highly significant policy and aid * policy coefficients estimated against infant mortality rate[8]. The tiny share of government expenditure, relative to other sectors, to the health sector might be one reason for the statistical insignificance of health expenditure variable.

Poverty measured by GPI

$$LGPI= 1.93LRGDP - 0.54LODA + 1.2LPODA - 0.5LGEE - 0.24LGOV + 0.14LGEH$$

P-values - [0.0021]*** [0.0460]** [0.0011]*** [0.0964] [0.7877] [0.7444]

The LR test results indicated that logarithm of real GDP, ODA and PODA have a statistically significant effect on gross primary enrollment ratio the sigs on economic growth and aid policy coefficients coincide with previous knowledge (Arimah, 2004; Nakamura and McPherson, 2005). However aid appeared with a negative sign in this model implying that increasing aid flows led to reduced enrollment in the study period. Similar result was found by Lamb (2010) having life expectancy as a measure of poverty. Nonetheless, in line with expectations, aids impact found to be positive when interacted with policy index, which implies that aid is effective when augmented by macroeconomic conditions to contribute to the gross primary enrollment ratio.

Poverty measured by RHFCE

$$LRHFCE= 2.87 LRGDP + 5.03LODA - 1.76LPODA - 7.96LGOV - 0.92LODA^2$$

P-value [0.0281]** [0.0040]*** [0.0737] [0.0000]*** [0.0396]**

In this model the estimation result indicated that LRGDP, LODA, LGOV and $LODA^2$ have a significant effect on poverty reduction. Besides, all the significant variables found with their theoretically expected signs. Similar results have been found in Akekere and Yousuo (2012) and Amin (2011) for consumption expenditure and real GDP.

The short run dynamic models

Model 1

$$DLIMR = -0.032 - 0.8DLIMR_1 - 0.082DLRGDP + 0.035DLRGDP_1 + 0.11 DLODA + 0.06DLODA_1 - 0.04DLPODA + 0.04DLPODA_1 + -0.01 DLGEOH_1 + 0.03DLGOV_1 -0.02DLODA^2 - 0.763079 ECT_1$$

[7] See appendix C

[8] -48.55112 (policy coefficient) and -24.85417(aid*policy coefficient) both significant at 1 percent.

The error correcting term (ECT_1) is statistically significant at 5 % level of significance. The coefficient indicates that 76 percent of the disequilibrium in the previous period is corrected in one year.

Among the estimated short run coefficients in the parsimonious model, the coefficients on DLPODA and one period lagged values of DLIMR and DLODA found to be statistically significant. The result indicated that previous year's infant mortality and macroeconomic policy interacted with aid contribute for the reduction of infant mortality in the short run. In contrast to the long run model results, the coefficient on aid found to be positive in the short run, implying higher infant mortality with higher aid. Thus, indicating the divergent impact of aid on poverty reduction in the short run and long run.

Model 2

DLGPI = - 0.04+0.74 DLGPI_1+0.16 DLRGDP + 0.42 DLRGDP_1- 0.09 DLODA_2 + 0.1 DLPODA_1 + 0.18 DLPODA_2 – 0.27 DLGEOE – 0.15 DLGOV_1 - 0.18 DLGOV_2 + 0.16 DLGEOH – 0.69 ECT_1

Among the estimated short run coefficients, DLGEOH, the one period lagged values of DLGPI, DLRGDP and DLPODA as well as two period lagged value of DLPODA found to be statistically significant with expected signs. Unlike theoretical expectations, the first difference of government expenditure on education appeared with a significant negative coefficient. This may be due to tradeoffs between the distributions of government spending on education, in the different education sub-sector. That is, being much of spending allocated for higher (secondary and tertiary) education sector there might appear such a negative correlation.

The error correcting term (ECT_1) is also found to be statistically significant. The coefficient indicates that 69 percent of the disequilibrium in the previous period is corrected in one year.

Model 3

DLRHFCE = -0.05 + 0.35 DLRHFCE_1 + 0.7 DLRGDP + 0.99 DLRGDP_1 + 0.04 DLODA_1+0.2 DLPODA + 0.33 DLGOV – 0.77 DLGOV_1 – 0.04 $DLODA^2$ – 0.65 ECT_1

The result of the estimated short run model produced coefficients which resembled the long run coefficients in terms of signs. However, unlike the long run results, only the one period lagged values of DLRGDP and DLGOV found to be statistically significant. According to the estimated short run coefficients, previous year's real GDP led to rise in current year's household consumption expenditure while a similar increase in governance measure causes reduction in consumption expenditure.

The error correcting term (ECT_1) is also found to be statistically significant with a negative sign indicating that 65 percent of the disequilibrium in the previous period is corrected in one year

Conclusion

The study is conducted using a time series data from Ethiopia over the period 1975-2010 with the objective of analyzing the role of aid (ODA) in reducing poverty. Three indicators of poverty used to conduct the empirical analysis; infant mortality rate, gross primary enrollment ratio and real household final consumption expenditure. With respect to the three measures, three models were estimated using the Johansen maximum likelihood procedure after the necessary tests. The estimation results indicated that foreign aid has a positive role in reducing poverty depending on its size and in some cases on the Macroeconomic policy. Further more economic growth found to be a significant factor that reduces poverty while poor quality of governance exacerbates it; and government's expenditure on social sectors is found to be insignificant factor.

Policy implications

Based on the findings of the study the following policy interventions, which are expected to accelerate the poverty reduction efforts in the country, are forwarded.

As the results of the study indicated, though foreign aid helped for the reductions of poverty by reducing infant mortality rate and increasing household consumption expenditure, its effect found to be adverse on gross primary enrollment ratio. And the macroeconomic policies which have improved aid's effectiveness in improving enrollment ratio found to exacerbate infant mortality rate. Thus, sector specific macroeconomic policies have to be formulated and implemented to achieve the targeted goals of development and poverty reduction through foreign aid.

Revisiting the allocation of foreign aid for different sectors is required to arrive at the desired low level of poverty. That is more aid needs to be allocated for the sectors which can eradicate poverty permanently rather than for consumption.

Policies that can accelerate the economic growth of the country and reduce the governance conditions can also be major intervention areas. The empirical analysis justified that economic growth is a significant factor in reducing poverty. Thus, by developing policies that can secure the expansion of economic activities and persistent economic growth, poverty can be reduced largely. Similarly, the government has to take firm actions in a way to improve the quality of governance.

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APPENDICES

Appendix A: Unit Root Test Results.

Variables	Constant	P-value	Trend and constant	p-value	No trend and constant	Order of Integration
LIMR	2.708	0.9991	-1.544	0.8136	-8.091	I(1)
DLIMR	-5.409	0.0000***[9]	-7.402	0.0000***	-1.768	
LRHFCE	0.431	0.9826	-2.157	.5143	2.007**	I(1)
DLRHFCE	-4.268	0.0005***	-4.406	0.0021***	-3.445	
LGPI	-1.008	0.7502	-2.109	0.5413	1.140	I(1)
DLGPI	-3.000	0.0349**	-2.950	0.1466	-2.689***	
LRGDP	2.272	0.9990	.717	1.0000	-2.030	I(1)
DLRGDP	-4.692	0.0001***	-6.371	0.0000***	-3.115***	
LODA	-1.350	0.6058	-2.267	0.4524	0.782	I(1)
DLODA	-4.236	0.0006***	-4.343	0.0027***	-4.008***	
LPODA	-1.069	0.7272	-3.067	0.1144	0.731	I(1)
DLPODA	-4.061	0.0011***	-4.025	0.0081***	-3.523***	
$LODA^2$	-1.610	0.4788	-2.797	0.1981	0.275	I(1)
$DLODA^2$	-3.729	0.0037***	-3.710	0.0217**	-3.586***	
LGEOE	-0.499	0.8923	-2.939	0.1499	0.688	I(1)
DLGEOE	-6.132	0.0000***	-6.350	0.0000***	-6.133***	
LGEOH	0.949	0.7715	-2.763	0.2108	0.358	I(1)
DLGEOH	-4.834	0.0000***	-5.108	0.0001***	-4.790***	
LGOV	-0.108	0.9487	-1.872	0.6690	-1.196	I(1)
DLGOV	-4.825	0.0000***	-4.765	0.0005***	-4.080***	

[9] *** and ** indicates the rejection of the null hypothesis at 1% and 5% level of significance, respectively

Appendix B: Results of Johansen Cointegration Test.

Rank =>H0	Eigen value	Log lik	Trace test	P – value
Model 1: Variables: LIMR, LRGDP, LODA, LPODA, $LODA^2$, LGEOH and LGOV				
0		225.5237	174.51	[0.000] ***
1	0.90667	265.8406	93.875	[0.065]
2	0.71070	286.9257	51.704	[0.565]
3	0.43803	296.7230	32.110	[0.610]
4	0.39396	305.2367	15.082	[0.778]
5	0.23310	309.7486	6.0587	[0.692]
6	309.7486	312.3943	0.76722	[0.381]
7	0.022313	312.7779		
Model 2: Variables: LGPI, LRGDP, LODA, LPODA, LGEOH, LGEOE and LGOV				
0		153.8556	158.65	[0.015] **
1	0.79680	179.3523	107.66	[0.181]
2	0.69945	198.5866	69.192	[0.541]
3	0.56834	212.0286	42.308	[0.764]
4	0.43382	221.1301	24.105	[0.830]
5	0.35595	228.1697	10.026	[0.917]
6	0.16915	231.1345	4.0962	[0.728]
7	0.12015	233.1826		
Model 3: Variables: LRHFCE, LRGDP, LODA, LPODA, LGOV and $LODA^2$				
0		121.5140	119.08	[0.039] **
1	0.71989	143.7844	74.536	[0.341]
2	0.53639	157.2368	47.632	[0.526]
3	0.49572	169.2178	23.669	[0.848]
4	0.33300	176.3047	9.4957	[0.938]
5	0.15024	179.1538	3.7976	[0.768]
6	0.10282	181.0526		

Appendix C. Results of Weak Exogeneity Tests.

				Model 1			
variables	LIMR	LRGDP	LODA	LPODA	LGEOH	LGOV	$LODA^2$
α_1_s	-0.32709	-0.36161	-0.4054	0.7303	0.54001	0.69122	-0.4524
Chi^2(1)	12.184	0.95008	1.3141	4.0809	0.25669	2.6170	0.27313
P-value	[0.0005]***	[0.3297]	[0.2517]	[0.0434]**	[0.6124]	[0.1057]	[0.6012]
Model 2							
variables	LGPI	LRGDP	LODA	LPODA	LGEOE	LGOV	LGEOH
α_2_s	-0.27181	-0.070730	0.29878	0.40857	-0.047760	-0.052175	0.0074818
Chi^2(1)	10.591	2.0542	2.1812	2.5076	0.18942	0.69215	0.0015154
P-value	[0.0011]***	[0.1518]	[0.1397]	[0.1133]	[0.6634]	[0.4054]	[0.9689]
Model 3							
Variables	LRPFCE	LRGDP	LODA	LPODA	LGOV	$LODA^2$	
α_3_s	-0.12253	0.018571	-0.094067	-0.16835	-0.035188	-0.57560	
Chi^2(1)	11.241	0.98761	2.1852	3.7926	3.3892	5.4279	
P-value	[0.0008]***	[0.3203]	[0.1393]	[0.0515]	[0.0656]	[0.0198]**	

Appendix D. Results of Long Run Coefficients Significance Test.

Variables	**β-coefficients**	**Chi^2(1)**	**p-value**
	β_ coefficients		
Variables	β-coefficients	Chi^2(1)	p-value
LRGDP	0.23940	19.188	[0.0000]***
LODA	0.20394	30.558	[0.0000]***
LPODA	-0.057932	10.177	[0.0014]***
LGEOH	0.012457	0.18536	[0.6668]
LGOV	-0.54116	27.818	[0.0000]***
$LODA^2$	-0.024060	8.3129	[0.0039]***
	γ – coefficients		
LRGDP	-1.9347	9.4516	[0.0021]***
LODA	0.53692	3.9824	[0.0460]**
LPODA	-1.2048	10.721	[0.0011]***
LGEOE	0.49250	0.23888	-0.13755
LGOV	0.23888	0.072494	[0.7877]
LGEOH	-0.13755	0.10630	[0.7444]
	δ – Coefficients		
LRGDP	-2.8727	4.8196	[0.0281]**
LODA	-5.0343	8.2670	[0.0040]***
LPODA	1.7554	3.1983	[0.0737]
LGOV	7.9608	16.965	[0.0000]***
$LODA^2$	0.91887	4.2359	[0.0396]**

[i] This study was conducted as a master's thesis by the researcher using the fund from Jimma university under the supervision of Girum Abebe (Dr., Ethiopian development research institute) and Hassen Abda (Ass .Prof, Jimma University)

[ii] The policy index is developed out of a regression result obtained from growth (captured by logarithm of real GDP) equation which included three explanatory variables as in Burnside and Dollar (2000): trade openness, budget surplus/deficit excluding grants (defined as government revenue - expenditures) and inflation rate. Specifically, the trade openness index is computed using the ratio of export plus import to GDP, and using the regression coefficients from the estimated growth equation, the policy index is constructed as: $P_t = 0.026452\text{openness} + 0.0054728\text{inflation} + 0.0043453\text{b. deficit}$

[iii] The quality of governance variable is measured by the average of political right and civil liberty indices. These measures are chosen based on the availability of time series data that fits the study period.

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