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Economic Growth: case Study Iran and
Indonesia**

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**Revisiting Health and Income Inequality
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**Evidence of Global Financial Shocks
Transmission: Changing Nature of Stock
Markets Integration during the 2007/2008
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EDITORIAL NOTE

Five papers make up this issue. The first one, titled **Analysis of Islamic Bank's Financing and Economic Growth: Case Study Iran and Indonesian** by *Yazdan Gudarzi Farahani* and *Seyed Mohammad Hossein Sadr*, examines the short-run and the long-run relationships between Islamic banking development and economic growth in the case of Iran and Indonesia, with this regard we use quarterly data (2000:1-2010:4), this paper utilizes the bound testing approach of cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework. Some of the issues and challenges that Islamic banking has been facing in Iran have also been addressed. It also seeks to examine modes of Islamic financing and the commitment of commercial banks to implement the Islamic banking law. The results show a significant relationship in short-run and long-run periods between Islamic financial development and economic growth. The relationship appears to be bi-directional relationship. This paper uses empirical evidence to show the role of Islamic banks' financing towards economic performance of a country.

The second paper, titled **Revisiting Health and Income Inequality Relationship: Evidence from Developing Countries** by *Mohammad Habibullah Pulok*, examines the health-income inequality hypothesis using panel data from 31 low income and low middle income countries for the period of 1982-2002. Application of fixed effects and random effects model to control for country specific heterogeneity in this study provides contradictory findings to the existing cross country studies. In other words, empirical results of this paper confirm that there is a positive relation between health and income distribution in this set of developing countries over the study period.

The third paper, titled **Bid-Ask Spread, Futures Market Sentiment and Exchange Rate Returns** by *M. Faisal Safa* and *Neal C. Maroney*, analyzes spot foreign exchange bid-ask spread and the future market sentiment as two important variables to explain the exchange rate returns. In this paper uses two sentiment indices based on futures market return and volume. Time series and cross-sectional analyses of three different currency exchange rates; Australian Dollar, British Pound and Canadian Dollar – to US Dollar suggest that the spot market bid-ask spread is one important variable that positively affects the spot exchange rate returns. The return based sentiment index does not seem to be a

significant factor, but the volume based sentiment index affects the spot exchange rate returns significantly. The negative sign of sentiment indices implies lower spot market return associated with higher investor interest in futures market, although higher trading in futures market contributes positively in the spot market.

The fourth paper, titled **Food Security, Policies and Institutions in Africa: Prospects for a Revolution** by *Ogujiuba Kanayo, Ogbonnaya Ufiem Maurice* and *Omoju Oluwasola Emmanuel*, examines the challenges and problems of food security in Africa and identifies the prospects for a double green revolution in Africa. The paper recommends, as a strategy in tackling the food crisis, a restructuring of existing state institutions and collaborations among African states to ensure food sufficiency.

The last and fifth paper, titled **Evidence of Global Financial Shocks Transmission: Changing Nature of Stock Markets Integration during the 2007/2008 Financial Crisis** by *Salina H. Kassim*, aims to empirically examine the nature of integration among the Malaysian stock market with two of the world's biggest stock markets, namely the US and Japan, during the global financial crisis in 2007/2008. By assessing the changes in the nature of integration among these markets during the crisis, the study aims to find evidence on the international transmission of the financial shocks through the global stock markets. The study covers the period from September 1, 2006 to May 30, 2009. In efforts to capture the changing nature of integration among the stock markets, the sample period is divided into three sub-periods, namely the pre-crisis period, during crisis period I and during crisis period II. The study finds that the nature of integration among these markets changes over the three periods due to the crisis.

Analysis of Islamic Bank's Financing and Economic Growth: Case Study Iran and Indonesia

Gudarzi Farahani, Yazdan¹ and Sadr, Seyed Mohammad Hossein²

The purpose of this paper is to examine the short-run and the long-run relationships between Islamic banking development and economic growth in the case of Iran and Indonesia, with this regard we use quarterly data (2000:1-2010:4), this paper utilizes the bound testing approach of cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework. Also in this paper addresses some of the issues and challenges that Islamic banking has been facing in Iran. It also seeks to examine modes of Islamic financing and the commitment of commercial banks to implement the Islamic banking law. The results show a significant relationship in short-run and long-run periods between Islamic financial development and economic growth. The relationship appears to be bi-directional relationship. This paper uses empirical evidence to show the role of Islamic banks' financing towards economic performance of a country.

1. Introduction

The theory of Islamic banking is based on the concept that interest is strictly forbidden in Islam, and that Islamic teachings provide the required guidance on which to base the working of banks. The basic principle that has guided all theoretical work on Islamic banking is that although interest is forbidden in Islam, trade and profit is encouraged.

Islamic banking is a financial system whose key aim is to fulfill the teachings of the Holy Quran. Islamic law reflects the commands of God

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and this law regulates all the aspects of a Muslim's life and hence Islamic finance is directly involved with spiritual values and social justice (Gudarzi Farahani and Dastan, 2013).

The basic principle in Islamic law is that exploitative contracts or unfair contracts that involve risk or speculation are impermissible. Under Islamic banking, all partners involved in financial transactions share the risk and profit or loss of a venture and no one gets a predetermined return. This direct correlation between investment and profit is the key difference between Islamic and conventional banking which its main objective is maximizing shareholders' wealth (Dar and Presley, 2000).

Islamic banking has introduced itself as an emerging alternative to conventional banking system and has grown rapidly over the last two decades both in Muslim and non-Muslim countries. Islamic banks have recorded high growth rates in both size and number and have operated in over 60 countries worldwide and bankers predict that Islamic banking would control over 50% of savings in the Islamic countries within the next decade (Ahmad, 2004 and Muhamad. A and Azmi Omar. M, 2012).

Recent articles and theoretical papers have called on economies to consider Islamic economic theories as an alternative solution to the current capitalist system. There are also numerous good and well-organized papers respecting Islamic banking system which attempt to clarify the effects of Islamic banking on economic growth in comparison to the effects of conventional banking on it. However, most of empirical studies conducted in this field were not able to explain the overall effect of Islamic bank's financing on economy, due to the fact that they consider a single-country sample.

Islamic banking activities can be classified into two groups: In one group, their activities are without any competition with conventional banking based on interest rate, due to the domestic laws and regulations of some Islamic countries which do not allow any activities based on interest rate (ribah) for financial institutions, banks in those countries. In the second group, there is a high competition between these two banking systems which is because of this fact that they are operating in non-Muslim countries or Muslim countries which do not forbid interest rate-based banking system (Gudarzi Farahani and Dastan, 2013).

Out of the extensive research carried out in this field, there are no sufficient works conducted within the Islamic financial framework. The objective of this paper, therefore, is to narrow the gap in literature by examining the short-run and the long-run relationships between Islamic financial development and economic growth, particularly in these countries using the bound testing approach of cointegration and error correction models (ECMs), developed within an autoregressive distributed lag (ARDL) framework by Pesaran and Shin (1995), Pesaran et al. (1996) and Narayan (2004). However, most of studies in this field have applied the bound testing approach of cointegration, error correction models (ECMs), Auto Regressive Distributed lag (ARDL) and Vector Autoregressive Model (VAR).

This study is guided by the following research questions: What is the relationship between Islamic financial development and economic growth in these selected countries? Does Islamic financial development have significant effect on these countries' economic growth in the short-run and in the long-run?

This paper uses the selected Islamic countries' information includes Iran and Indonesia based on data availability and compatibility to test the validity of the theoretical findings. Accordingly, the following hypotheses are considered:

Hypothesis 1: There is a long-run relationship between Islamic financial development and economic growth.

Hypothesis 2: Islamic financial development leads to economic growth.

Hypothesis 3: Economic growth leads to Islamic financial development.

In this paper, we use Muhamad Abduh and Azmi Omar (2012) article "the relationship between Islamic financial development and economic growth for Asian countries".

In this paper the relationship between Islamic financing and economic growth is tested by using panel data of these selected Islamic countries over the period 2000:1 – 2010:4. This paper consists of four sections.

Section 1, discusses the introduction, in which the background and rationale of the study is outlined. Section 2, covers the review of literature, of the relationship between financial development and economic growth. Section 3, captures the background of Islamic banking in Iran and Indonesia. Section 4, covers the detail of the data and research methodology employed in this study reports the findings and discussion. The final section contains the conclusions.

2. Literature review

In recent years a number of both theoretical and empirical studies about the Islamic banking have been published. Most of these studies have been argued that Islamic bank's products must confirm to principles set by sharia board and this prevents the emergence of speculative demand for money and Islamic bank also use profit and loss sharing criteria. These advantages help the Islamic banks to cope with instability in the economy.

Muhamad Abduh, Mohd Azmi Omar (2012) examines the short-run and the long-run relationships between Islamic banking development and economic growth in Indonesia. For this purpose they use quarterly data (2003:1-2010:2), they utilizes the bound testing approach of cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework. Their results show a significant relationship in short-run and long-run periods between Islamic financial development and economic growth. The relationship, however, is neither Schumpeter's supply-leading nor Robinson's demand-following. It appears to be bi-directional relationship.

Furqani and Mulyany (2009) examine the dynamic interaction between Islamic banking and economic growth in Malaysia by employing the cointegration test and vector error correction model. Their results show that in the short run, only fixed investment is the granger cause of Islamic banking for period 1997:1 – 2005:4. While in the long run, there is evidence of a bidirectional relationship between Islamic banking and fixed investment and also there is evidence supporting demand following hypothesis of GDP and Islamic banking, where increases in GDP causes Islamic banking to develop and not vice versa.

Dahduli (2009) investigates the effectiveness of Islamic banking and finance concepts and concludes that in addition to the traditional prohibitions, Islamic banks should be aware of the immoral defrauding and selfish sales behavior that took place in Western financial institutions, which only protects banks' interests and the bonuses paid to management. In addition and through discussing developed countries banking practices in the 19th century, it has been concluded that the Islamic PLS (profit and loss sharing) contracts would have helped accelerate economic growth by its force of directing funds into profitable industries that increases banks' cash flows and market confidence.

Mirakhor and Khan (1990) point out that reliance on profit sharing arrangements makes the Islamic system akin to an equity-based system, relatively straightforward theoretical models that have been developed for analyzing the working of the system. In these models, depositors are treated as shareholders (as in a mutual fund or investment trust, for example) and bank provides no guarantee on the rate of return or nominal value of shares. Symmetrically, banks themselves become partners with the borrowers and accordingly share in the returns obtained from the borrowed funds. They add that an interesting result emerging from such models is that the Islamic system may be better suited than an interest-based system to adjust to shocks that can lead to banking crises.

King and Levine (1993) for instance, studied this issue using data from 80 countries over the 1960-1989 periods. They constructed four indicators of the level of financial sector developments which is regressed with the real gross domestic product (GDP) per capita and its sources. First is "financial depth" which equals the ratio of liquid liabilities of the financial system to GDP. Second is the ratio of deposit money bank domestic assets to deposit money bank deposit assets plus central bank domestic assets to measure the relative importance of specific financial institutions. The third and fourth financial development indicators are designed to measure domestic asset distribution.

The significant relationship only appears in the high income countries. Some studies have taken a more microeconomic approach and some used stock markets as the proxy for financial development. For example, Fisman and Love (2003) revisited an earlier paper by Rajan and Zingales (1998) by re-examining their assumptions, and the robustness of their results to alternative theories and interpretations. The result is supporting the hypothesis that financial development helps industries with good growth opportunities. It also reinforces their hypothesis that the role of financial development is to reallocate resources to industries that have good growth opportunities and not to industries with “technological dependence” on external finance.

Another study by Beck and Levine (2004) investigates the impact of stock markets and banks on economic growth using a panel data set for the period 1976-1998. The results strongly reject the notion that overall financial development is unimportant or harmful for economic growth. Therefore, they argue that stock markets and banks positively influence economic growth.

With regard to the role of Islamic financial development in economic growth, Furqani and Mulyany (2009) and Majid and Kassim (2010) are among the limited articles in this area. However, using not-so-different time span of quarterly data, their findings are different in terms of the direction of the relationship. Furqani and Mulyany (2009), on the one hand, posit that the relationship between Islamic financial development and economic growth is following the view of “demand-following” which means that economic growth causes Islamic banking institutions to change and develop. On the other hand, findings of Majid and Kassim (2010) are in favor of the supply-leading view.

3. Iranian and Indonesian Islamic banking

As explained in the previous section under Islamic banking, the lender and borrower share the profits of enterprise (and associated risk) according to some previously agreed upon share. Thus, the actual size of the profit to the lender is determined only after completion of the projects. An increase in risk sharing, as entailed by Islamic banking, encouraged borrowers to adopt more risky projects. Naturally this made the loan portfolios of banks more risky. Hence, banks were persuaded to ration credit more strictly, and to divert a large proportion of their assets

away from long term investment loans to commercial and short-term ones.

The central feature of the Iranian monetary system in the 1980s was that the money and credit council administered the interest rates. The underlying purposes of such an administered structure of interest rates were the mobilization of savings and the provision of funds for productive activity to the preferred sectors at concessional rates of interest. Monetary policy was also influenced by the need to raise the domestic savings rate. If there is a larger proportion of savings in the form of financial assets, there is need to offer depositors a positive real rate of interest. The monetary authorities of Iran realized that low interest rates might not be able to generate savings. So they geared policy towards encouraging deposits with long maturities.

The International Monetary Fund (IMF) released a report which stated that Islamic banking is one of the fastest growing segments in the financial industry with a tracking of 10-15 percent growth over the past decade, and globally, Islamic banking assets are estimated to grow around 15 percent a year of \$1 trillion by 2016.

In Indonesia, Islamic banking industry started 17 years ago, in 1992 with the establishment of the first Islamic bank in Jakarta, namely Bank Muamalat Indonesia.

It remained the only Islamic commercial banking (BUS) until the financial crisis 1997, which caused massive destruction to the Indonesian financial system (Bank Muamalat Indonesia, 2002). In 1999, as the impact of 1997-1998 financial and multi-dimensional crises in Indonesia, four big banks under the auspices of the government were merged and become PT. Bank Mandiri (BM). These four banks were PT. Bank Dagang Negara, PT. Bank Bumi Daya, PT. Bank Exim and PT. Bapindo. BM later on bought PT. Bank Susila Bakti (BSB) which has affected by financial crises as well with condition that BSB will operate again as an Islamic bank under name of PT. Bank Syariah Mandiri (BSM). Hence, on 1 November 1999, the number of Islamic bank grows to two BUS, one Islamic window and 78 Islamic rural banks (Muhamad. A and Azmi Omar. M, 2012).

To date, there are ten Islamic commercial banks (i.e. BSM, Bank Muamalat Indonesia, Bank Syariah Mega Indonesia, BRI Syariah, BUKOPIN Syariah and PANIN Syariah) with 1,113 branches and 23 Islamic windows of the conventional banks with 251 branches. The total number of Islamic rural banks also increased significantly from 105 in 2006 to 146 in July 2010. Currently, there are 1,640 branches of Islamic banks spreading in the country (Table I). This rapid development is the result from government strategies through The Blueprint of Islamic Banking Development in Indonesia, released by Islamic banking central bank (BI) in year 2002. The blueprint mentions phases in developing Islamic banking in Indonesia and its parameter of success like:

- Placing strong base for sustainable development;
- Strengthening industrial structure; and
- Complying with international standards for financial products and services.

Finally, after the Islamic Banking Act No. 21 Year 2008 concerning Islamic banking legal foundations was passed by the House of Representatives of Indonesia, many conventional banks spin-off their Islamic windows to full-fledged Islamic bank and conversion of rural banks to Islamic rural banks which base their operation within the Islamic tenets. On the other hand, demand from Muslim customers in Indonesia is also pushing the industry to fulfill their needs in terms of banking transaction under shariah principles. Both sides of government regulation and demand from customers have encouraged Islamic banking in Indonesia to grow faster.

The growth achieved, however, not only in terms of the number of banks and branches, With regard to economic growth, these countries are still experiencing a positive growth of 3.5 and 6 percent in 2008 and 2.3 and 4.5 percent in 2009. While in the first half of 2010 the growth is higher than previously estimated of 1.8 and 5.7 percent. The Iranian and Indonesian economy is expected to grow at 6 and 8 percent at the end of 2012. The extensive transformation in many aspects, including the rapid development of Islamic banking, has provided a more resilience foundation into the Indonesian economic development today. Focusing on the rapid development of Islamic banking in Indonesia, this paper is, therefore, aimed at providing an empirical evidence of the contribution

of Islamic banking towards Indonesian economy (Muhamad. A and Azmi Omar. M, 2012).

4. Data and research methodology

Data

In this paper, regressions are based on data concerning a group of 9 Islamic countries over the period 2000:1 – 2010:4. Data for real GDP growth (GDP), gross fixed capital formation (GFCF) and total Islamic bank's financing (FIN) for these Islamic countries namely Iran and Indonesia come from the World Bank Statistics and International Financial Statistics published by the International Monetary Fund.

Countries have been selected based on data availability. One of the main reasons for choosing these countries is similarity in their financial markets which the use of homogeneous data leads to more accurate coefficients and more consistent results.

GDP is a common statistic for representing the income level of a particular country within a certain time range. Study about finance-growth nexus always use GDP as the principal variable reflecting economic growth. We use gross fixed capital formation (GFCF) as a representation of investment in order to measure net new investment during an accounting period. It is to be noted that the financing variable applied in this model is a portion of total financing in the economy provided by Islamic banks.

After collecting all data required, the unit root test for all variables is carried out using Augmented Dickey-Fuller (ADF) and Phillips-Perron (P-P) (Table 1). Even though the ARDL framework does not involve pre-testing variables to be done, the unit root test could convince as to whether or not the ARDL model should be used. Table 1 shows the summary of unit root test which lead to the mixture of I(0) and I(1) of underlying regressors and therefore, the ARDL testing could be proceeded.

ADF Unit Root Test

Nelson and Plosser (1982) argue that almost all macroeconomic time series typically have a unit root. Thus, by taking first differences the null hypothesis of nonstationarity is rejected for most of the variables. Unit root tests are important in examining the stationarity of a time series because nonstationary regressors invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality.

Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.

The test is the t statistic on ϕ in the following regression:

$$\Delta Y_t = \beta_0 + \beta_1 \cdot trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \phi_i \Delta y_{t-i} + \varepsilon_t$$

Where Δ is the first-difference operator, ε_t is a stationary random error.

The results of the unit root tests for the series of bank's financing and GDP variables are shown in Table 1. The ADF test provides the formal test for unit roots in this study. The p-values corresponding to the ADF values calculated for the two series are larger than 0.05. This indicates that the series of all the variables are non-stationary at 5% level of significance and thus any causal inferences from the two series in levels are invalid.

Table 1. Results of unit root test

	ADF t-statistic		PP t-statistic	
	Trend and Intercept	First difference	Trend and Intercept	First difference
ln(FIN)	-3.97	-4.36	-3.74	-4.38
ln(GDP)	-2.51	-5.72	-2.59	-5.93
GFCF	-1.97	-4.27	-2.12	-4.89
Critical values (5%)	-3.63	-3.64	-3.57	-3.58

Note: The optimal lags for the ADF tests were selected based on optimising Akaike's information Criteria AIC, using a range of lags. We use the Eviews soft ware to estimate this value.

Source: IMF, 2012

The analysis of the first differenced variables shows that the ADF test statistics for all the variables are less than the critical values at 5% levels (Table 1). The results show that all the variables are stationary after differencing once, suggesting that all the variables are integrated of order I(1).

ARDL and ECM

The ARDL models are models formed by an autoregressive part plus a regression with distributed lags over a set of other variables. Put differently, an ARDL model regresses a variable over its own past plus the present and past values of a number of exogenous variables (Fabozzi et al., 2006). The ARDL method does not involve pre-testing variables, which is particularly problematic in the unit root-cointegration literatures where the power of the unit root tests is typically very low and there is a switch in the distribution function of the test statistics, therefore, obviating uncertainty (Narayan, 2004). In other words, the ARDL approach to testing for the existence of a relationship between variables in levels is applicable regardless the underlying regressors are purely I(0), purely I(1), or mixed.

Without having any prior information about the direction of the long-run relationship among the variables, the ARDL approach to cointegration

involves estimating the conditional error correction (EC) version of the ARDL and its model in this study is divided into three models:

$$\Delta \ln gdp_t = \alpha_1 + \sum_{i=1}^m \beta_i \Delta \ln gdp_{t-i} + \sum_{i=1}^m \gamma_i \Delta \ln fin_{t-i} + \delta_1 \ln gdp_{t-i} + \delta_2 \ln fin_{t-i} + \delta_3 gfcf_{t-i} + \varepsilon_t \quad (1)$$

$$\Delta \ln fin_t = \alpha_1 + \sum_{i=1}^m \vartheta_i \Delta \ln gdp_{t-i} + \sum_{i=1}^m \theta_i \Delta \ln fin_{t-i} + \delta_1 \ln gdp_{t-i} + \delta_2 \ln fin_{t-i} + \delta_3 gfcf_{t-i} + \varepsilon_t \quad (2)$$

$$\Delta gfcf_t = \alpha_1 + \sum_{i=1}^m \psi_i \Delta gfcf_{t-i} + \sum_{i=1}^m \varphi_i \Delta \ln fin_{t-i} + \delta_1 gfcf_{t-i} + \delta_2 \ln fin_{t-i} + \delta_3 \ln gdp_{t-i} + \varepsilon_t \quad (3)$$

where:

$\ln gdp$: natural logarithm of real gdp.

$\ln fin$: natural logarithm of Islamic banks' total financing.

$gfcf$: gross fixed capital formation.

The F-statistic is the underlying statistic for testing the existence of the long-run relationship. When long-run relationship (cointegration) exists, F-statistic test indicates which variable should be normalized. This F-statistic is in a generalized Dickey-Fuller regression, which is used to test the significance of lagged levels of the variables in a conditional unrestricted equilibrium correction model (Pesaran et al., 2001).

Having found a long-run relationship (cointegration), equations (1)-(3) are estimated using the following ARDL (p, q) model:

$$\ln gdp_t = \alpha_1 + \sum_{i=1}^m \beta_1 \ln gdp_{t-i} + \sum_{i=0}^n \beta_2 \ln fin_{t-i} + \omega_t \quad (4)$$

$$\ln fin_t = \alpha_1 + \sum_{i=0}^m \beta_1 \ln gdp_{t-i} + \sum_{i=1}^n \beta_2 \ln fin_{t-i} + \omega_t \quad (5)$$

$$gfcf_t = \alpha_1 + \sum_{i=1}^m \beta_1 gfcf_{t-i} + \sum_{i=0}^m \beta_2 \ln fin_{t-i} + \omega_t \quad (6)$$

The orders of the lags in the ARDL model are selected by the Akaike information criterion (AIC) and the Schwartz Bayesian criterion (SBC) before the selected model is estimated by ordinary least squares (OLS). After that, we reconfirm the lag by checking lag-length criteria and the

correlogram of residuals from unrestricted VAR using the selected lag. Lag length which minimizes AIC-SBC and showed by the lag-length criteria as well as insignificant residual's correlogram probability of unrestricted VAR is selected. Narayan (2004) argues that the estimates obtained from the ARDL approach to cointegration are unbiased and efficient given the fact that: it can be applied to studies that have a small sample, such as the present study; it estimates the long-run and short-run components of the model simultaneously, removing problems associated with omitted variables and autocorrelation; and the ARDL method can distinguish between dependent and independent variables. In the presence of cointegration for ARDL equations (1)-(3), short-run elasticity can also be derived by constructing an ECM of the following forms:

$$\Delta \ln gdp_t = \alpha_1 + \sum_{i=1}^m \beta_1 \Delta \ln gdp_{t-i} + \sum_{i=0}^n \beta_2 \Delta \ln fin_{t-i} + \psi ECT(-1) + \Theta_t \quad (7)$$

$$\Delta \ln fin_t = \alpha_1 + \sum_{i=0}^m \beta_1 \Delta \ln gdp_{t-i} + \sum_{i=1}^n \beta_2 \Delta \ln fin_{t-i} + \psi ECT(-1) + \Theta_t \quad (8)$$

$$\Delta gfcf_t = \alpha_1 + \sum_{i=1}^n \beta_1 \Delta gfcf_{t-i} + \sum_{i=0}^m \beta_2 \Delta \ln fin_{t-i} + \psi ECT(-1) + \Theta_t \quad (9)$$

where:

Δ : the first difference of the operator.

β 's : coefficients relating to the short-run dynamics of the model's convergence to equilibrium.

ψ : measures the speed of adjustment.

Error term with lagged parameter (ECT) is an adaptive parameter measuring the short-term dispersal from long-term equilibrium. In short-run, the variables may disperse from one to another which will cause system in equilibrium. Hence, the statistical significance of the coefficient associated with ECT provides us with evidence for an EC mechanism that drives the variables back to their long-term relationship.

Variance decomposition

Variance decomposition (VDC) serves as a tool for evaluating the dynamic interactions and strength of causal relations among variables in the system. The VDC indicates the percentages of a variable's forecast error variance attributable to its own innovations and innovations in other variables. Thus, from the VDC, we can measure the relative importance of Islamic financial development in accounting for fluctuation in growth and business activity variables.

Granger causality test

Engle and Granger (1981), note that if two time-series variables are not cointegrated there may be unidirectional or bidirectional Granger causality in the short-run. Short-run causality is determined by test on the joint significance of the lagged explanatory variables, using an F-test or Wald test. The traditional practice in testing the direction of causation between two variables has been to use the standard Granger causality test (i.e. pair wise Granger causality tests for bivariate time-series). As an alternative, the short-run Granger causality can be tested by the Wald test.

Under the Wald test, the maximum likelihood estimate of the parameters of interest is compared with the proposed value, with the assumption that the difference between the two will be approximately normal. Typically the square of the difference is compared to a chi-squared distribution. The Block Exogeneity Wald test in the VAR system provides chi-squared statistics of coefficients on the lagged endogenous variables, which are used to interpret the statistical significance of coefficients of the regressors. In this way, Wald test statistics can be used to find out the Granger causal effect on the dependent variable. In the VAR system, Granger causality is done to glimpse the short-run causality running from independent variables to a dependent variable, using asymptotic t-statistics that follow chi-squared distribution instead of F distribution. The hypothesis in this test is that the lagged endogenous variable does not Granger causes the dependent variable. Before testing the long-run relationship between Islamic banks' financing and the proposed variables, we run the Granger causality test among those variables and the result is reported in Table 2. From this test, we found a relationship between Islamic banks' financing and

growth (GDP). However, as displayed in equations (1) and (2), we are still encouraged to run both direction of relationship between Islamic banks' financing and growth.

Table 2: Granger causality test (Indonesia)

Dependent variable	F-statistics [P-value]			t - statistics
	<i>LnGDP</i>	<i>LnFIN</i>	<i>GFCF</i>	ECM_{t-1}
<i>LnGDP</i>	-	0.675(0.236)	-	-0.22(0.021)
<i>LnFIN</i>	5.322(0.021)	-	2.314(0.082)	-0.16(0.031)
<i>GFCF</i>	-	1.012(0.112)	-	-

Table 3: Granger causality test (Iran)

Dependent variable	F-statistics [P-value]			t - statistics
	<i>LnGDP</i>	<i>LnFIN</i>	<i>GFCF</i>	ECM_{t-1}
<i>LnGDP</i>	-	0.524(0.352)	-	-0.25(0.035)
<i>LnFIN</i>	4.251(0.031)	-	2.519(0.131)	-0.15(0.042)
<i>GFCF</i>	-	0.922(0.135)	-	-

The empirical results reported in Table 2 show that there is a distinct short-run and long-run unidirectional causal flow from *LnFIN* to economic growth.

The short-run causality from *LnFIN* to economic growth is supported by the F-statistic in the economic growth equation, which is statistically significant. The long-run causal flow, on the other hand, is supported by the lagged error-correction term in the economic growth function, which is negative and statistically significant as expected. The results also show that economic growth is not Granger-causes Ln FIN. The long-run causality, on the other hand, is supported by the coefficient of the error-correction term, which is negative and statistically significant in the economic growth function as expected.

The next step is estimating the long-run relationship in equations (1)-(3). The combination of the smallest value of AIC-SBC, lag-length criteria

technique and observation towards insignificant correlogram of residuals from unrestricted VAR are used to determine the optimal number of lags to be included in the model. The lag length chosen is 1 for all equations.

The cointegration relationship between [GDP, FIN and GFCF] is examined using the ARDL bounds testing procedure. Two steps are used in this procedure. In the first step, the order of lags on the first differenced variables in equations (1) - (3) is obtained from the unrestricted models - using the Akaike Information Criterion (AIC) and the Schwartz- Bayesian Criterion (SBC). In the second step, we apply bounds F-test to equations (1) – (3) in order to establish whether there exists a long-run relationship between the variables under study. The results of the bounds test are reported in Table 4.

Table 4: Bounds F-test for Cointegration

Dependent variable	Function		F-test statistic			
$\Delta \ln GFCF$	CFC (GDP, FIN)		5.251***			
$\Delta \ln GDP$	GDP(FIN, GFCF)		2.355			
$\Delta \ln FIN$	FIN(GDP, GFCF)		4.681***			
Asymptotic Critical Values						
	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Pesaran et al (2001), p. 300, Table CI(ii) Case II	4.24	5.21	3.89	3.94	2.75	3.28

Note: *** denotes statistical significance at the 1% level.

The results reported in Table 3 show that there is evidence of cointegration when GDP and FIN are taken as a dependent variable, but not when CFC is taken as a dependent variable. This is supported by the calculated F statistic, which is found to be statistically significant in GDP and FIN equations but not in the GFCF equation.

The overall F-statistic shows that the null hypothesis of no cointegration between Islamic banks' financing and the two variables tested is rejected in various level of significant and therefore, there is evidence of the long-run relationship between Islamic financial development and economic performance of Iran and Indonesia. However, we find evidence that economic growth also important for the development of

Islamic financial system. Therefore, the relationship between Islamic financial development and growth appears to be bi-directional in Iran and Indonesia.

Given the results from the cointegration tests, ECM based causality test is conducted for all equations and the ECM results are presented in Table 3. The ECM coefficients for all equations tested are significant and negatively correlated. This shows the evidence of causality in at least one direction. The overall ECM coefficients indicate low rate of convergence to equilibrium. The positive significance of Islamic financial depth coefficients in equations (1) and (3) support the view that Islamic financial development could positively affect the economic growth and business activity.

The result of VDC is displayed in Table 5 and 6. From Table 5, VDC substantiate the significant role played by Islamic financing depth in accounting for fluctuations in Iran economic growth and investment. After 10 years horizon, while the fraction of Islamic financing forecast error variance attributable to variations in growth is 37.96 percent, the fraction of income and investment forecast error variance attributable to variations in the Islamic financial deepening are 60.25 and 1.77 percent, respectively.

Table 5- Variance decomposition in Iran

Variance Decomposition of growth: Period	S.E.	growth FIN	INV	growth
1	0.005034	100.0000	0.000000	0.000000
2	0.008279	93.26622	0.042632	6.691148
3	0.011451	79.35250	0.114892	20.53261
4	0.014998	69.30703	0.367730	30.32524
5	0.018260	61.87366	0.753789	37.37255
6	0.021223	55.39407	1.125239	43.48069
7	0.024010	49.98583	1.383585	48.63059
8	0.026605	45.40000	1.563380	53.03662
9	0.029019	41.41817	1.694026	56.88780
10	0.031290	37.96274	1.778169	60.25909

From Table 6, VDC substantiate the significant role played by Islamic financing depth in accounting for fluctuations in Indonesia economic growth and investment. After 10 years horizon, while the fraction of Islamic financing forecast error variance attributable to variations in growth is 32.59 percent, the fraction of income and investment forecast error variance attributable to variations in the Islamic financial deepening are 56.60 and 10.80 percent, respectively.

Table 5- Variance decomposition in Indonesia

Variance Decomposition of growth:	S.E.	FIN	INV	growth
Period				
1	0.004943	100.0000	0.000000	0.000000
2	0.007942	95.13987	0.042005	4.818125
3	0.010488	82.08506	0.204025	17.71091
4	0.013215	70.63403	0.970971	28.39500
5	0.015722	59.45482	3.201557	37.34362
6	0.018116	50.93684	4.659504	44.40366
7	0.020410	45.01222	6.226080	48.76170
8	0.022607	39.97836	7.911583	52.11005
9	0.024700	35.95653	9.331504	54.71196
10	0.026747	32.59245	10.80059	56.60696

5. Conclusion

Many studies had been conducted to see the link and impact of financial development upon economic growth. In term of the role of financial deepening towards economic growth, studies had found that at least three direction appeared:

- (1) finance drives growth;
- (2) growth drives finance; and
- (3) bi-directional.

However, despite the extensive studies done in direct relationship between financial deepening and economic growth within the conventional financing framework, studies conducted within the Islamic financial framework are limited. This paper finds evidence that in the long-run, Islamic financial development is positively and significantly correlated with economic growth and capital accumulation. In this regard, domestic financing provided by Islamic banking sector has been found to contribute to the growth of the Indonesian economy. In other words, Islamic banking has shown to be effective as financial intermediaries that facilitate the transmission of funds from surplus households to deficit households. However, unlike earlier studies, the relationship between Islamic financing and growth in Indonesia is bi-directional indicating the development in Islamic banking stimulates growth and at the same time, growth propels Islamic banking development in Iran and Indonesia.

Our results support that current as well as past changes in Islamic banks' financing have significant impact on the changes in income in these countries. It is clear for these countries in general that in short run Islamic banks' financing is an important ingredient for economic development. The results generally show that in the long run, Islamic bank's financing is positive and significantly correlated with economic growth and capital accumulation of these countries. In this regard, Islamic banking has effectively played its main role as financial intermediaries that facilitate the transmission of saving from surplus households to deficit households. Furthermore, results show the reliability and contribution of Islamic banking to the real economic sectors of these countries specifically economic growth and capital accumulation. These results reveal that improvement of the Islamic financial system in these countries may benefit economic development and it is important in the long run for economic welfare.

This interesting finding provides a number of implications. First, the Indonesian Government should continue to promote Islamic banking as it has shown to benefit the economy. This can be done by setting a target ratio of Islamic banking assets to total banking assets to be achieved by a certain year as was done in Malaysia. Currently the ratio is 2.8 percent and it should be set at a reasonably high percentage in order to make

Islamic banking more impactful to the economy. As a corollary to this, the government needs to encourage and promote the establishment of more Islamic commercial banks, Islamic windows, and Islamic rural banks whilst at the same time encourage existing Islamic banks to establish more branches. In addition, allowing foreign Islamic banks to operate in Iran and Indonesia can also help to foster more innovation in the domestic Islamic banking industry. Second, as the number of Islamic banks and Islamic financial institutions increases, there is also a need to have sufficient skill manpower to manage these institutions. There is a need to relook at the current regulations and guidelines in order to bring it at par with the development of Islamic banking worldwide. For example, the judiciary must have a dedicated unit to handle Islamic banking legal cases should it go to the court for adjudication. Finally, as the relationship is found to be bi-directional, Islamic banking will not be able to contribute fully to economic growth if the economy is not growing well, hence a positive economic growth will help spur Islamic banking growth further.

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Revisiting Health and Income Inequality Relationship: Evidence from Developing Countries

Mohammad Habibullah Pulok*

In general, countries with more equal distribution of income enjoy better health. Earlier empirical studies on the relationship between income distribution and health at country level present strong evidence that income inequality on an average impedes the improvement of population health. However, a majority of these empirical studies are based on data from either only developed countries or pooled data from developing and developed countries. They mainly study the relationship at a single point of time or at an average of several years. These studies also fail to take into account the country specific unobserved heterogeneity. Departing from the general trend of the current literature, this paper examines the health-income inequality hypothesis using panel data from 31 low income and low middle income countries for the period of 1982-2002. Application of fixed effects and random effects model to control for country specific heterogeneity in this study provides contradictory findings to the existing cross country studies. In other words, empirical results of this paper confirm that there is a positive relation between health and income distribution in this set of developing countries over the study period.

1. Introduction

In last couple of decades, there has been a rising trend in life expectancy and a declining trend in infant mortality and under-five mortality rates in the world. This large improvement in health outcome of population is more pronounced in developing countries as compared to developed

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ones. Meanwhile, income inequality has also increased in many countries. It is a common belief that countries with more unequal distribution of income usually lag behind in terms of many indicators of human development including health. In this context, more than 200 articles have already been published to understand the relationship between income distribution and health. The nexus between population health and income inequality was first brought about by Preston in his famous seminal paper in this fashion "...the distribution of income is clearly a likely source of variance in the basic relation between national life expectancy and average national income" (Preston 1975, p. 242). Though Preston did not directly claim that income inequality is detrimental to average health of population, a large body of empirical literatures in this field provides overwhelming evidence in this direction. For example, Wilkinson and Pickett (2006) have reviewed 155 peer published reports on the relationship between different measures of income distribution and health and found that 131 studies either completely or partially support the proposition that income inequality, in general is harmful to health.¹ Previous empirical works motivated Wilkinson (1996) to conclude that the distribution of income is "one of the most powerful influences on the health of whole populations in the developed world to have come to light" (as cited in Herzer and Nunnenkam, 2011, p. 1). Several other authors including Rodgers (1979) and Waldmann (1992) are also in favor of this view. However, Judge et al. (1998) states that aggregate cross country studies often suffer from inadequate samples, employing too simple bi-variate specifications without appropriate controls, consider only single point of time and lack high quality data for income inequality. Several recent works (Mellor and Milyo, 2001; Leigh and Jencks, 2007) have tried to overcome these limitations and have explored that the strong negative association between health and income inequality could be reversed. However, majority of these empirical studies are based on data from either only developed countries or pooled data from developing and developed countries. To the best of my knowledge, there is no single study, which solely makes use of cross sectional data for several time periods to assess how income inequality affects health of population in the developing countries.

¹ See Table 1 for the Wilkinson and Pickett s' classifications of the 168 analyses in "Income inequality and population health: A review and explanation of the evidence" in *Social Science & Medicine* 62 (2006)

Considering the above limitations of previous studies, this paper takes an attempt to examine the relationship between health and income inequality in low income and low-middle income countries over the period of 1982-2002 at aggregate level. Besides the objective of overcoming the drawbacks of earlier works, I have been motivated by several factors to undertake this research. To mention some of these, in many developing countries, it is frequently observed that both income inequality and average health are rising on the face of economic development. For example, Bangladesh has been able to make significant progress in several health indicators such as improving life expectancy at birth and reducing infant mortality rate in past three decades. In contrast, income distribution has become more uneven over time. Again, countries with high poverty rate and with high inequality in income compared to their counterparts have made good progress in terms of average population health. For instance, proportion of people living on less than \$2 per day income in Bangladesh is much higher than Pakistan but the former has been successful to reduce the under-five mortality rate at a greater speed than latter. Again income inequality measured by Gini index is higher in Ecuador than in Algeria but the under-five mortality rate is higher in the latter country. Many other low income countries also show similar trends. So, addressing the research question of the link between health and income distribution has important implications for these countries. My study contributes to the current literature of this field in several ways. First of all, this study uses panel data for 31 developing countries since the variation in income inequality in low income countries is higher as compared to high income countries. No other earlier work used panel data solely focusing on developing countries. Secondly, the difficulty of international comparison of income inequality data is solved using the best available measure of income distribution. I have used estimated household income inequality index (EHII), which overcomes the limitations of previously used income inequality indices. Thirdly, I have applied the standard panel data technique to account for the unobserved country specific effects. Finally, I have done a thorough sensitivity analysis using different indicators of health outcome to check the robustness of the findings. The results from the simple pooled OLS analysis indicate that health and income equality is negatively related in these countries. This finding is in line with the most of the earlier cross sectional studies in this field. But this result is not valid as pooled OLS method fails to capture country specific heterogeneity. To overcome this limitation, I

have used the fixed effects and the random effects methods in this paper and I have obtained contradictory results. In other words, my findings from this study confirm that there is a positive relation between health and income distribution in this set of developing countries during the study period.

This paper is organized sequentially as outlined here. The section afterwards provides a non-technical over view of the main hypotheses relating income, income inequality and health. Section 3 discusses the previous literatures on the relationship between health and income distribution and I limit this review to the aggregate studies only. In section 4, I outline the empirical framework of this paper. I present data description and their sources in section 5. Section 6 provides a detailed explanation of the panel data methodology applied in this paper. A short summary of the key statistics and a brief graphical analysis are given in section 7. I present the main empirical results and discuss the important findings in section 8. Section 9 deals with the sensitivity analysis of the results obtained in this study. Section 10 focuses on the main limitations of this research and it highlights the scope for future research in this field. Finally, I conclude the paper in section 11.

2. Income, Income Inequality and Health: Different Hypotheses

Since 1960's researchers and scholars of several disciplines such as economics, sociology, public health etc. have been debating on the subject of relation among income, income inequality and health. The debate has become more intense in recent decades on the face of worldwide improvement in several indicators of health along with rising income inequality. Though several arguments in the related literature suggest that a more equal distribution of income is coupled with better average health outcomes such as higher life expectancy and lower mortality, there is a substantial theoretical ambiguity in many aspects. Much effort has been given to explore the relationship between income inequality and health. However, the debate is still open and agreement on many fundamental matters is not also obvious. In this regard, the focus of this section is to highlight the underlying hypotheses regarding the relationship between income distribution and health. The discussion of this part is mainly based on Wagstaff and Doorslaer(2000) and Deaton(2003). With respect to the previous literatures, the underlying mechanisms of income inequality and health is grouped under three

broad titles :absolute income, relative income, and income inequality hypothesis.

Hypothesis 1: Absolute Income Hypothesis (AIH)

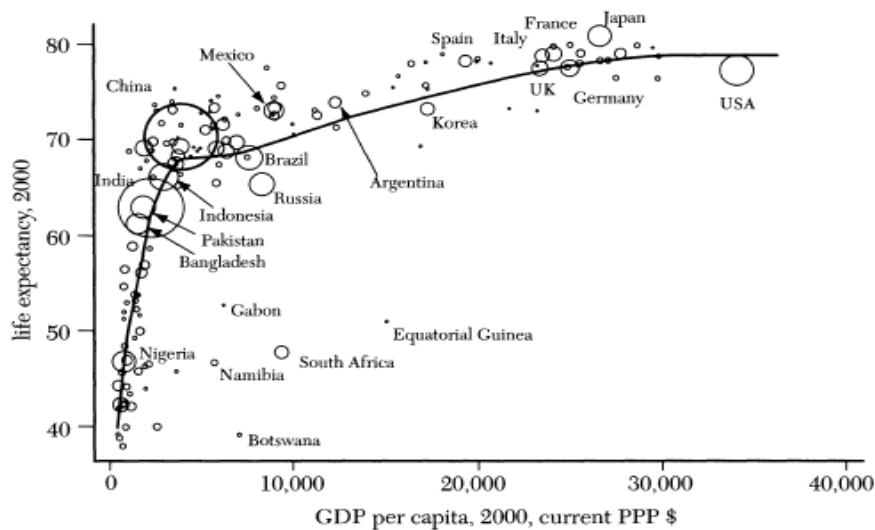
The absolute income hypothesis states that higher average income leads to better health but the improvement in health occurs at a decreasing rate. In other words, the relationship between income and health is concave. The famous seminal paper by Preston (1975) formulated the ground for the absolute income hypothesis. AIH postulates that people with higher incomes have better health outcomes, but income inequality or relative income has no direct effect on health. Deaton (2003) argues that bad health is an outcome of low income or intense poverty and it is known as poverty hypothesis also. The updated relationship between life expectancy and per capita GDP at international level are shown in Figure 1, which is well known as Preston Curve. Preston (1975, p.241) states “Increases in average income are strongly correlated with increases in life expectancy among poor countries, but as income per head rises, the relationship flattens out, and is weaker or even absent among the richest countries”. Some scholars describe AIH in this way that lower tail of income distribution must be pushed up to a certain level from where income has strong impact on health. So, absolute income hypothesis reveals that average income is more important in poorer countries while income inequality matters more for health in wealthy nations.

Hypothesis 2: Income Inequality Hypothesis (IIH)

The income inequality hypothesis states that income inequality itself has an impact on the health of people within a country, holding their average incomes constant. According to the IIH, there is a direct link between health and income inequality. Mellor and Milyo (2002) identify two versions of this hypothesis; “strong” and “weak”. Argument of the strong version is that inequality affects all individuals in a society equally, regardless of their income levels. On the other hand, the weak version states that income inequality has more impact on the health of persons with lowest level of income in the society. Therefore, the IIH suggests that the extent of the difference between the rich and poor matters for population health and mortality. The key difference between the AIH and the IIH stems from the fact that the latter explicitly

considers the effect of income distribution on health while the former manifests the concave relationship between health and income.

Figure 1: New version of Preston curve: Life Expectancy versus GDP Per Capita



Source: Deaton (2003, pp.116), Journal of Economic Literature, Vol. XLI

Hypothesis 3: Relative Income Hypothesis (RIH)

The relative income hypothesis is conceptually different from above two hypotheses. RIH states that it is neither average income nor income inequality affects individual's health, rather individual's health depends on his or her income relative to average income of one or more reference groups. Several aspects such as psychosocial stress and material deprivation may explain the connection between relative income and health. Sometime is difficult to distinguish between IIH and RIH but they are not similar. The relative income hypothesis is more or less parallel to the weak version of income inequality hypothesis in a sense that poor people suffer more than the rich when the income distribution spreads out more. But the strong version is more consistent with AIH. So it is important to unveil the subtle distinction among these three hypotheses.

This discussion thus comes to a conclusion that there is a direct link between income inequality and health implied by IIH. The RIH indicates that individuals' income relative to their social group average is important to determine their health. Relative income hypothesis can be only tested using individual level data. In this study, I employ aggregate data from developing countries to test the relevance of strong version of income inequality hypothesis.

3. Survey of Previous Literatures

There exists a growing body literature examining the relationship between health and income inequality. As noted already, the purpose of this study is to re-investigate the association between income inequality and health using aggregate level data from developing countries. So, the intention of this section is to provide a brief summary of the previous empirical researches in this topic confining the discussion only to economics literatures. Additionally, this discussion focuses only on the empirical findings and methodological debates. In line with Wagstaff and Doorslaer (2000), studies on the link between health and income distribution can be divided into three broad categories by their levels of aggregation; individual level, community level and population level. Prior individual level studies both theoretically and empirically have almost reached a conclusion that poor people always have worse health because they are unable to afford goods and services such as better health care, better nutrition, good sanitation and housing to improve their health. However, the conclusion regarding this relationship is still open to the debate both at the community and aggregate level. With the purpose of not departing from the main objective of this paper, I restrict my review only to the existing aggregate level studies. Those who are interested can consult Deaton (2003), Lynch et al. (2004), Wilkinson and Pickett (2006) and De Maio (2010) for an extensive and comprehensive review on methodological, theoretical and epistemological issues on the relationship between income and health. In aggregate studies, the objective is to investigate whether difference in income distribution can determine the differences in average health of population across countries. Life expectancy and infant mortality are the two most widely used indicators of health while Gini coefficient and different shares in income distribution measure the degree of inequality in country level. Moreover, earlier studies on the relationship between inequality and health at national level can be divided into two groups as:

cross-sectional evidence at a certain point of time and longitudinal studies, which simultaneously examine the relationship across countries and over several periods.

3.1 Country Level Evidence: Cross Sectional Studies

The most important feature of the previous literatures on population level is that most of the studies are done using data on a single year's cross section to investigate the association between inequality and health. This raises the question of methodological problem, sample coverage and quality of data in these studies. However, cross-country studies are the dominant part in the literature on income inequality and health. This why the the natural starting point in reviewing the earlier studies is to critically discuss the main findings of the most cited papers in this topic of research. International comparison of health and income distribution goes back to Preston (1975), in which he examined the international patterns of per capita GDP and life expectancy at birth for three different decades of the 20th century. Preston shows that life expectancy is positively related with national income but the effect of income on health diminishes at high level of income, which results in curvilinear relation between income and health. He suggests that that at least some of the variation in life expectancy among richer countries may be a result of variations in income distribution. Later on, Rodgers (1979) finds a statistically significant negative effect of the Gini coefficient on life expectancy at birth, life expectancy at age five, and positive effect on the rate of infant mortality in a sample of 56 countries in a simple regression model after controlling for income. The argument for including income inequality in aggregate models of health outcomes comes from the fact that the effect of income inequality reflects the individual-level nonlinear relationship between income and health. In sample of developing countries, Flegg (1982) shows that there is a significant positive association between income inequality and child mortality after adding maternal illiteracy rates and measures of the availability of nurses and physicians. In an influential paper, Waldmann (1992) looks into the link between infant mortality and income share held by sub-group of population in a pooled sample of 57 developing and developed countries. The main conclusion is that inequality directly affects the infant mortality rate; among the poor it increases when the rich get richer, even when their own incomes do not suffer. According to Wennemo (1993) and Duleep (1995), there is a significant negative

relationship between income inequality and infant mortality and male mortality in several age cohorts. Wilkinson (1992) provides evidence of significant relationship between income inequality and life expectancy across a number of developed countries. However, Wilkinson's 1992 analysis has been heavily criticized by Judge (1995). Judge for an instance, argues that Wilkinson's findings are not robust to changes in the unit of income. De Vogli et al. (2005) in a more recent paper present evidence that the Gini index is inversely related with life expectancy after controlling for per capita GDP and educational attainments in 21 economically developed nations. A comparable research to previous one finds statistically significant relation between income inequality and mortality among men aged 15-29 using data of 126 countries (Dorling et al. 2007). Although the discussion highlights that the findings of many cross-country analyses support the proposition that income inequality has a hazardous impact on health, there are also exceptions to some extents. Pampel and Pillai (1986) are unable to get a significant effect of income inequality on infant mortality. Making use of updated data from World Bank's World Development Report (1993 edition), Baumbusch (1995) replicates Waldmann's study for the same period but finds that income accruing to the top 5 percent decreased infant mortality. Judge (1995) comes with new findings that there is no significant relationship between income inequality and health for a cross section of 13 countries. Judge et al. (1998) show that there is no significant correlation between changes in income inequality and changes in either life expectancy or infant mortality in a cross sectional study of 10 countries. In a sample of 75 countries, Gravelle et al. (2002) also fail to find any significant relation between income distribution and population health.

3.2 Country Level Evidence: Longitudinal Studies

Empirical studies using panel data are rare in the prior population level literature of health and income inequality nexus. The main reason behind this exception as compared to other fields of research is the unavailability of consistent data on income inequality for longer time horizon for many countries especially for less developed countries. The first study that attempts to make use of panel data to investigate this relationship is done by Mellor and Milyo (2001). Applying first-difference method, they try to control for country-specific effects in sample of 47 developing and developed countries. Their analysis brings us the evidence that the positive correlation between the gini coefficient

and infant mortality disappears once secondary school enrolment is controlled for. Moreover, negative association between life expectancy and income inequality eliminates when income per capita is taken into account. The main limitation of this study is that time period cover is very short (four years only.) In a sample of 115 countries, Beckfield (2004) applies fixed effect model to consider unobserved heterogeneity but he finds no support for income inequality-health hypothesis. Recently, Shkolnikov et al. (2009) uses a country fixed-effect method for a set of comparable data from 17 developed countries and conclude that unequal income distribution cannot explain reduction in life expectancy losses over time. However, it can explain differences in life expectancy losses across countries.

To sum up, many of the cross national studies use straightforward bi-variate regression method without appropriate controls. Moreover, they do not consider for the possibility of unobserved country heterogeneity and the measures of income distribution used are often not internationally comparable (Beckfield 2004). Another problem of these studies is that they pool together rich and poor countries without considering different mechanisms through which income inequality affects health. I term this as a heterogeneous sample problem in this topic of research. Unobserved heterogeneity is not taken into account in many studies, which leads to bias the results. Though few studies have used panel data, time the period is usually in short many cases, which limits statistical power. Last of all, aggregate studies suffer from unreliable measures of income inequality at the country level and from inconsistent data from one period to other.

4. Empirical Framework

The purpose of this section is to introduce the empirical models to be estimated in this paper to examine the association between health and income inequality in population level in developing countries. It is discussed in the previous section that majority of the existing literature studying the relationship between health and income distribution relies on comparisons across countries at a single point in time or on changes over time within one or two countries. In contrast, this paper takes an attempt to utilize panel or longitudinal specification, which takes into account unobserved heterogeneity among countries. There are several advantages to use panel data. For instance, it increases precision in

estimation as there is more information and more degrees of freedom. Moreover, omitted variables problem can be dealt with sometimes and it captures the unobserved heterogeneity. It helps to take into account the issues that cannot be studied in either cross-sectional or time-series setting alone. Time series and cross-section studies not controlling this heterogeneity are at risk of obtaining biased results. Therefore, in line with Leigh and Jencks (2007), the general representation of the panel data model of this study can be specified as below:

$$\ln H_{it} = \beta_0 + \beta_1 \ln EHII_Gini_{it} + \beta_2 \ln GDP_PC_{it} + e_{it} \quad \text{for } i = 1, 2, \dots, N \text{ and } t = 1, 2, \dots, T \quad (1)$$

In equation (1), subscripts i and t denote cross section entities and time series dimensions for each variable respectively. In the this empirical specification, H is the measure of health status such as life expectancy at birth, the infant mortality rate and the under-five mortality rate, while $EHII_Gini$ stands for the proxy of income inequality. Average income is measured by real per capita gross domestic product, which is denoted by GDP_PC and e is the error term with classical properties. All the variables are in natural logarithm to ease the interpretation and comparison. It also helps me to achieve linearity and to control for heteroskedasticity in the data. This specification allows us to estimate the relationship between income inequality and health, holding average income constant. However, it must be considered that education is one of the key determinants of population health. It is evident in the prior researches that education has strong positive impact on health status. Empirical findings suggest that impact of education on health is almost as large as the impact of income. In a sample of 72 developing countries, Subbarao and Raney (1995) find that female literacy has a strong impact on infant mortality during the period of 1970 –1985. That is why a proxy for national educational attainment is included as a control variable. Additionally, a control term for year of observation is included in the regression models motivated by previous researches (Judge, 1995; Mellor and Milyo, 2001). It takes into account for health improvements that accrue to development not captured by changes in real GDP (Wilkinson, 1996) and it captures the spurious association between trending variables. So considering these facts, equation (1) can be reformulated as below:

$$\ln H_{it} = \beta_0 + \beta_1 \ln EHII_Gini_{it} + \beta_2 \ln GDP_PC_{it} + \beta_3 \ln EDU_Sec_{it} + \lambda_t + e_{it} \quad (2)$$

Here the gross secondary school enrollment rate is used as a proxy for educational achievement denoted by EDU_Sec and λ_t is a period dummy capturing time fixed effects. In line with most of the previous findings, the expected sign of the coefficient associated with income inequality should be negative that postulates the negative relation between income inequality and average health outcome when measured by life expectancy. On the other hand, I expect that coefficients of real GDP per capita and education should be positive and it is established by previous studies. In fine, the hypothesis that I am going to test is that average health of population is negatively associated income inequality in developing countries i.e the higher the unequal income distribution the lower is the health status.

5. Data

This section provides a discussion on the choice of indicators used in this paper and their sources focusing a special attention to the proxy of income inequality variable. Due to the unavailability of the data on the good quality measurement of income inequality for the recent years, the time span covered in this study is 1982-2002 (Twenty One Years). I have selected 31 (Thirty One) low income and lower-middle income countries (Developing Countries) out of 91 (Ninety One) countries according to the World Bank classification of economies worldwide². A complete list of the countries is given in Table: A1 of the appendix. The reason to choose the above time period is that the most consistent data on income inequality and other variables is available only for these countries. In constructing panel data set, repeated observations on the same cross section are observed for several time periods. The above time period is grouped into seven periods by taking three-year average of all the variables. The rationale behind method is that different health indicators and income inequality do not change over short span. This procedure of constructing panel data set should provide me a balanced panel of 217 ($n.t=N$) country-period observations but I ended up with an unbalanced panel since data on some variables of different countries for few periods are unavailable. Data on all variables except income inequality are collected from World Development Indicator-2010 (WDI) database of

² <http://data.worldbank.org/about/country-classifications>

the World Bank. Income inequality data comes from the UTIP-UNIDO project at the University of Texas³.

Dependent Variables: Several indicators of health outcome at population are used in the previous studies of income inequality and health but life expectancy at birth (LEB) is the most common used measure of health status. Because it is not biased by age structure and data on life expectancy at birth are available for a reasonably large number of countries and time periods. In line with with prior researches, I also use two alternative measures of health status such as the infant mortality rate (IMR) and the under-five mortality rate ((MR_5) in order to test the robustness of the results. The definitions of the three measures of health are given below according to the World Bank:

Life Expectancy at Birth (LEB): Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Infant Mortality Rate (IMR): Infant mortality refers to the number of infants dying before reaching one year of age, per 1000 live births in a given year.

Mortality Rate Under-five (MR_5): Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates.

Independent Variables: It is discussed earlier that income inequality hypothesis will be tested in this study. I briefly discuss three independent variables below:

Income Inequality (EHII_Gini): The main difficulty in any income distribution related empirical work is to obtain reliable and comparable measure on income inequality, especially for developing countries. The most widely used measure of income inequality is Gini index, which shows how equally income is distributed across the population. It scales between zero and one; the higher the Gini, the more the extent of

³ University of Texas Inequality Project (UTIP) and the United Nations Industrial Development Organization (UNIDO)

inequality is. To answer the research question in this kind of longitudinal study, it is essential to measure inequality in a consistent way for a large number of countries over time. As noted by Beckfield(2004), most of the previous cross- national studies suffer from using income inequality data from multiple sources, which limit international and inter-temporal comparability(e.g., Rodgers 1979; Waldmann 1992; Wilkinson 1992). There are several sources for income inequality database. For instance, Gini coefficient dataset constructed by Deininger and Squire (1996), hereafter D&S are used in a number of previous studies. But several problems are associated in D&S database. For example, the coverage of this dataset is sparse and unbalanced and the mixture of varied data types into a single dataset, thus limiting the comparability, not only across countries but also over periods. Another source is Luxembourg Income Study (LIS) database. LIS has data for longer periods but it covers mainly high income countries. Lastly, several researches depend on inequality data from the World Income Inequality Database (WIID). However, the use of different income definitions such as gross or net, different beneficiary units such as individuals or households and population coverage of urban or rural causes the Gini coefficient in WIID to be inconsistent. This results in serious problems of comparability that can challenge the robustness of the empirical evidences. But in this paper, I have opted for using Estimated Household Income Inequality (EHII) index, which is extracted from the UTIP-UNIDO project at the University of Texas. It has become an alternative but more reliable source of income inequality data in recent studies (Meschi and Vivarelli, 2009; Gimet and Lagoarde-Segot, 2011). I am not going to give details of the construction procedure of this index. Galbraith and Kum (2003) provide comprehensive explanation of the methodology to construct this index. This index is estimated by merging information from the D&S dataset with information from the UTIP-UNIDO dataset. To be specific, the EHII index is constructed by regressing the D&S Gini indices on the UTIP-UNIDO Theil inequality measures and then using the predicted values as estimated Gini coefficients (Herzer and Nunnenkam, 2011). The objective of this method is to detach the useful information from the doubtful information in the D&S dataset. The EHII inequality index ranges from 0 to 100 like the conventional Gini index. The higher the estimated household income inequality value, the more unequal the country is. I choose this index is as it is available for a reasonably large number of developing countries over a sufficiently long and continuous

time period (Galbraith and Kum; 2005) and it sorts out the many limitations of the other measurements of inequality.

GDP per capita (GDP_PC): Real (price-adjusted) GDP per head (constant 2000 US\$) is used as proxy for economic development, is the main control variable in my empirical models. It is the value of all final goods and services produced within the geographical area of a country during one year period divided by consumer price index.

Gross Secondary School Enrollment Rate (EDU_Sec) : It is a measure of the ratio of secondary school enrollment to the population of the age group that officially corresponds to the secondary level in percentage term.

6. Estimation Strategies

Since this paper widely applies various panel data estimation techniques, it is important to present a brief overview on their relevance and importance. Several empirical strategies exist in literature to estimate static and dynamic panel data models but I am confining this discussion on the static models as the number of countries far exceeds the number time periods. This section discusses basically three commonly used panel data models giving attention to their advantages and disadvantages; Pooled Ordinary Least Squares (Pooled OLS) regression, panel model with fixed effects (FEM) and random effects (REM).

6.1 Pooled Ordinary Least Squares (Pooled OLS)

The natural starting for panel data analysis is estimating a pooled OLS model. Pooled panel method is more or less analogous to the method of standard ordinary least squares but pooled OLS estimation widens the database by pooling together cross sectional and time series observations of the sample to get more reliable estimates of the parameters. So it uses more information than standard OLS. Pooled estimators use both between (cross section) and within (time- series) variation in the data. The following pooled OLS model can be specified using the general panel specification model from the previous section:

$$\ln H_{it} = \beta_0 + \beta_1 \ln EHII_Gini_{it} + \beta_2 \ln GDP_PC_{it} + \beta_3 \ln EDU_Sec_{it} + \lambda_t + u_{it} \quad (3)$$

Here, β_0 is the overall intercept. It seems that there is no difference between equation (3) and (4). In fact the subtle difference is that in equation (4), we have the composite error term, $u_{it} = \alpha_i + e_{it}$. Here α_i denotes unobserved factors that differ between countries but are constant over time for each country such as political system, climate conditions, geographical location, health system etc. and λ_t is the time fixed-effect or unobserved factor present in all countries at a specific point in time. So, e_{it} represents the net effect of omitted variables which change over both country and time. The above model can be easily estimated by ordinary least squares method. It provides more consistent estimators compared to simple OLS estimates as long as the composite error in the model is uncorrelated with regressors. However, the error, $u_{it} = (\alpha_i + e_{it})$ are most likely to be correlated over time for a given country. Additionally, this method ignores unobservable country fixed effects or α_i in equation (3). If α_i is correlated with any of the regressors, OLS estimates will be biased. These estimates will be also biased because e_{it} and α_i are likely to be correlated in this specification. So, we can say that heterogeneity of the countries under consideration for investigation can influence estimated parameters. Standard errors should be adjusted for any error correlation and it can be done using more efficient feasible generalized least squares (FGLS) estimation. In pooled FGLS individual effects are assumed to be random and averaged out. This is why it is also known as Population- Averaged (PA) regression. I estimate and present results from both method and compare the parameters.

6.2 Fixed Effects Model (FEM)

Unlike Pooled OLS, the fixed effects model takes into account country specific characteristics. So a two way fixed effects model, which allows intercept to vary over countries and periods can be stated as below:

$$\ln H_{it} = \beta_1 \ln EHII_Gini_{it} + \beta_2 \ln GDP_PC_{it} + \beta_3 \ln EDU_Sec_{it} + \lambda_t + \alpha_i + e_{it} \quad (4)$$

In the above equation, u_{it} from the previous equation is replaced with $\alpha_i + e_{it}$. So the basic difference between fixed effect and pooled OLS lies in α_i . The underlying assumption in the FEM is that individual effects are correlated with regressors or $E(X_{it}, \alpha_i) \neq 0$. Under the strict exogeneity assumption of the explanatory variables, the fixed effect estimators will be unbiased, which implies that e_{it} must be uncorrelated with independent variables across all time period (Wooldridge, 2010).

Moreover, e_{it} should be homoskedastic and serially uncorrelated across time. In FEM, the unobserved heterogeneity or a_i is eliminated using within transformation, which leads OLS estimates to consistent and unbiased. This method allows for a limited form of endogeneity. However fixed effect method is not without draw backs. For example, individual specific group wise heteroskedasticity or serial correlation over period can result into inefficient estimation.

6.3 Random Effect Model (REM)

The random effect model assumes that individual country effects are purely random, which means that a_i is uncorrelated with the regressors. An ideal REM model incorporates all the FEM assumption plus the extra assumption that a_i is independent of all explanatory variables in all time periods. So we can state the random effect model as below:

$$\ln H_{it} = \beta_0 + \beta_1 \ln EHII_GINI_{it} + \beta_2 \ln GDP_PC_{it} + \beta_3 \ln EDU_Sec_{it} + \lambda_i + v_{it} \quad (5)$$

I

n the above model $v_{it} = \varepsilon_i + e_{it}$ where ε_i is the country specific random disturbance. We can write the underlying assumption of the random effects model as $E(X_{it}, \varepsilon_i) = 0$, which implies that individual effect are not correlated with any of regressors. The random effect estimators are consistent and completely efficient when it is appropriate but it is inconsistent if the fixed effect model is correct. It is worth noting that term “fixed effects” is sometime confusing because in both types of models level effects are random. Finally, the problem of having an unbalanced panel in this study is not important since there is no attrition in the panel.

6.4 Model Selection and Dealing with Serial correlation and Heteroskedasticity

The starting point is to estimate a pooled OLS model. Nevertheless, we must consider the potential pitfalls of pooled OLS model such as failing to take into account the unobserved heterogeneity. So, the strategy is to proceed step by step to select the correct model. The first step is to test the presence of fixed effect in the Pooled OLS model. In this step, if the null hypothesis of no country specific intercept rejected, the conclusion is that there is unobserved heterogeneity in the panel or there is significant improvement in goodness-of-fit in the fixed effects model. So the fixed effects model is preferred to the pooled OLS. The second

step is to test the null hypothesis of no random effect by Lagrange multiplier (LM) test (Breusch and Pagan's; 1980). Rejection of null hypothesis in this case indicates the existence of significant random effect and that the random effect model is able to deal with heterogeneity better than does the pooled OLS. When both hypotheses are rejected, the final step is to compare the fixed-effect model and random-effect model using the Hausman test. The Hausman specification test compares fixed and random effect models under the null hypothesis that individual effects are uncorrelated with any of the regressors in the model (Hausman, 1978). If the null hypothesis is rejected, the test concludes that correlation is important and a fixed effect technique is so far the best method to examine the relationship between health and income inequality. Lastly, the Baltagi-Wu LBI test (Baltagi and Wu;1999) implemented in STATA is used to the test for serial correlation of the residuals. In this test, the value for the test statistic below 1.5 indicates that there is serial correlation in the errors. As this study deals with short panel, I use country wise cluster-robust inference, which allows heteroskedasticity and general correlation over time for a given country in pooled OLS and and fixed effects models

7. Descriptive Statistics and Graphical Analysis

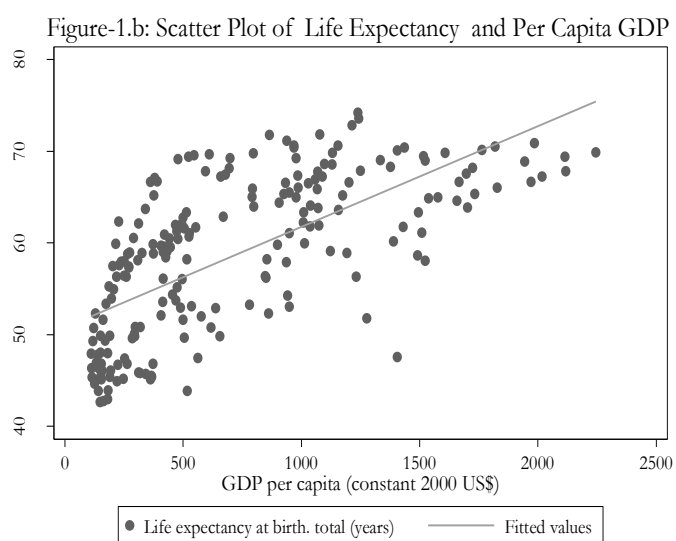
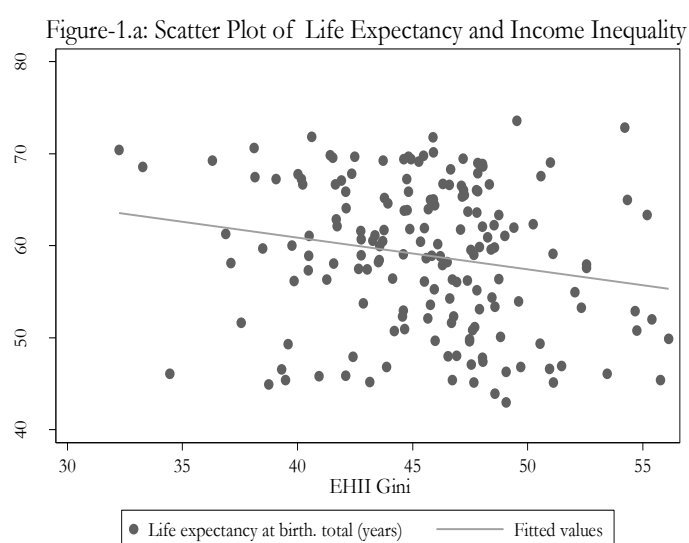
Ahead of formal empirical analysis, a short discussion on sample statistics and graphical representation of the key variables can give us important insights on the characteristics of the sample covered in this study. The following table 1 illustrates the summary statistics of the dependent and independent variables separately for each period. It is apparent from the table that life expectancy at birth has steadily increased over the period in this sample of countries while infant mortality rate has decreased by 25.75 per 1000 live births. However, there is also a considerable reduction in under-five mortality amounting to almost 42 per 1000 children. Per capita GDP has also increased moderately in this sample of developing countries over this period. It is not possible to comment on the overall trend of the estimated household income inequality as data for some countries are randomly missing over the covered period.

Table 1: Decomposed Summary Statistics of the Sample by Periods

Period	Variables	Obs.	Mean	Std. Dev.	Period	Variables	Obs.	Mean	Std. Dev.
1982-84	LEB	31	56.621	7.5585	1985-87	LEB	31	57.756	7.7488
	IMR	31	82.387	36.968		IMR	31	77.051	36.397
	MR_5	31	126.414	63.805		MR_5	31	117.375	62.671
	EHII_Gini	26	45.236	3.3531		EHII_Gini	26	44.684	3.983
	GDPPC	28	662.205	483.936		GDPPC	29	687.218	488.629
	EDU_Sec	29	33.676	25.183		EDU_Sec	28	35.675	24.354
1988-90	LEB	31	58.725	8.126	1991-93	LEB	31	59.216	8.514
	IMR	31	72.316	35.324		IMR	31	68.629	34.192
	MR_5	31	109.33	60.929		MR_5	31	103.426	59.393
	EHII_Gini	27	44.923	4.713		EHII_Gini	31	44.713	5.327
	GDP_PC	30	698.517	496.767		GDP_PC	30	701.961	510.369
	EDU_Sec	26	38.543	27.685		EDU_Sec	26	41.026	27.795
1994-96	LEB	31	59.398	8.898	1997-99	LEB	31	59.598	9.3691
	IMR	31	65.291	33.160		IMR	31	61.169	31.520
	MR_5	31	98.3462	57.954		MR_5	31	91.861	55.053
	EHII_Gini	29	47.048	4.713		EHII_Gini	20	46.682	3.582
	GDP_PC	30	717.809	555.889		GDP_PC	31	753.08	573.652
	EDU_Sec	19	40.8371	25.481		EDU_Sec	27	43.850	26.266
2000-02	LEB	31	60.068	9.778					
	IMR	31	56.634	29.813					
	MR_5	31	84.483	51.634					
	EHII_Gini	12	47.002	2.7269					
	GDPPC	31	789.911	607.381					
	EDU_Sec	27	48.162	27.521					

It is noted that this variable is available for all countries only in the period of 1991-93. Pair wise scatter plots of per capita GDP, EHII_Gini and life expectancy are shown in the figure 1. From figure-1.a, we can see that there is a weak

Figure-1: Cross-country scatter plots of GDP per capita, life expectancy and income inequality



but negative relation between income inequality and life expectancy at birth. However, there is a strong positive association between GDP per capita and life expectancy and it almost resembles the famous Preston curve (Figure-1.b) for this set developing countries also.

8. Empirical Results and Analysis

This section presents the econometric results and discussion on the main findings in line with earlier studies. To facilitate the comparison with the conclusions drawn in prior works on the relationship between health and income inequality, I first estimate the pooled OLS models along with pooled FGLS models and the results are reported in table 2. Pooled FGLS leads to more efficient estimates in short panel under the assumption that errors are independent across countries. Results of model-1 in the following table are the most consistent with the existing cross sectional results. It shows that life expectancy at birth is negatively

Table 2: Dependent Variable--Log of Life Expectancy at Birth

Estimation Method	(1) Pooled OLS	(2) Pooled OLS	(3) Pooled FGLS	(4) Pooled FGLS
Log (EHII_Gini)	-0.224* (0.130)	-0.115 (0.101)	0.0292 (0.0207)	-0.0115 (0.0189)
Log(GDP_PC)	0.130*** (0.0146)	0.0814*** (0.0161)	0.103*** (0.0155)	0.109*** (0.0233)
Log(EDU_Sec)		0.0864*** (0.0166)		0.0499*** (0.0186)
Constant	4.074*** (0.532)	3.688*** (0.399)	3.297*** (0.137)	3.247*** (0.128)
Time Effects	Yes	No	Yes	Yes
F-Test:	2.45	1.07		
Observations	165	140	138	86
R-squared	0.602	0.774		
Number of country			24	18

Notes: 1. Robust standard errors clustered in country level are in parentheses
 2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively
 3. F-Test is a test for the joint significance of time effects.

related with the estimated household income inequality (EHII_Gini) and it is positively related per capita real GDP. Coefficients of both of the variables are statistically significant. The double log or constant

elasticity model implies that estimated elasticity of EHII_Gini is -0.224. It means that holding average income constant, a 1 percent increase in income inequality on an average leads to a 0.224 percent fall in life expectancy across these developing countries. However, adding secondary enrollment rate as a control variable in model-2 eliminates the statistical relationship between EHII_Gini and LEB, but the sign remains same as before. Thus, I can say that income inequality does not play any role in determining the average health of population. In this model, both average income and educational attainment are highly significant and has positive impact on health status of the population. The results also indicate that the effect of education is as great as income in these countries, as discussed earlier. Population average (PA) or pooled FGLS method produces the results, which are more or less similar as pooled OLS in the extended model (Model-4). But the problem is that this method takes into account a small number of countries, which may violate the asymptotic property of the estimates. The following table 3 illustrates the results of fixed effects

Table 3: Dependent Variable--Log of Life Expectancy at Birth

Estimation Method	(5) Fixed Effect	(6) Fixed Effect	(7) Random Effect GLS with AR(1)	(8) Random Effect GLS with AR(1)
Log (EHII_Gini)	0.139** (0.0635)	0.149** (0.0615)	0.0753** (0.0353)	0.0851** (0.0425)
Log(GDP_PC)	0.0812** (0.0307)	0.0875*** (0.0275)	0.111*** (0.0142)	0.0859*** (0.0143)
Log(EDU_Sec)		0.00409 (0.0340)		0.0684*** (0.0142)
Constant	3.005*** (0.346)	2.917*** (0.381)	3.056*** (0.170)	2.957*** (0.187)
Time Effects	Yes	No	Yes	No
F-Test	2.59	1.13		
Country Effects	Yes	Yes	RE	RE
F-Test	35.75	15.62		
Observations	165	140	165	140
R-squared	0.370	0.355	0.5709	0.7539
Number of country	30	30	30	30

Notes: 1. Robust standard errors clustered in country level are in parentheses for fixed effect models
2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively
3. R-Squared is the within-R-Squared for fixed effects and the between-R-Squared for random effects
4. F-Test is a test for the joint significance of the country fixed effects or time fixed effects.

and random effects estimations. Before proceeding, it should be noted that F-test for joint hypothesis of no country specific effect is rejected and it discards the use of pooled OLS. The test of null hypothesis of no random effect by Breusch and Pagan's LM test is also rejected in every case. So, there is random effect in the panel. Moreover, Baltagi-Wu LBI test of serial correlation of the residuals suggests the presence of serial correlation. That is why I prefer to use generalized least squares (GLS) random effect model with AR (1), which allows autocorrelation in the residuals. Finally, Hausman test is carried on to compare the fixed effects model with the random effects model. Though the fixed effects models are appropriate suggested by this test, I present the results from both models. In line with (Wooldridge, 2010), it can be stated that the random country and fixed period effect model are useful over the alternative with both effects fixed if the number of observations are relatively small. Moreover, fixed effects estimation tackles endogeneity problem to some extent, since unobserved county effects are swept away. Now, we see that there is a dramatic change in the results as compared to the previous results in table 3. The results show that there is a positive relation between income inequality and life expectancy at birth. The coefficients of EHII_Gini are significant at 5 percent level even after controlling for educational attainment in all models. For instance, if I analyze the results of model-8, life expectancy at birth increases by 0.0851 percent on an average when EHII_Gini rises by 1 percent, holding income and education constant. These results are against the income inequality-health hypothesis. One important point is that impact of GDP per capita on average health among these countries is positive and highly significant and it is confirmed by the all the four econometric techniques above.

Earlier studies on the relationship between health and income inequality using pure cross sectional data such as Rodgers (1979) and Wilkinson (1992) show that at country level income inequality and average health of people are inversely related. However, some of the recent studies (Judge et al. 1998; Gravelle et al. 2002; Dorling et al. 2007; Babones, 2008) provide mixed evidences for income inequality- health hypothesis. On the other hand, Mellor and Milyo (2001) shows that income inequality leads to better health once education is controlled for in samples of 12 to 47 countries. Additionally, Beckfield (2004) using panel data is unable give evidence in favor of this hypothesis. Leigh and Jencks (2007) have not denied the possibility that inequality increases

life expectancy to some extent a panel of 12 rich countries. In a recent paper, Torre and Myrskylä (2011) have studied this hypothesis for 21 developed countries over the period 1975-2006 and have reached the conclusion that there is no statistical link between life expectancy at birth and income inequality measured by Gini Index. However, their study is subject to the criticism that it covers only the wealthy countries where income inequality is not as high as poor countries. Lastly, Herzer and Nunnenkam (2011) have lately made a novel attempt using panel co-integration method to deal with omitted country-specific factors, endogeneity, and cross-country heterogeneity to examine the impact of inequality on health. Their findings suggest that population health is positively affected by the inequality in income in a balanced panel of 35 countries during 1970-1995. This discussion encourages me to state that when unobserved country specific effects are not considered, my findings from pooled OLS analysis coincide with findings from prior cross country studies to some extent. In contrast, fixed effects and random effects estimations, which take into account unobserved county effects and time effects provide me the results similar to the most recent studies based on longitudinal data. Additionally, the relation between health and inequality becomes weak after controlling for educational attainment.

9. Sensitivity Analysis

Since the results in the previous section contrast with earlier empirical works of cross-sectional design, this section is devoted to check the robustness of my findings. Sensitivity of results is tested using alternative measures of aggregate health outcome. The first sensitivity test of my findings is presented in the table 4, where I replace the log life expectancy at birth with log infant mortality rate as the dependent variable. It is established in the empirical literature that higher income inequality tends to increase infant mortality. Similar results are obtained by pooled OLS as shown in the following table. It indicates that higher income inequality has significant positive relation with infant mortality while raising average income significantly reduces it. Adding education as control weakens the significance of the results to much in pooled OLS (see model 10). This result is more or less in line with Mellor and Milyo (2001), who find that the positive correlation between the Gini coefficient and infant mortality disappears once secondary school enrolment is controlled for. However, these results are not beyond doubt

as unobserved heterogeneity is not captured in these models. Using the same strategy applied in the previous section, I re-estimate the fixed effects and random effects GLS models. The results are presented in table 5. In fixed effects estimation coefficients of EHII_Gini is significant at 5 percent level in basic model as well as in the extended model but it is now negatively related with infant mortality. It implies that the more unequal the income distribution the lower is the infant mortality rate. However, this relationship is not statistically significant in Random Effect GLS

Table 4: Dependent Variable--Log of Infant Mortality Rate

Estimation Method	(9) Pooled OLS	(10) Pooled OLS	(11) Pooled FGLS	(12) Pooled FGLS
Log (EHII_Gini)	1.367** (0.584)	0.832* (0.438)	-0.0519 (0.0360)	0.00771 (0.0917)
Log(GDP_PC))	-0.474*** (0.0665)	-0.268*** (0.0710)	-0.248*** (0.0712)	-0.268*** (0.0997)
Log(EDU_Sec)		-0.343*** (0.0954)		-0.202** (0.0907)
Time Effects	Yes	Yes	Yes	Yes
F-Test	4.69	2.37		
Observations	165	140	138	86
R-squared	0.566	0.715		
Number of country			24	18

Notes: 1. Robust standard errors clustered in country level are in parentheses

2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

3. F-Test is a test for the joint significance of time effects.

models but the sign is same as it is in fixed effects models. For instance, results of model-14 for tells us that if EHII_Gini goes up by 1 percent, keeping average income and secondary education fixed the number of infant deaths per 1000 live birth in a year decreases by 0.356 percent on average. The effect of income and education reflect the existing findings. I have also checked the sensitivity of the results using exclusion single country but the results remain almost similar In

Table 5: Dependent Variable--Log of Infant Mortality Rate

Estimation Method	(13) Fixed Effect	(14) Fixed Effect	(15) Random Effect GLS with AR(1)	(16) Random Effect GLS with AR(1)
Log (EHII_Gini)	-0.312** (0.142)	-0.356** (0.146)	-0.150 (0.106)	-0.197 (0.129)
Log(GDP_PC)	-0.255** (0.0987)	-0.273** (0.100)	-0.355*** (0.0480)	-0.292*** (0.0531)
Log(EDU_Sec)		0.0275 (0.106)		-0.224*** (0.0525)
Constant	7.069*** (0.988)	7.247*** (1.074)	7.073*** (0.535)	7.581*** (0.607)
Time Effects	Yes	Yes	Yes	Yes
F-Test	27.61	15.10		
Country Effects	Yes	Yes	RE	RE
F-Test	102.70	52.49		
Observations	165	140	165	140
R-squared	0.752	0.748	0.4940	0.6460
Number of country	30	30	30	30

Notes: 1. Robust standard errors clustered in country level are in parentheses for fixed effect models

2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

3. R-Squared is the within-R-Squared for fixed effects and the between-R-Squared for random effects

4. F-Test is a test for the joint significance of the country fixed effects or time effects.

addition, estimation of the models without time controls changes the results marginally. Table A3 and table A4 in the appendix provide the empirical findings using under-five mortality rate as the dependent variable. It also confirms that the results obtained in the previous section in testing health-income inequality hypothesis are robust to the change in the measurement of health. My sensitivity analysis thus concludes that income inequality causes a reduction in both infant mortality and under-five mortality. These findings are again different from the large body of existing studies in this field.

10. Limitations and Further Research

It must be admitted that my study is not beyond limitations. First of all, the sample covered in this study is one third of the entire list of developing countries and the time period covered is not very recent. This is because of the unavailability of recent data on income inequality for these countries. My results may be biased due to exclusion of

relevant variables, which affect health and it causes omitted variable problem. But it does not imply that findings are completely invalid. Moreover, the estimated household income inequality (EHII_Gini) as an index of income distribution is not without flaws. The robustness of the results could be checked in principle with other measures of inequality such as top 10 or bottom 10 percent share of income. This is again halted by the unavailability of data.

Most importantly, the endogenous nature of income inequality is not fully solved in this study, though an attempt is made to tackle it with the fixed effects models. In the fixed effects estimation, time-invariant unobservable factors correlated with income inequality are swept away but time-variant unobservable factors cannot be removed. Studies based on observational data like this one are not appropriate to draw causal inference. This happens as the endogeneity problem is not tackled appropriately in the earlier studies in this field. Finding an appropriate instrumental variable in aggregate studies is always hard, which hinders to deal with possible correlation between income inequality and unobserved factors. Wagstaff and Doorslaer (2000) ideally point out that unavailability of high-quality data on inequality makes it difficult to apply best-available methods to get rid of spurious correlations and identify the causal effects in empirical research of inequality and health. Though findings from population level studies are informative to get a broad overview it is difficult to distinguish between the Absolute Income and the Income Inequality hypotheses. It is also impossible to test the Relative Income hypothesis using aggregate data to identify the true impact of inequality on health. These studies thus may not differentiate the “statistical artefact” (Gravelle, 1998) from the mechanisms in which income inequality has a direct effect on individual health. Gravelle (1998) emphasized that further research is necessary to estimate the direct impact of income inequality on health by combining individual and aggregate level data. Wagstaff and Doorslaer (2000) also support the use of individual level studies. They argue that “What seems to be required to discriminate between the various hypotheses are individual-level studies, because it is only at this level of aggregation that one can observe relationships that are consistent with one hypothesis and not with another.” (Wagstaff and Doorslaer; 2000, p. 564). They also put emphasis on using natural experiments in this field. This discussion provokes the importance of several future researches. For example, the problem of endogeneity must be addressed properly in

aggregate studies to get true causal effect of income inequality. Individual level studies in developing countries should be performed to distinguish between the Income Inequality and Relative income hypothesis.

11. Conclusion

It is well evident in the majority of the previous empirical works that income inequality on an average impedes the improvement in health of population. However, some recent studies have challenged the health and income inequality proposition and presented evidence that the relation between health and income inequality is far more ambiguous than it is supposed. Departing from the general trend of current literature, this paper reexamines health-income inequality hypothesis using population level cross country-time series data from 31 low income and low middle income countries over the period of 1982-2002. My results based on pooled OLS method show that health is negatively associated with income inequality. It is worth mentioning that when I add education as a control variable, statistical significance between health and income inequality disappears though negative relation still remains. This finding is consistent with majority of the literature, which manifests that inequality is detrimental to population health. However, this analysis fails to capture the country specific fixed factors and thus the estimated coefficient on inequality may be biased. So, I go further to apply fixed effects and random effects methods to take in account for such unobserved heterogeneity. It allows me to identify the cross-national heterogeneity, while earlier approaches are based on usual restrictive assumption that the coefficients of the income inequality are same across all countries. Empirical results from these estimations confirm that life expectancy at birth is positively related with income inequality. Sensitivity analysis using different measures of population level health outcome provides evidence that my findings are robust indeed. Exclusion of single country from the sample or time control does not alter the result largely. So, it implies that there is a statistically significant positive relation between health and income inequality in developing countries over the study period at least. One possible explanation of this evidence is that multilateral donor (World Bank, IMF ADB etc.) funded health improvement initiatives help these countries to obtain better health outcome even in the face of rising income inequality. However, from a policy perspective it is important to

understand that income inequality is an attribute of a social system while income is a characteristic of an individual person. My findings do not necessarily recommend that the inequality in income should be remained or widen to improve health of the population. In general, it is better to have more equal distribution of income in the society but overemphasizing income inequality as a determinant of population health is redundant from a policy perspective. Redistributive policy could be expensive or even useless when it has little or no impact on the target specific health outcome of the population in developing countries.

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Appendix

Table-A1: List of Countries

Bangladesh	India	Pakistan
Bolivia	Indonesia	Philippines
Burundi	Iraq	Senegal
Cameroon	Kenya	Sri Lanka
El Salvador	Malawi	Swaziland
Ethiopia	Moldova	Syrian Arab Republic
Fiji	Morocco	Tanzania
Ghana	Mozambique	Tonga
Guatemala	Nepal	Uganda
Honduras	Nigeria	Ukraine
		Zimbabwe

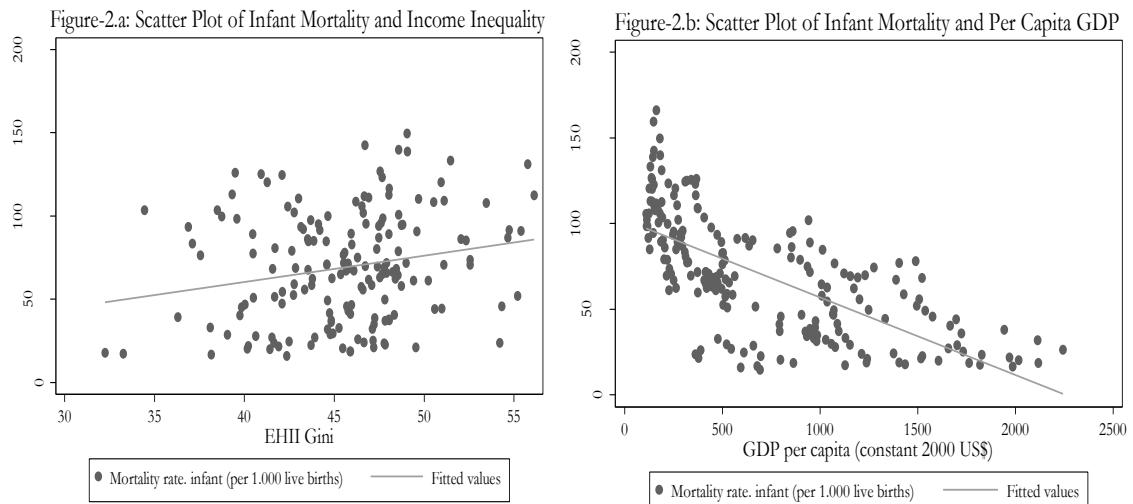
Note: As per World Bank Classification of Low income and Lower-middle income countries

Table-A2: Variables and Sources

	Variables Involved	Original Source
Response Variables	Life Expectancy at Birth (LEB) (In number of years)	World Bank : (World Development Indicators: WDI Online data base) http://data.worldbank.org (Accessed April 15, 2012)
	Infant Mortality Rate (IMR) (Per 1,000 live births)	World Bank: (World Development Indicators: WDI Online data base) http://data.worldbank.org (Accessed April 15, 2012)
	Mortality Rate Under-five (MR_5) (Per 1,000)	World Bank: (World Development Indicators: WDI Online data base) http://data.worldbank.org (Accessed April 15, 2012)
Explanatory Variables	Estimated Household Income Inequality (EHII_Gini): (Gini format: on a 0 to 100 scale)	University of Texas Inequality Project: (UTIP-UNIDO) http://utip.gov.utexas.edu/data.html (Accessed April 12, 2012)
	Real GDP per capita (GDP_PC) (Constant 2000 US\$)	World Bank: (World Development Indicators: WDI Online data base) http://data.worldbank.org (Accessed April 17, 2012)
	Gross Secondary School Enrollment Rate (EDU_Sec) (Ratio in percentage term)	World Bank: (World Development Indicators: WDI Online data base) http://data.worldbank.org (Accessed April 17, 2012)

Note: Natural logs of all variables are taken after extracting from the original source.

**Figure- 2: Scatter plot of Infant Mortality Rate against
Income Inequality and GDP per Capita**



**Figure-3: Scatter plot of Under Five Mortality Rate against Income
Inequality and GDP per Capita**

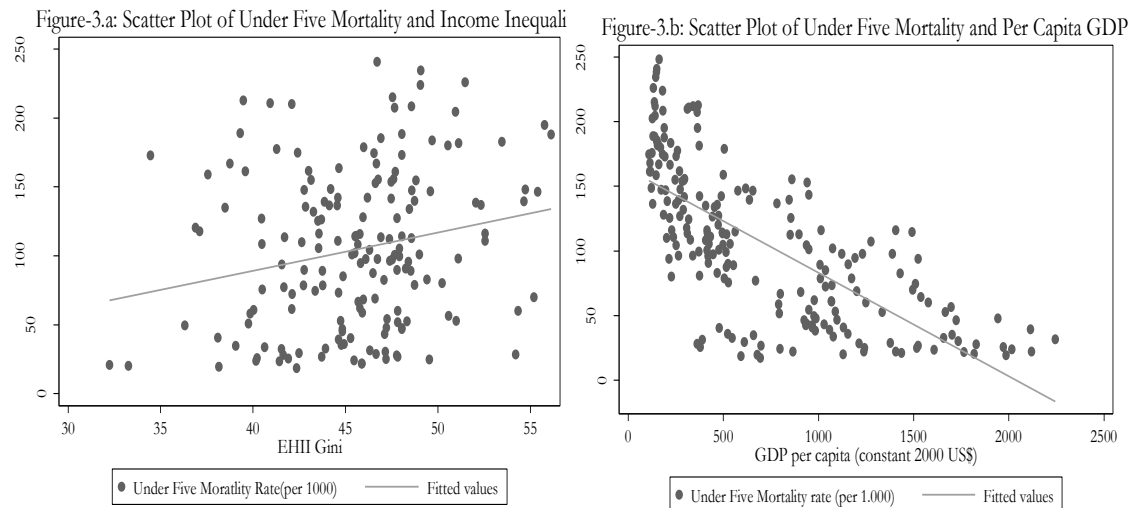


Table A3: Dependent Variable--Log of Under-Five Mortality Rate

Estimation Method	(17) Pooled OLS	(18) Pooled OLS	(19) Pooled FGLS	(20) Pooled FGLS
Log (EHII_Gini)	1.614** (0.673)	0.950* (0.499)	-0.0700 (0.0429)	0.0206 (0.109)
Log(GDP_PC)	-0.578*** (0.0741)	-0.318*** (0.0771)	-0.303*** (0.0850)	-0.326*** (0.120)
Log(EDU_Sec)		-0.427*** (0.112)		-0.260** (0.112)
Constant	2.185 (2.696)	4.470** (1.989)	6.766*** (0.606)	7.463*** (0.859)
Time Effects	Yes	Yes	Yes	Yes
F-Test	4.02	2.60		
Observations	165	140	138	86
R-squared	0.582	0.738		
Number of country			24	18

Notes: 1. Robust standard errors clustered in country level are in parentheses
2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively
3. F-Test is a test for the joint significance of time effects.

Table A4: Dependent Variable--Log of Under-Five Mortality Rate

Estimation Method	(21) Fixed Effect	(22) Fixed Effect	(23) Random Effect GLS with AR(1)	(24) Random Effect GLS with AR(1)
Log (EHII_Gini)	-0.382** (0.165)	-0.433** (0.172)	-0.184 (0.127)	-0.230 (0.155)
Log(GDP_PC)	-0.286** (0.115)	-0.308** (0.116)	-0.428*** (0.0570)	-0.345*** (0.0624)
Log(EDU_Sec)		0.0244 (0.121)		-0.287*** (0.0616)
Constant	7.923*** (1.164)	8.157*** (1.286)	8.048*** (0.640)	8.632*** (0.723)
Time Effects	Yes	Yes	Yes	Yes
F-Test	25.21	13.47		
Country Effects	Yes	Yes	RE	RE
F-Test	96.77	46.66		
Observations	165	140	165	140
R-squared	0.735	0.729	0.5127	0.6753
Number of country	30	30	30	30

Notes: 1. Robust standard errors clustered in country level are in parentheses for fixed effect models
2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively
3. R-Squared is the within-R-Squared for fixed effects and the between-R-Squared for random effects
4. F-Test is a test for the joint significance of the country fixed effects or time effects.

Bid-Ask Spread, Futures Market Sentiment and Exchange Rate Returns

M. Faisal Safa¹ and Neal C. Maroney

This paper analyzes spot foreign exchange bid-ask spread and the future market sentiment as two important variables to explain the exchange rate returns. We use two sentiment indices based on futures market return and volume. Time series and cross-sectional analyses of three different currency exchange rates; Australian Dollar, British Pound and Canadian Dollar – to US Dollar suggest that the spot market bid-ask spread is one important variable that positively affects the spot exchange rate returns. The return based sentiment index does not seem to be a significant factor, but the volume based sentiment index affects the spot exchange rate returns significantly. The negative sign of sentiment indices implies lower spot market return associated with higher investor interest in futures market, although higher trading in futures market contributes positively in the spot market.

1. Introduction

Literature on foreign exchange focuses on understanding the exchange rate dynamics both in short and long horizons. Prior researches use both macro- and micro-based models in order to explain the exchange rate return fundamentals. Macro-based models associate macroeconomic variables, e.g., relative money supplies, outputs, inflation and interest rates, with exchange rates (Engel and West, 2005; Groen, 2000; Clarida, Gali and Gertler, 1998). Empirical macro-based researches test the direct impact of both expected and unexpected macroeconomic news on exchange rate return (Evans and Lyons, 2008; Anderson et. al., 2003). These models pay a little attention on the trading mechanism in the

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foreign exchange market. On the other hand, micro-based models test how pricing information are reflected in the exchange rate through the trading process by analyzing the order flow in the foreign exchange market (Evans and Lyons, 2005b, 2002).

Like the spot foreign exchange market, the price discovery in foreign exchange futures market is also important. Tse, Xiang, and Fung (2006) argue that futures market provides both public and private information held by various economic agents. They also show that futures contracts provide the most price discovery for euro. Chen and Gau (2010) analyze the competition in price discovery between spot and futures markets for the euro and Japanese yen and find that the spot rates, on average, provide more price discovery than the futures rates; but the futures rates contribute more to price discovery during macroeconomic announcement releases.

In this paper we analyze this issue from a different direction by focusing on the contribution of spot market bid-ask spread and futures market sentiment on the price discovery in the spot foreign exchange market. Researchers (Evans and Lyons, 2007, 2005a, 2005b, 2002; Cerrato, Sarantis and Saunders, 2011) consider order flow as an important factor that can explain the exchange rate returns. But these studies do not focus on the bid-ask spread (spread) - another important factor in foreign exchange market. On the other hand, liquidity plays an important role in foreign exchange market. Amihud (2002) suggests that spread partly represent the illiquidity premium on the expected stock return. In this light Chen, Chien and Chang (2012) suggest that liquidity providers in the market supply liquidity at a cost – the spread. They find order flow the main explanatory variable for active currencies, but the spread is a potential candidate in explaining the daily returns on infrequently traded currencies. For this, this paper uses spread as one important factor explaining the spot foreign exchange returns.

In this paper, we also analyze foreign exchange futures market sentiment as another important factor that explains the spot exchange rate returns. A number of papers examine futures market effect on the spot market. Board, Sandmann and Sutcliffe (2001) analyze the futures market volume on spot market volatilities. They do not find any evidence suggesting that one market instantly destabilize another after adjusting for the effects of information arrival and time trends. Illueca and

Lafuente (2003) also analyze the relation between spot volatility and trading volume in the stock exchange futures market, but again they find no significant link between the two. Both papers examine the futures market effects on stock market, but ignore the foreign exchange market.

In this paper, we examine the effect of futures market sentiment on the return of spot market in the foreign exchange market. We use two measures of future market sentiment – one based on futures market return and the other based on futures market volume. The return based sentiment index mainly focuses on the returns in the futures market and corresponding investor sentiment, while the volume based sentiment index analyzes the liquidity and trading activity in the futures market. By analyzing three different currencies - Australian Dollar, British Pound and Canadian Dollar – to US Dollar for the period from January 2, 2009 to April 15, 2011, we find that both spread and future market sentiment have significant effect on exchange rate returns. This finding is consistent with the Grossman (1988) theories suggesting that futures trading improves depth and liquidity in spot (equity) market.

This finding of this paper contributes to the literature by adding spread as an explanatory variable to explain the exchange rate returns. Although spread has been used in various researches to explain various macroeconomic variables; e.g., forward rates; very few papers attempt to explain exchange rate returns by using spread. Chen, Chien and Chang (2012) shows that spread can explain exchange rate returns when the trading density is high. In this paper, we extend their analysis by adding two future market sentiment indices as explanatory variables in explaining exchange rate returns.

Section 2 of the paper discusses the information flow in the foreign exchange market and the proposed hypotheses. Section 3 discusses the data sources and summary statistics of the variables used in this paper. Section 4 presents the time series and cross-sectional estimates and section 5 concludes the paper.

2. Information Flow in the Foreign Exchange Market and Hypothesis Development

No dealer in the spot foreign exchange market has complete information about the overall market. Electronic brokerages systems provide

information on the best posted bid and ask; which act as benchmarks for prices. The dealers also have information about order flow, but they do not observe the structure of limit orders that determines market liquidity. This liquidity information is important to dealers as they try to keep an overnight position at a minimum. Moreover trades over \$25 million need to be split into multiple small trades in order to minimize market impact and execution costs. For all these reasons, it is difficult for dealers to collect information from trades. So in spot foreign exchange market, participants have only two sources of information – order flow and spread.

Order flow is one important measure of net liquidity demand in the market. Evans and Lyons (2002) define order flow as the differential order number initiated by buyers and sellers. It measures the net buying pressures and determines prices as it conveys information on market liquidity. Evans and Lyons (2002), by using a macro based portfolio shifts model and tick data, calculate order flow and show that such order flow significantly explains daily exchange rate returns.

Spread is another important source of information foreign exchange market. Osler (2008) defines spread as the difference between the best (lowest) price at which one can buy any currency (the ask) and the best (highest) price at which one can sell it (the bid). Admati and Pfleiderer (1988) suggest that the price discovery process in foreign exchange market is a result of adverse selection process. They develop an asymmetric information model where uninformed traders choose to trade at one time since this brings low adverse selection costs to dealers and thus low spreads. Madhavan and Cheng (1997) show that high spreads at the NYSE reflect high adverse selection risk as information accumulates overnight in the market. Bessembinder (1994) finds that spreads widen with foreign currency inventory risk, price risk and liquidity risk. High spreads reflect high inventory risk. Payne (2003), by using VAR decomposition model, shows that the permanent impact of order flow can account for 60% of spread. Bollerslev and Melvin (1996), by using a GARCH model, find that the size of spread is positively related to the exchange rate uncertainty. Ding (2009) finds spreads to be independent of order sizes in the inter-dealer market and negatively correlated in the retail market. Chen, Chien and Chang (2012) argue that the Evans and Lyons' (2002) order flow model should incorporate spread – the transaction cost of liquidity. They find that both

order flows and spreads significantly affect the exchange rate returns when trading density is high. We should expect the same results in our sample. Thus the first hypothesis we propose is:

Hypothesis1: The spot exchange rate spread has a positive and significant effect on spot exchange rate returns.

That is an increase in spot exchange rate spread should increase the spot exchange rate return.

Another important source of information in the futures market is the open interest - the total number of future contracts entered into, but not yet offset, by a transaction or delivery. That is open interest is the sum of positive *net* positions in each contract across traders. It can help futures traders to get a sense of whether the market is gaining strength or getting weaker. It also indicates the market sentiment, which is one aspect of trading often ignored by the researchers. Wang, Keswani and Taylor (2006) suggests open interest as the preferred measure of sentiment in the options market as they argue that the open interest of options is the final picture of sentiment at the end of the day or the week and is therefore likely to have better predictive power for volatility in subsequent periods. Chen, Cuny and Haugen (1995) test a theoretical model of basis and open interest of stock index futures. They find that increased volatility decreases basis and increases open interest. Bessembinder, Chan and Seguin (1996) analyzes open interest as an important factor analyzing foreign exchange return and finds that in a rising foreign exchange future market, trading volume varies positively with open interest – the divergence of trader opinion.

Wang (2004) first transforms the open interest as a measure of market sentiment and find that speculator sentiment is positively related to future returns. Charlebois and Sapp (2006), uses daily data on Dollar-Mark return for the period 1988-1998 and find that moving-average trading rules generate significant excess returns and the excess returns increase when information is included on the open interest differential on currency options. They interpret this partly as risk premia and partly as extra fundamental information that is reflected in options prices. In this paper, we link the spot market to futures market by analyzing the futures market sentiment, by using two indices as proxy for futures market sentiment and by analyzing their effects on spot exchange rate

returns. The first index associates the future market returns with the open interest. We calculate this return based sentiment index (*RBSI*) by taking the ratio of daily percent changes in futures prices to the daily percent changes in open interest as presented in equation (1):

$$RBSI_t = \ln \left[\frac{\left(\frac{F_t - F_{t-1}}{F_{t-1}} \right)}{\left(\frac{OI_t - OI_{t-1}}{OI_{t-1}} \right)} \right] \quad (1)$$

Here, F_t indicates the exchange rate futures price, OI_t indicates the open interest in futures market, and t is the time index. A positive sign of $RBSI_t$ indicates the same directional movement, while a negative sign indicates the opposite directional movement by futures returns and open interests. Thus a positive sign implies the investors' interest in the futures market and a negative sign implies lack of investor's interest in the futures market.

The second index associates the open interest with the liquidity and trading activity in the futures market. We calculate this volume based sentiment index (*VBSI*) by taking the ratio of daily open interest to the daily volume in the futures market as presented in equation (2):

$$VBSI_t = \ln \left[OI_t / VOL_t \right] \quad (2)$$

Here VOL_t indicates the volume in the futures market. A $VBSI_t$ ratio more than one indicates the higher trading pressure, less than one indicates the lack of trading pressure, and a ratio of one indicates balanced trading pressure in the futures market. A higher return and associated volume in futures market should take the spotlight off of the spot market and thus should reduce the spot market return. In this light, the second hypothesis we propose is:

Hypothesis 2: The foreign exchange futures market sentiment has a negative effect on the spot exchange rate returns.

That is an increase in futures market sentiment or investor interest in futures market should reduce the spot exchange rate return.

3. Data and Variable Description

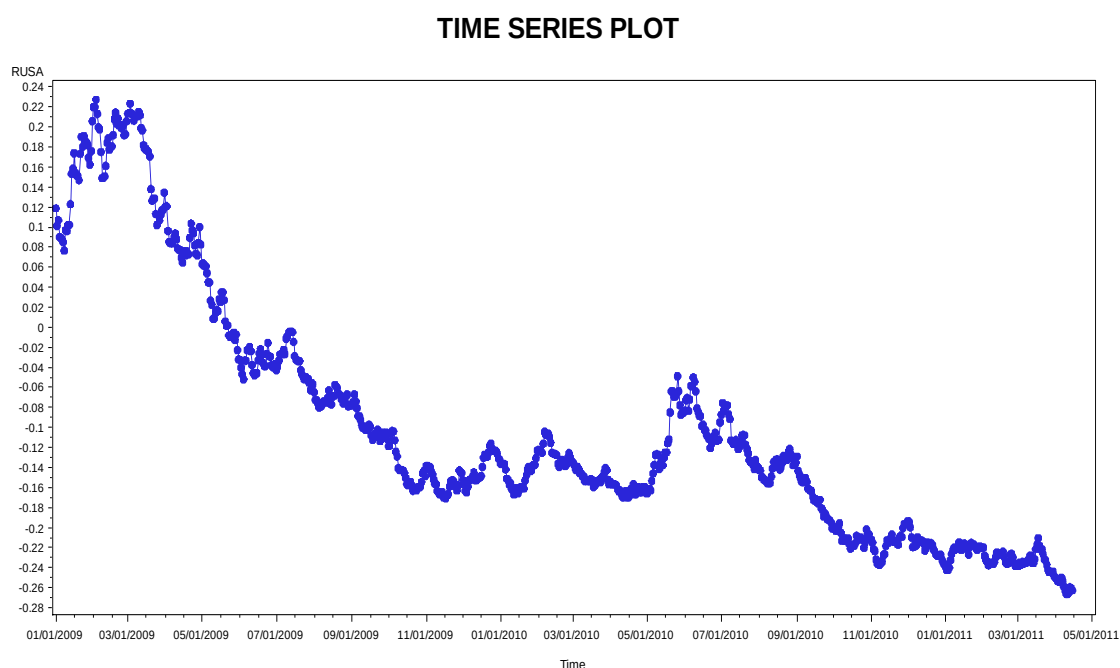
We collect the daily data of foreign exchange rates and their returns on three currencies – Australian Dollar – US Dollar (AUD-USD), British Pound – US Dollar (BP-USD) and Canadian Dollar – US Dollar (CAD-USD) for the sample period from January 2, 2009 to April 15, 2011. The total number of observation for each currency is 578. We collect both the exchange rate and bid-ask rate data from OANDA (www.oanda.com) and calculate the bid-ask spread by deducting the daily bid rate from the ask rate. We calculate the returns of each exchange rate as $\frac{fx_t - fx_{t-1}}{fx_{t-1}}$ where, fx indicates the foreign exchange rate and t is the time index. We also calculate the futures returns for each currency using the same approach and collect futures data on price, volume, and open interest for the same three currencies over the sample period from Trading Blox (<http://www.tradingblox.com>), which uses the daily net open interest position available for each currency at the Chicago Mercantile Exchange (CME).

We collect the data on the overnight interest rate from the Federal Reserve Bank of St. Louis, Reserve Bank of Australia, Bank of England, and Bank of Canada. In this paper, we use the interest differential as a control variable as it is used by Evans and Lyons (2002). We calculate such interest rate differential as $i_t - i_t^*$, where i_t is the U.S. overnight interest rate, and i_t^* is the foreign overnight interest rate. This interest differential controls for the “uncovered interest rate parity” condition, which suggests that the expected exchange rate changes is the difference in the interest rates between two countries². This paper does not include order flow in the analysis as it uses the daily foreign exchange returns.

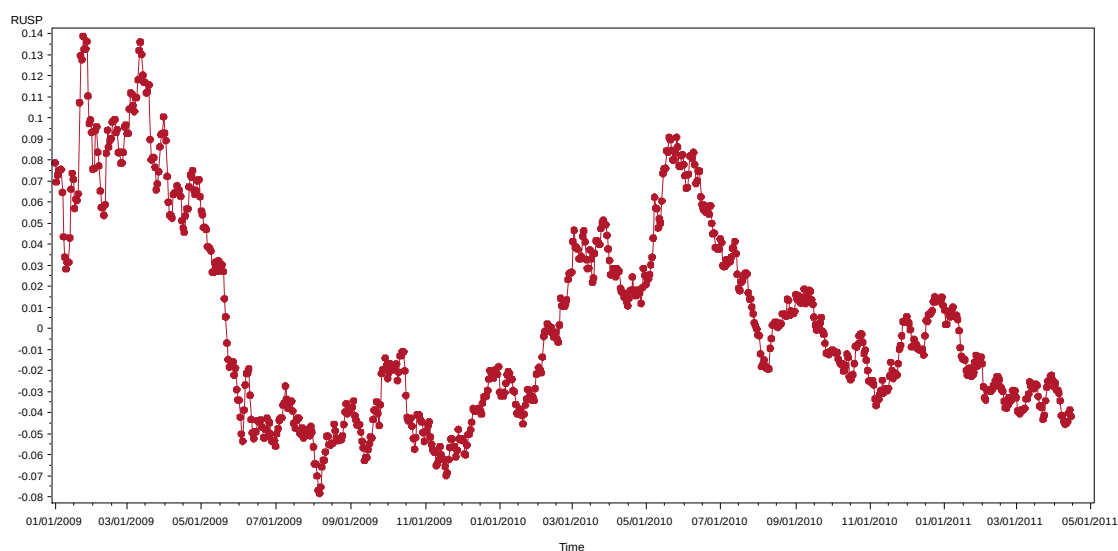
² See Bekaert, Wei and Xing (2007) for a detailed overview of “uncovered interest rate parity” condition.

Figure 1, 2 and 3 presents the time series graphs for exchange rate returns for three currencies – AUD-USD, BP-USD and CAD-USD. From all three figures we see a definite trend in the exchange rate returns. For this we control for time trend in the time series analysis, and use futures market returns as an explanatory variable in cross-section analysis.

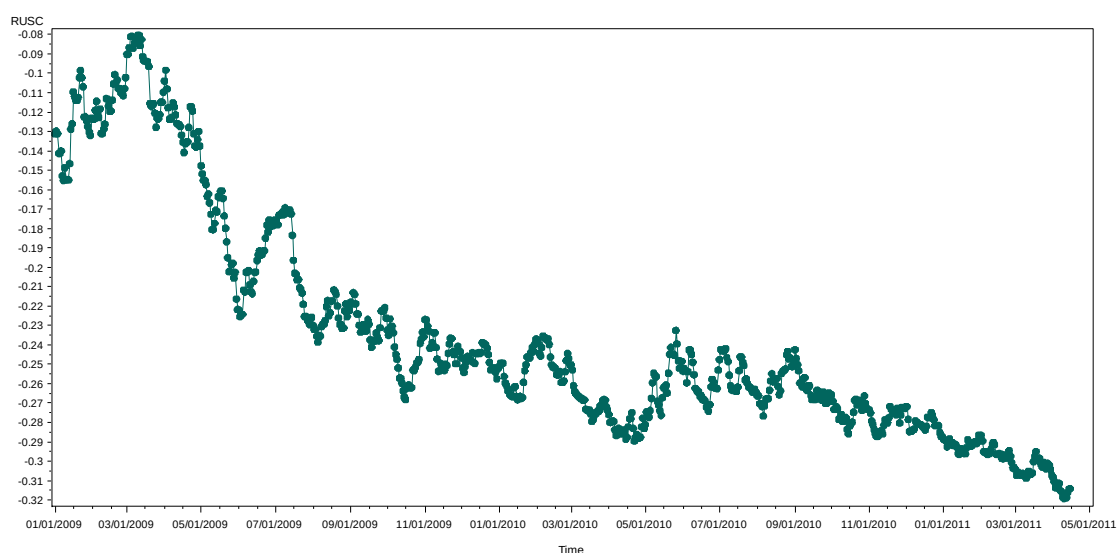
Figure 1: AUD-USD



Note: This figure presents the time series plot of the Australian Dollar-U.S. Dollar return for the period January 2, 2009 to April 15, 2011

Figure 2: BP-USD**TIME SERIES PLOT**

Note: This figure presents the time series plot of the British Pound-U.S. Dollar return for the period January 2, 2009 to April 15, 2011

Figure 3: CAD-USD**TIME SERIES PLOT**

Note: This figure presents the time series plot of the Canadian Dollar-U.S. Dollar return for the period January 2, 2009 to April 15, 2011

4. Results

4.1. Summary Statistics

Table 1: Summary Statistics

Currency	Variables	Mean	Std. Dev.	Min	Max
AUD-USD	Spot Return	-10.056%	12.149%	-26.600%	22.750%
	Futures Return	0.103%	1.221%	-5.467%	4.501%
	Futures Volume	86,771.23	38,544.34	7,052	269,973
	RBSI	0.005	4.523	-64.303	30.761
	VBSI	1.420	0.961	0.384	19.463
	Interest Differential	-3.766%	0.675%	-4.670%	-2.750%
	Bid-Ask Spread	0.0005	0.0005	0.0001	0.0030
BP-USD	Spot Return	0.348%	4.773%	-7.830%	13.650%
	Futures Return	0.025%	0.772%	-5.084%	2.088%
	Futures Volume	111,203.71	36,043.55	12,149	307,280
	RBSI	0.407	28.477	-194.769	630.915
	VBSI	1.028	0.533	0.441	10.549
	Interest Differential	-27.499%	6.292%	-36.640%	-11.280%
	Bid-Ask Spread	0.0002	0.0001	0.0000	0.0009
CAD-USD	Spot Return	-23.567%	5.827%	-31.890%	-8.030%
	Futures Return	0.045%	0.787%	-3.028%	2.198%
	Futures Volume	75,187.77	28,894.04	7,205	222,644
	RBSI	0.044	10.186	-221.202	63.392
	VBSI	1.550	0.970	0.585	20.540
	Interest Differential	-0.400%	0.353%	-1.403%	0.007%
	Futures Spread	0.0005	0.0003	0.0002	0.0020
	Obs.	578	578	578	578

Note: This table provides the summary statistics of returns, spreads and open interests of three foreign exchange rates – Australian Dollar – U.S. Dollar (AUD-USD), British Pound - U.S. Dollar (BP-USD), and Canadian Dollar – U.S. Dollar (CAD-USD) over the period of January 2, 2009 to April 15, 2011. The spot market returns of each exchange rate is calculated as $(fx_t - fx_{t-1})/fx_{t-1}$, where fx indicates the spot exchange rate and t is the time index. The futures returns are calculated using the similar approach. The return based sentiment index is calculated as $RBSI = \% \Delta \text{Futures prices} / \% \Delta \text{open interest}$. The volume based sentiment index is calculated as $VBSI = \text{Open interest} / \text{Volume}$. The interest rate differential is calculated as $i_t - i_t^*$, where i_t is the U.S. overnight interest rate and i_t^* is the foreign overnight interest rate (Australia, U.K., and Canada). The spread for each exchange rate is calculated by $\text{Spread} = \text{Ask} - \text{Bid}$.

Table 1 presents the summary statistics of spot market exchange rate returns, futures market exchange rate returns, futures market volume, return based sentiment index (*RBSI*), volume based sentiment index (*VBSI*), overnight interest rate differential, and spot market bid-ask spreads for three currencies. The summary statistics indicate that the BP-USD has the highest average return (0.348%) of all three currencies with a standard deviation of 4.77%. The other two foreign exchange returns are negative in the sample period. The AUD-USD and CAD-USD returns are volatile and negative; average -10.056% and -23.567% respectively. The AUD-USD return has the highest standard deviation and is the least stable among the three currency returns. All three currency futures earn positive returns with little volatility. Because of the stable nature of the BP-USD, the volume of its futures is the highest of three futures. The volumes of AUD-USD and CAD-USD are close to each other.

RBSI is the highest for the BP-USD (0.407) and lowest for the AUD-USD (0.005), but it is the most volatile for the BP-USD. *VBSI* is the highest for the CAD-USD (1.55) and lowest for the BP-USD (1.028), but in this case it is the least volatile for the BP-USD. Both the indices indicate a positive sentiment and active futures market for these three exchange rates. The average *VBSI* is above one for all three currencies, implying sufficient trading pressure and positive sentiment in the futures market.

The average spreads of three exchange rates are very close. The variations in the spreads are also very low. BP-USD has the largest interest differential (-27.499) with a large standard deviation of 6.292%. The average interest differential for Australian dollar futures and Canadian dollar futures are relatively small with low volatility.

4.2. Time Series Analysis

4.2.1. Lag Selection

For three currencies, lag one was selected as the optimum number of lags by using the *Minimum Information Criterion (MINIC)* based on AICC (corrected Akaike's information criterion; Hurvich and Tsai, 1989), AIC (Akaike's information criterion; Akaike, 1974), SBC (Schwarz Bayesian information criterion; Schwarz, 1978) and HQC

(Hannan–Quinn information criterion; Hannan and Quinn, 1979) values. Table 2 presents the values of information criterion, which show that the value for ARMA (1, 0) order is the smallest one, indicating lag one as the optimal lag.

Table 2: Information Criteria for ARMA (1,0) Model

		AUD-USD	BP-USD	CAD-USD
Information Criteria	AICC	-16.789	-19.888	-18.792
	HQC	-16.754	-19.854	-18.758
	AIC	-16.789	-19.888	-18.793
	SBC	-16.698	-19.798	-18.702

Note: This table provides with different values for lag selection criterion – AICC (corrected Akaike’s information criterion), HQC (Hannan-Quinn information criterion), AIC (Akaike’s information criterion), and SBC (Schwarz Bayesian information criterion) for all three exchange rate returns.

4.2.2. Unit Root Test

For cointegration test, it is important that at least two of the series should be non-stationary process that contain a single unit root (Integrated of order one ($I(1)$)). Otherwise the test significance becomes overstated and provides a spurious result. We use the Augmented Dickey-Fuller (1981) test to test for the non-stationarity of the series. The test equation is –

$$\Delta y_t = \alpha_0 + \theta y_{t-1} + \gamma t + \alpha_1 \Delta y_{t-1} + \alpha_2 \Delta y_{t-2} + \cdots + \alpha_p \Delta y_{t-L} + \varepsilon_t \quad (3)$$

where, y is any time-series variable ($RBSI$ or $VBSI$), Δ is the first-difference operator, t is the time trend, L is the augmented lags and ε_t is a stationary random error. The hypotheses for the test are:

H_0 : $\theta = 0$, the series need to be differenced to make it stationary.

H_a : $\theta < 0$, the series is trend stationary.

Table 3 indicates the results of Unit Root test for each series. The Augmented Dickey-Fuller (1981) test indicates that the spot market

returns of all three currencies and all other series are stationary at 1% level, except for return based sentiment index (*RBSI*), which is stationary at 5% level. The Phillips-Perron (1988) unit root test also provides similar results for all series.

Table 3: Unit Root Tests

Variables	Currency	ADF test: <i>p</i> -values	Phillips-Perron Test: <i>p</i> -values
Returns in the Spot Market	AUD-USD	0.001 ^a	0.0001 ^a
	BP-USD	0.001 ^a	0.0001 ^a
	CAD-USD	0.001 ^a	0.0001 ^a
Returns in the Futures Market	AUD-USD	0.001 ^a	0.001 ^a
	BP-USD	0.001 ^a	0.001 ^a
	CAD-USD	0.001 ^a	0.001 ^a
Interest Differential ($i_t - i_t^*$)	AUD-USD	0.001 ^a	0.0001 ^a
	BP-USD	0.001 ^a	0.0001 ^a
	CAD-USD	0.001 ^a	0.0001 ^a
Return based Sentiment Index	AUD-USD	0.0497 ^b	0.0392 ^b
	BP-USD	0.0180 ^b	0.0104 ^b
	CAD-USD	0.0248 ^b	0.0146 ^b
Volume based Sentiment Index	AUD-USD	0.001 ^a	0.001 ^a
	BP-USD	0.001 ^a	0.001 ^a
	CAD-USD	0.001 ^a	0.001 ^a
Futures Market Spread	AUD-USD	0.001 ^a	0.0001 ^a
	BP-USD	0.001 ^a	0.0001 ^a
	CAD-USD	0.001 ^a	0.0001 ^a
Futures Market Volume	AUD-USD	0.001 ^a	0.001 ^a
	BP-USD	0.001 ^a	0.001 ^a
	CAD-USD	0.001 ^a	0.001 ^a

a, b, and c indicates significance level at 1%, 5% and 10% level.

Note: This table presents the significance level for the Augmented Dickey-Fuller (1981) and Phillips-Perron (1988) unit root test for each variable and their first differences.

4.2.3. The Engle-Granger (1987) Cointegration Test

This test suggests that, for any two time series variables y_t and x_t , if y_t and x_t are both $I(1)$, and if

$$y_t = \theta' x_t + e_t \quad (4)$$

then the test include estimating $\hat{\theta}'$ by ordinary least squares (OLS) and testing for unit roots in $\hat{e}_t = y_t - \hat{\theta}' x_t$. Table 4 indicates the results of the Engle-Granger (1987) cointegration test for the returns of three currencies with corresponding spreads, sentiment indices, and the interest rate differentials. The estimates are compared with the critical values suggested by Mackinnon (1991). The results suggest existence of significant long-run cointegration among the variables for all three currencies.

Table 4: Engle-Granger (1987) Cointegration Test

Return		Return based Sentiment Index	Volume based Sentiment Index	Spread	Interest Difference
AUD-USD	Single	-15.965 ^a (0.001)	-16.568 ^a (0.001)	-17.996 ^a (0.001)	-17.284 ^a (0.001)
	Trend	-16.016 ^a (0.001)	-16.572 ^a (0.001)	-18.006 ^a (0.001)	-17.289 ^a (0.001)
BP-USD	Single	-16.523 ^a (0.001)	-16.579 ^a (0.001)	-19.186 ^a (0.001)	-16.884 ^a (0.001)
	Trend	-16.537 ^a (0.001)	-16.583 ^a (0.001)	-19.188 ^a (0.001)	-16.891 ^a (0.001)
CAD-USD	Single	-17.281 ^a (0.001)	-16.591 ^a (0.001)	-18.613 ^a (0.001)	-17.983 ^a (0.001)
	Trend	-18.287 ^a (0.001)	-16.623 ^a (0.001)	-18.618 ^a (0.001)	-17.991 ^a (0.001)

a, b, and c indicates significance level at 1%, 5% and 10% level.

Note: This table presents the test of cointegration for the returns for each currency with corresponding spread, sentiment indices, and interest rate differential by using Engle-Granger (1987) two-step method. The p -values are presented in parentheses.

4.2.4. Granger (1969) Causality Test and Error Correction Model

For any two time series variables y_t and x_t , if y_t and x_t are both $I(0)$, then the error correction model is –

$$\Delta y_t = \gamma_1 \Delta x_t + \gamma_2 [y_{t-1} - \alpha_i x_{t-1}] + \epsilon_t \quad (5)$$

The terms in the parenthesis is the long-run model and the first differences are used to estimate the error correction model to determine the short-run deviations from the long-run equilibrium. Table 5 presents the short-run analysis by Granger (1969) causality analysis and error correction model estimates for three currencies. All error correction coefficients except one are statistically significant. The estimates suggest causality from spot exchange rate spread and futures market sentiment indices toward the spot exchange rate returns.

Table 5: Granger Causality and Error Correction Model

		Δ Return based S.I.	Δ Volume based S.I.	Δ Return	Δ Spread	ECM _{t-1}
<i>Dependent Variable</i>						
AUD- USD	Δ Return	0.87287 (0.646)	0.75982 ^c (0.063)	-	0.27469 (0.872)	4.8124 ^c (0.09)
	Δ Spread	10.292 ^a (0.006)	7.543 ^a (0.001)	2.725 (0.256)	-	10.931 ^a (0.004)
	Δ Return based S.I.	-	16.589 ^a (0.001)	9.7282 ^a (0.008)	1.0767 (0.584)	715.28 ^a (0.000)
	Δ Vol. based S.I.	11.698 ^a (0.007)	-	10.368 ^a (0.006)	0.6981 (0.758)	736.589 ^a (0.00)
BP-USD	Δ Return	0.05379 (0.973)	5.96547 ^c (0.092)	-	0.7908 (0.673)	6.1402 ^d (0.046)
	Δ Spread	3.123 (0.21)	9.517 ^d (0.021)	10.73 ^a (0.005)	-	16.341 ^a (0.000)
	Δ Return based S.I.	-	8.985 ^d (0.032)	13.394 ^a (0.001)	0.07279 (0.964)	532.93 ^a (0.000)
	Δ Vol. based S.I.	7.699 ^d (0.025)	-	12.698 ^a (0.002)	0.85631 (0.823)	978.15 ^a (0.000)
CAD- USD	Δ Return	0.57516 (0.75)	6.96284 ^c (0.075)	-	0.22611 (0.893)	3.5202 (0.172)
	Δ Spread	15.4 ^a (0.000)	19.37 ^a (0.000)	2.0267 (0.363)	-	34.751 ^a (0.000)
	Δ Return based S.I.	-	17.269 ^a (0.000)	3.5538 (0.169)	0.88461 (0.643)	5.4347 ^c (0.066)
	Δ Vol. based S.I.	16.547 ^a (0.001)	-	11.689 ^a (0.003)	0.42691 (0.378)	4.965 ^c (0.072)

a, b, and c indicates significance level at 1%, 5% and 10% level.

Note: This table presents the Granger Causality test and Error Correction Model estimates for the returns for each currency with corresponding spread and open interest. The first entry of each row indicates the χ^2 estimates and the second entry indicates the p -values in parenthesis.

4.3. Cross-sectional Analysis

For cross-sectional analysis, we use ordinary least squares (OLS) estimates of the following model –

$$R_t = \beta_0 + \beta_1 RBSI_t + \beta_2 VBSI_t + \beta_3 RF_t + \beta_4 FVol_t + \beta_5 (i_t - i_t^*)_t + \beta_6 SPR_t + \varepsilon_t \quad (6)$$

Here R is the foreign exchange rate return calculated as $\frac{f_{x_t} - f_{x_{t-1}}}{f_{x_{t-1}}}$, and f_x indicates the foreign exchange rate, for each exchange rate and combined and t is the time index. RF is the futures returns calculated using the similar approach. $FVol$ is the volume in the futures market, $RBSI$ is the return based sentiment index calculated in equation (1), $VBSI$ is the volume based sentiment index calculated in equation (2). The interest rate differential is calculated as $i_t - i_t^*$, where i_t is the U.S. overnight interest rate and i_t^* is the foreign overnight interest rate (Australia, U.K., and Canada). The spread for each exchange rate is calculated by $SPR = Ask - Bid$. Table 6 presents the OLS estimates of equation (6).

From Table 6, we find that spread has a significant effect on the spot market returns in all specifications. The sign of spread is positive, which is consistent with our first hypothesis and literature. This implies that higher spread contributes to higher returns in the foreign exchange market to compensate for various risks. This finding is consistent with the findings of Bessembinder (1994), which states that spreads include foreign currency inventory risk, price risk, liquidity risk, and inventory risk.

The return based sentiment index ($RBSI$) is significant at 1% level only for Canadian dollar spot market returns. For Australian dollar and British pound spot market returns, $RBSI$ is not significant at all. The futures return does not seem to be an important factor as it is not significant in most of the specifications. In the same way, the return based sentiment index ($RBSI$) does not seem to be affecting the spot returns except for Canadian dollars. This implies the returns in the futures market do not have much impact on the spot exchange rate returns.

Table 6: Ordinary Least Squares (OLS) Results

	Const.	Return Based S. I.	Volume Based S. I.	Futures Return	Futures Volume	$i_t - i_t^*$	Spread
<i>Panel A: Dependent Variable: Spot Return (AUD-USD)</i>							
(I)	0.27709 ^a (0.000)	0.00228 (0.499)	-	0.81907* (0.054)	-0.0000005 ^a (0.004)	9.54015 ^a (0.000)	40.98710 ^a (0.000)
(II)	0.39857 ^a (0.000)	-	-0.19560 ^a (0.000)	-0.13863 (0.665)	-0.0000024 ^a (0.000)	6.97707 ^a (0.000)	45.35050 ^a (0.000)
(III)	0.41381 ^a (0.000)	-0.00317 (0.263)	-0.21833 ^a (0.000)	0.62564 ^b (0.049)	-0.0000025 ^a (0.000)	7.30675 ^a (0.000)	39.42720 ^a (0.000)
<i>Panel B: Dependent Variable: Spot Return (BP-USD)</i>							
(I)	0.071472 ^a (0.000)	-0.00055 (0.726)	-	0.471271 (0.222)	0.0000000 (0.535)	0.298344 ^a (0.000)	66.8227 ^a (0.001)
(II)	0.05038 ^a (0.000)	-	-0.084264 ^a (0.000)	0.463692 (0.037) ^b	0.00000063 ^a (0.000)	0.436646 ^a (0.000)	30.5049 ^b (0.039)
(III)	0.037602 ^a (0.010)	-0.00165 (0.231)	-0.078118 ^a (0.000)	0.412447 (0.235)	0.0000005 ^a (0.000)	0.385596 ^a (0.000)	36.898 (0.105)
<i>Panel C: Dependent Variable: Spot Return (CAD-USD)</i>							
(I)	-0.169557 ^a (0.000)	0.00565 ^a (0.002)	-	0.508281 (0.110)	-0.0000008 ^a (0.000)	3.4259 ^a (0.000)	24.355 ^b (0.020)
(II)	-0.069373 ^a (0.000)	-	-0.106805 ^a (0.000)	-0.093749 (0.718)	-0.0000018 ^a (0.000)	1.43743 ^a (0.006)	31.1269 ^a (0.000)
(III)	-0.0551 ^a (0.002)	0.00370 ^a (0.009)	-0.112133 ^a (0.000)	0.547173 (0.030) ^b	-0.0000019 ^a (0.000)	1.70387 ^b (0.014)	21.5417 ^a (0.009)
<i>Panel D: Dependent Variable: Spot Returns of all exchange rates (pooled regression)</i>							
(I)	-0.11377 ^a (0.000)	-0.00041 (0.776)	-	0.71127 (0.342)	-0.000002 ^a (0.000)	1.7889 (0.000)	45.569 ^a (0.000)
(II)	-0.09173 ^a (0.000)	-	-0.14895 ^a (0.000)	0.46832 (0.412)	-0.0000027 ^a (0.000)	2.6417 ^a (0.000)	61.673 ^a (0.000)
(III)	-0.01147 ^a (0.001)	0.00249 ^a (0.004)	-0.19856 (0.000)	0.44823 (0.085)	-0.0000019 ^a (0.000)	3.1296 ^a (0.000)	51.957 ^a (0.000)

a, b, and c indicate significance at 1%, 5%, and 10% level.

Note: This table presents the heteroskedasticity corrected OLS estimates and p -values of the model, $R_t = \beta_0 + \beta_1 RBSI_t + \beta_2 VBSI_t + \beta_3 RF_t + \beta_4 FVol + \beta_5 (i_t - i_t^*) + \beta_6 SPR + \varepsilon_t$, for each exchange rate and combined. Here R is the foreign exchange rate return calculated as $(fx_t - fx_{t-1})/fx_{t-1}$, where fx indicates the spot exchange rate and t is the time index. RF is the futures returns calculated using the similar approach. $RBSI$ is the return based sentiment index calculated as

$RBSI = \% \Delta \text{Futures prices} / \% \Delta \text{open interest}$. $VBSI$ is the volume based sentiment index calculated as $VBSI = \text{Open interest} / \text{Volume}$. The interest rate differential is calculated as $i_t - i_t^*$, where i_t is the U.S. overnight interest rate and i_t^* is the foreign overnight interest rate (Australia, U.K., and Canada). The spread for each exchange rate is calculated by $\text{Spread} = \text{Ask} - \text{Bid}$. The p -values are in parentheses. (I), (II) and (III) indicates the rows with different specifications.

On the other hand the volume based sentiment index ($VBSI$) is significant at 1% level for all three spot exchange rate returns. The effect of both the sentiment indices on spot market returns is negative. This implies reduced spot exchange rate returns when trading activity in futures market is high and also investors reveal high interest in the futures market. This suggests that active futures market contributes significantly in the spot market returns.

The control variables volume of the futures market and interest rate differentials are significant in all specifications. Both these variables positively affect the spot market returns. This implies that higher volume in futures market does not attract away the investors from the spot market. Even after controlling for volume the negative sign of sentiment indices implies that, the investor sentiment in the futures market reduces spot market returns because of higher interest of investors in the futures market. The positive significance of the interest rate differentials provides evidence for “uncovered interest rate parity” condition.

5. Conclusion

This paper tests the effects of spot exchange rate bid-ask spread and the future market sentiment as two important factors that explain the spot exchange rate returns. We use the future market open interest to develop two sentiment indices – return based sentiment index and volume based sentiment index. The sample includes three different currencies - Australian Dollar, British Pound and Canadian Dollar – to US Dollar for the period January 2, 2009 to April 15, 2011. We use time series and cross-sectional analyses to test the impact of spot market spread and future market sentiment on the spot exchange rate returns.

The time series estimates indicates that, variables of three currencies are cointegrated and both spot market spread and future market sentiment indices have significant causal relation with the exchange rate returns. The cross-sectional analysis shows that both spot market spread and

futures market indices significantly affect the spot market returns. The positive sign of the spot market spread implies that higher returns in the spot markets are risk premia for higher spread and corresponding risks, as suggested by Bessembinder (1994). The positive sign of futures market volume and the negative sign of the sentiment indices imply that spot market returns suffer because of investors' higher interest in futures market, but not because of higher trading in the futures market. The overnight interest rate differentials are also positive and significant, and provide support for "uncovered interest parity" condition in foreign exchange market.

The overall results suggest that, the spot market bid-ask spread and futures market investor sentiment have significant impact on the spot exchange rate returns. Although the return based sentiment index does not seem to be significant for all currencies, the volume based sentiment index provide a clear picture of trading activities in futures market and its impact on the spot market. This finding is important as to incorporate futures market dynamics in spot market returns. Further research may include the classification of futures market sentiments into hedging and speculation activities and analyzing their impact on the spot exchange rate returns.

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Food Security, Policies and Institutions in Africa: Prospects for a Revolution

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Ogbonnaya Ufiem Maurice and Omoju Oluwasola Emmanuel

The current global financial crisis and economic meltdown has thrown up a number of questions. One of such, is how prepared national governments are to contend with the devastating food crisis plaguing the world generally and Africa in particular. In Africa for instance, this crisis is exacerbated by the fact that agricultural and food productivity per capita has been dwindling over the years; standing at about 2.5 per cent currently. This is abysmal when compared to population growth which stands at about 3.6 per cent. Nonetheless, political reforms as dictated by international financial institutions, which resulted in the democratization of political and administrative structures, have not been accompanied by socio-economic reforms and appropriate development policies, strategies and programmes that will enhance agricultural and food productivity. This has occasioned revolutionary pressures on African states and those who act on its behalf, and calls for urgent reappraisal of existing state policies, programmes and institutions on food security in Africa. This paper is part of the attempts at the reappraisal. It examines the challenges and problems of food security in Africa and identifies the prospects for a double green revolution in Africa. The paper recommends, as a strategy in tackling the food crisis, a restructuring of existing state institutions and collaborations among African states to ensure food sufficiency.

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1. Introduction

One of the negative outcomes of the current global economic crisis is the devastating food crisis plaguing the world generally. Over the past five years, the world has been hit by a series of economic, financial and food crises that have slowed down, and at times reversed, global efforts to reduce poverty and hunger (IFAD, 2012). In Africa for instance, this crisis is more deepened by dwindling agricultural and food productivity per capita which stands currently at about 2.5 per cent. This is abysmal when compared to population growth which stands at about 3.6 per cent (Nzamujo, 2008:66). Low agricultural and food productivity in Africa is on the other hand caused by unfavourable climatic conditions, land degradation and natural disasters such as drought especially in the Horn of Africa, desertification and desert encroachment in other parts of Africa (IFAD, 2011; IFPRI, 2012). This has resulted in increased food prices in the region.

Consequently, ensuring food security has been a major thrust and central focus of policy agendas of many national governments not just in Africa but around the world. Achieving this objective was at the heart of the Rome Declaration on World Food Security in 1996, attended by 183 participating nations. It also formed the basis of the first Millennium Development Goal (Eradication of Extreme Poverty and Hunger) and an important part of the agenda in the last G8 Food Security Submit in May, 2012 (Karuku, 2012:43; Weekly Trust, 2012:54). However, government policies and efforts have been severally undermined by food price volatility, devastating drought in some parts of Africa, global population explosion, among other factors. This calls for urgent reappraisal of existing state policies, programmes and institutions on food security in Africa in order to identify the challenges and problems arising from these policies and programmes and also to identify the prospects for a double green revolution.

Structurally, the paper is divided into four major parts. Part one discusses basic concepts in their correct and critical perspectives. This is necessary to justify whatever directions our argument will lead to. Part two is a review of related literature on food security. While part three reappraises existing food security policies and programmes in Africa part four points the way out of the challenges and draws conclusion.

1.1 Conceptual Framework

The concept of food security is a new entrant in international development and political economy literature. Public interest in global food crisis grew following the world oil and related food crisis that occurred between 1972 and 1974. Though attention at this time was concentrated in the developed countries of Europe and the United States, the African famine of 1984-85 increased the numbers of people looking for food assistance in developing nations. This resulted in the quest to arrest the trend. As government policies and programmes increased, researches and studies along this line also increased resulting in growing number of literature on food security. Consequently, a large number of definitions of food security and related concepts have been developed. While Maxwell and Frankenberger (1992) have listed about 192 different studies on the concept and definition of food security and 172 studies on indicators, Hoddinott (1999) has identified a total of 200 definitions and 450 indicators of food security.

This array of studies and definitions has resulted in a somewhat disarticulated scholarly position on the concept of food security and other related concepts. Arising from this, some scholars have suggested alternatives to the term “food security” in an effort to avoid the perception of “food safety” or to shade the connotation of “food insecurity” being equated with only hunger and poverty (Maxwell & Frankenberger, 1992). Yet the concept of food security remains in wide usage among advocates working to meet global food demands (Benson, 2004; IFPRI, 2011; UNDP, 2012; IFAD, 2012).

Thus, the following definitions have evolved over time though critics have been concerned with the comprehensiveness of each of the definitions;

- i. According to Life Science Research Office (LSRO) (1990), food security is defined as access by all people to all times to enough food for an active, healthy life and includes at a minimum:
 - (a) The ready availability of nutritionally adequate and safe foods, and

- (b) The assured ability to acquire acceptable food in socially acceptable ways (e.g. without resorting to emergency food supplies, scavenging, stealing, and other coping strategies).
- ii. From the perspective of Food and Agricultural Organization (FAO) of the United Nations (1996), food security means that food is available at all times; that all persons have means of access to it; that it is nutritionally adequate in terms of quality, quantity and variety; and that it is acceptable within a given culture.
- iii. According to the World Food Summit (1996), food security is when all people at all times have physical and economic access to sufficient, safe and nutritious foods to meet their dietary needs and food preferences for active healthy life.

This definition was adopted in the Rome Declaration on World Food Security in 1996 and has been adopted by the United Nations, Government of Canada, World Health Organization and 183 participating countries in the conference.

- iv. Food and Hunger Action Committee (2000) defined food security as;
 - a. The availability of a variety of foods at a reasonable cost;
 - b. Ready access to quality grocery stores, food service operations, or alternative food service;
 - c. Sufficient personal income to buy adequate food for each household member each day;
 - d. The freedom to choose personally and culturally acceptable foods;
 - e. Legitimate confidence in the quality of the foods available;
 - f. Easy access to understandable, accurate information about food and nutrition;
 - g. The assurance of a viable and sustainable food production system.

Although the concept of nutrition security has received less attention in the literature compared to food security, Benson (2004) has observed that it constitutes a critical component in any discussion or any effort to bring about food security in any part of the world especially in Africa. Thus, the UNICEF conceptual framework of the determinants of nutritional status of children provides a succinct and useful way to understand nutrition security (UNICEF, 1990; Jonsson, 1993; Smith &

Haddad, 2000). From the UNICEF parameter, Benson (2004:9) has asserted that a household is said to have achieved nutritional security when it has secure access to food coupled with a sanitary environment, adequate health services, and knowledgeable care to ensure a healthy life for all household members. However, from the UNICEF perspective, nutritional security is more concerned with the utilization of the food obtained by a household and access to the food than with any other components. The differences in conceptualizing food security notwithstanding, there is a somewhat unanimity among scholars that quality (what kind of food?), quantity (how much food?), universality (who should get the food?), stability (when?) and dignity (how?) are universal components of the concept of food and nutrition security while availability (Household food production and crop diversity), access (Percentage food expenditure to total household expenditures), utilization (Degree of access to services-water, health and sanitation), and Stability (Stability of food prices and supply) are the set of indicators to be considered in any analysis of food and nutritional security (Maxwell and Frankenberger, 1992; Masters, 2012).

2. Review of Related Literature

Available literature on international development has considered food security from varied and divergent perspectives. Some have examined food security in relation to agricultural productivity, climatic condition and environmental issues. Those associated with this line of argument include Smith and Haddad (2000), Benson (2004), and Bouis and Hunt (1999). The argument here is that food crisis (insecurity) especially in Africa is caused by dwindling agricultural and food productivity which in itself is occasioned by unfavourable climatic conditions and environmental related issues such as droughts in the Horns of Africa and parts of the Sahel on the one hand and flood in the southern parts, on the other. Establishing a connecting link between agriculture and food crisis in Africa, the International Fund for Agricultural Development, IFAD (2011a) posit that declining public investment in agriculture, especially, in the developing world is at the root of the crisis. For instance, in 1979, official development assistance (ODA) aid to agriculture was 18 per cent of total ODA. By 2009, it was just 6 per cent. In developing countries, government investment in agriculture also fell in this period, by one third in Africa and by as much as two third in Asia and Latin America. In Africa for instance, agriculture remains the mainstay of

national economies. It employs about 90 per cent of the rural workforce, 60 per cent of the total (urban plus rural) labour force, and accounts for as much as 40 per cent of export earnings and provides over 50 per cent of household needs and income. Yet, as at 2003, the sector received the least attention from national governments (UNECA, 2007; NEPAD, 2009). This failure to invest in agriculture has kept millions of rural Africans trapped in a cycle of underproduction, underemployment, low incomes and chronic poverty (UNECA and AUC, 2009). On climate change and environment-related issues, (Headey, 2012) and Rena (2005) have asserted that unfavourable situations have created urban and rural poverty, chronic malnutrition and food insecurity. It is therefore, the submission of these scholars that “in any effort to improve food and nutrition security in Africa, agriculture must receive attention” (Haedey, 2012: 25). They have also opined that due to volatile food prices, there is need for the potentials of agriculture as a supplier of food, a source of income, and an engine of growth to be recognized (Benson, 2004: 50; Oriola, 2009).

Other scholars have considered food security from the view point of economic, socio-cultural and political role related issues. These include Maxwell and Frankenberger (1992), Onikoyi. Jr (2012), among others. For them, the concept of food security encompasses a wide range of food-related issues and it more completely reflects the complexity of the role of food in human society. The emphasis here is on secure access to food for a population, with a singular focus on the role of food as a vehicle for nutrition. It must however, be pointed out that food holds much more significance to humans than just its nutritional value. It can also have important symbolic, cultural, social and political roles. Food security, as a conceptual goal, has expanded to explicitly include more and more of these roles. The evolution of thinking reflects an attitude that society’s goals should reach beyond the ability of a country to produce and import enough food. Issues related to its production, distribution, availability and acceptability have become equally important.

Another group of scholars think of food security in relation to, population growth, health and disease prevalence. This line of thought is associated with Hopfenger and Pimentel (2001), Akhtar and Verhasselt (1990), Lunn and Theobald, (2006) and Iseki (1994), among others. The central argument of these scholars is that increased food demand

(resulting in food insecurity) is due to growth in world population and that attempt to intensify production to feed an increased population leads to a greater increase in population. To understand the nexus between population growth and global food crisis, one needs to appreciate that in 1999, the world population reached six billion and the United Nations estimates that the world population will exceed eight billion by 2025 and nine billion by 2050. Thus, “massive agricultural development will be needed to feed this added population” (Young, 1999: 6). What this means is that from the perspective of these scholars, population size is seen as the major determinant of amount of resources used. But as has been found in a study by Hopfenger and Pimentel (2001: 3) “as more food has been made available ostensibly to alleviate food shortages caused by the increased number of people, biologically determined response has been an increase in the population”. Thus the question of whether population growth causes food insecurity or whether excess food production results in population explosion remains a policy debate that has tasked the intellectual capabilities of population and development scholars.

Another fundamental issue raised by this group of scholars is the relationship among food crisis, population growth and human health. Here, available data indicate that due to global population growth, currently, about one billion people (precisely 840 million) are malnourished. The majority of this number (799 million) resides in developing countries, most of which are on the continents of Africa and Asia (WHO, 1996). The implication of this is that in many places, the number of humans exceeds the carrying capacity of the area in which they live. This group of malnourished people, according to Iseki (1994) is vulnerable to malnutrition, anemia, vitamin A deficiency, iodine deficiency, acute respiratory infections, malaria and fatigue. Iseki also asserts that food insecurity results in severe social, psychological, and behavioural consequences such as feelings of alienation, powerlessness, stress and anxiety which lead to reduced productivity, poor school performance, etc.

Drawing instances from around the world, Williams and Funk (2011) have considered the challenges of food security from the perspective of climatic conditions. According to them, climate change and global warming are considered major threats to agriculture and food production and have had immense negative impact on global food security. For

instance, in 2011 there were earthquakes in Japan, New Zealand, and Turkey; major floods in Pakistan, Southeast Asia, and Australia; and significant drought in the Horn (East) of Africa and parts of the Sahel.

With particular reference to Africa, in 2007, the United Nations predicted that ‘zones struck by drought in sub-Saharan Africa might increase from 60 million to 90 million hectares from now to 2060...’ and that ‘the number of people suffering from malnutrition might increase up to 600 million from now to 2080’. On 1 February 2008, the *Journal Science* published forecasts of Stanford University, California, which predicted that South Africa could lose more than 30% of its maize production from now to 2030. Catastrophic floods and severe droughts are inflicting heavy damage to sub-Saharan Africa’s ecosystems and agro-ecosystems, threatening the lives of tens of millions of people. For instance, on August 25, 2008, the United Nations’ humanitarian coordination in Chad announced that about 30,000 persons had been affected by floods in the south of the country. In Ethiopia, according to the Red Cross, 75,000 persons were severely hit by drought. The drought began with failed rains in the late 2010 and mid-2011. By August 2011; the peak of the drought, more than thirteen million people were in need of food assistance. The United Nations Children’s Fund (UNICEF) reported that more than 320, 000 children were suffering from severe malnutrition in Djibouti, Ethiopia, Kenya, and Somalia. The situation in Somali was particularly grave as four million people, more than half of the country’s population, were in crisis. Of these, 750, 000 were officially declared as famine. Since mid-2011, thousands are known to have died, especially infants and children (Williams and Funk, 2011).

Finally, food security in Africa has been examined from institutional dimensions. Aziz (2001), Kate Bird, David Booth and Nicola Pratt (2003), Oniang’o (2009) and Schwarzwadder (2012) are a few of the scholars in this group. According to them, food and nutritional crisis and insecurity arise due to the failure of government policies, programmes and institutions, political crisis and instability among other factors. With particular focus on East Africa, Onian’o (2009:4) has asserted that prolonged political crisis in the region has occasioned food/nutritional crisis. According to her, “in this region, conflicts may occur for a variety of reasons, ranging from inter-tribal resource competition to externally instigated wars”. In Southern African region, Bird, Booth and Pratt

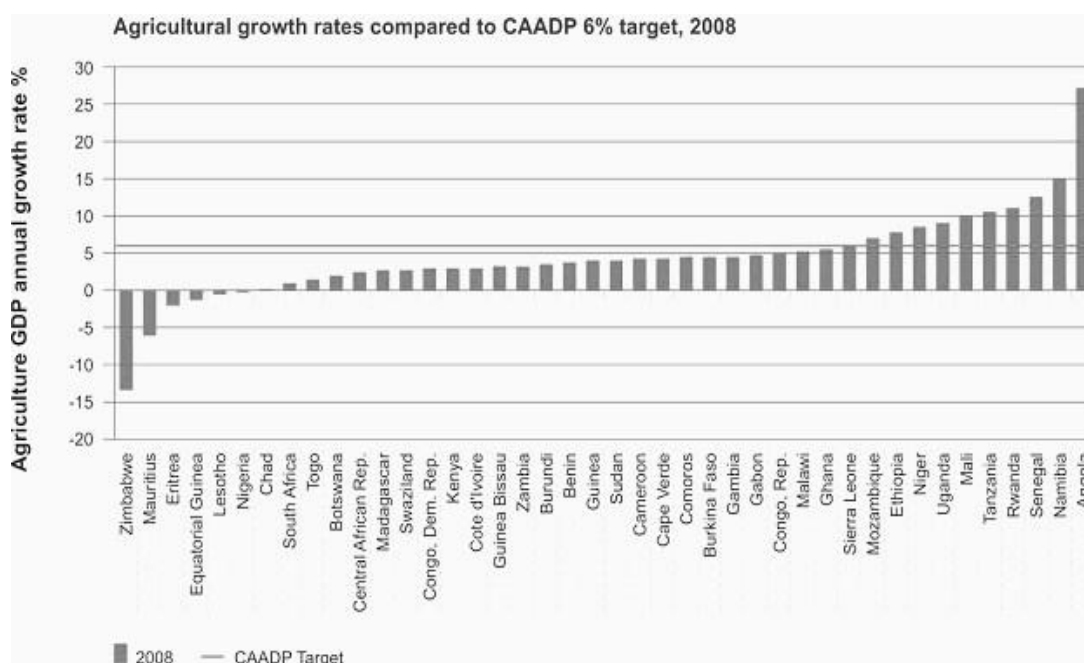
(2003) have examined the “political background to policy failure” that resulted in food security crisis within the region. In a Panel Discussion titled Governance and Food Security: Acting in the Public Interest?, Aziz (2001:2) considered the Impact of Corruption on Food Security. According to him, corruption which “concerns about standards of behaviour in the government sector as well as in international business transactions have impacted negatively on the implementation of sustainable food programs and other projects, the destructive nature of corruption manifests itself in that: (i) decisions are taken not for public benefit, and (ii) high cost, complex and prestigious projects invariably favoured over cost-efficient, community-based initiatives using appropriate technology”. All this are consequent upon the failure of government and the lack of will on the part of state actors to implement public policies.

3. Food Security in African: Appraising State Institutions, Policies and Programmes

Following the prevalence of food crisis and insecurity in Africa, a number of policy programmes and state institutions have been established to address the situation. These policy efforts towards food availability are seen in both the agricultural, educational and economic sector policy objectives and the various strategies that have been proposed or implemented.

In 2003, African heads of government through the New Partnership for Africa's Development (NEPAD), adopted the Comprehensive African Agriculture Development Programme (CAADP). CAADP, according to Mkandawire (2009) is a common framework, tool and process for the restoration of agricultural growth and food security in Africa. It aims at helping African countries reach a higher path of economic growth through agriculture-led development through the allocation of 10 per cent of public expenditure to agriculture and expected 6 per cent annual agriculture productivity growth rate by 2015. As at 2008 which was the target year, only 7 countries (Burkina Faso, Ethiopia, Ghana, Guinea, Malawi, Niger and Senegal) have exceeded the target of allocating 10 per cent of their national budget to agriculture. Also, only 9 countries (Angola, Eritrea, Ethiopia, Burkina Faso, DRC, Gambia, Guinea-Bissau, Nigeria, Senegal and Tanzania) have exceeded CAADP's targeted 6 per cent agricultural growth rate which is to be achieved by 2015. Another 4

countries have achieved growth rate of between 5 and 6 per cent (Mkandawire, 2009; NEPAD, 2013). This is shown in the graph below;



Source: Adapted from NEPAD (2013)

CAADP's work falls under 4 pillars, each dealing with key issues: Land and Water Management; Market Access; Food Security and Hunger; and Agricultural Research. However, this paper is concerned with pillar three; Food Security and Hunger. In Food Security and Hunger, which is Pillar 3, CAADP aims to increase food supply and reduce hunger across the region by raising smallholder productivity and improving response to food emergencies. Here, CAADP focuses on the chronically food insecure. The objectives of Pillar 3 are;

1. Improve domestic production and marketing;
2. Facilitate regional trade in food staples; and
3. Build household productivity and assets (NEPAD, 2009).

To achieve these objectives, CAADP has carried out the following programmes;

1. Regional Enhanced Livelihoods for Pastoral Areas (RELPA), funded by USAID (\$19.8 million). This Horn of Africa programme for enhancing livelihoods of pastoralists across three countries has been launched;
2. Regional Food Security and Risk Management Programme for Eastern and Southern Africa (REFORM), funded by the European Union (€10 million). This programme is mostly capacity building (i.e., skills transfer, technical studies, documentation of best practice, information sharing, policy dialogue, etc.).
3. Making Markets Work for the Poor: Enhancing Food Security and Productivity Growth in Eastern and Southern Africa (MMWP), funded by World Bank/DFID-UK (\$3.8 million). This project involves a three-year programme of practical analysis, policy outreach, consensus building, and capacity strengthening to promote the goals of national and regional food security, poverty reduction, and agricultural productivity growth.
4. Improved Regional Trade in Food Staples (RTFS), total \$5 million, with start-up funding by the World Bank. This programme of work aims to assemble spatial evidence on existing regional production and trade in food staples and to develop predictive analytical tools that will enable spatial mapping of the outcomes resulting from common natural and policy shocks.
5. Cassava Transformation in Southern Africa (CATISA), total \$2 million, with start-up funded by SIDA. The CATISA project aims to analyse and help accelerate cassava commercialisation in Southern Africa in order to help improve food security in the region.
6. Home-Grown School Feeding (HGSF), funded by the World Food Programme and DFID-UK (\$25 million). NEPAD, WFP and the Millennium Hunger Task Force (MHTF) launched a pilot Home-Grown School Feeding and Health Programme designed to link school feeding to agricultural development through the purchase and use of locally and domestically produced food (NEPAD, 20009).

In the framework of the African Union (AU), all member states committed to generate at least 6 per cent growth in the agricultural sector, and to invest at least 10 per cent of their national budgets to that end. The CAADP has further formulated rules for improving agricultural policy and sector investment planning and offers forums for dialogue with other African nations and the international community of donors.

However, Michael (2011) has observed that CAADP is far from realising its potential. What it has clearly achieved is making the African agricultural sector visible at the international level. At the continental and regional levels, the CAADP has created useful structures. However, these have yet to demonstrate their value. The processes that were created are now so far advanced at the all-important national level that their application raises expectations for significant improvements in agricultural planning. However, implementation is in its infancy and the value of older CAADP processes is somewhat doubtful. As at May 2011, only 26 countries have signed the CAADP Compact and incorporated the Compact into their agricultural agenda. Also, as at 2009, only 4 countries (Senegal, Kenya, Uganda and Malawi) have put machineries in place to deepen good governance and political stability, ensure policy and institutional reforms and encourage active participation of civil society organizations, agro-dealer networks, etc (Mkandawire, 2009; NEPAD, 2013).

Also, in response to food security crisis, African leaders attending the Abuja Summit of Food Security I Africa (December, 2006) committed to the following agenda:

1. Member states and RECs will promote and protect rice, legumes, maize, cotton, oil palm, beef, dairy, poultry and fisheries products as strategic commodities at the continental level and cassava, sorghum and millet at the sub-regional level, without prejudice to focused attention being given also to products of particular national importance;
2. AUC and NEPAD will facilitate the attainment of continental self-reliance by 2015 for the following: rice, maize, sorghum/millet and cassava, oil palm, beef, poultry, aquaculture (tilapia/cat fish); and to process 50 per cent of cotton produced in

Africa by 2015 while also making efforts to rapidly increase the share of local processing for other commodities;

3. Member States and RECs will take the following urgent measures to accelerate the development of the strategic commodities;
 - fast-track the implementation of trade arrangements adopted in the Regional Economic Communities (RECs) through lowering tariff barriers and the elimination of non-tariff barriers, both technical and non-technical, by 2010, and take account of these measures during global negotiations in the Doha Round and Economic Partnership Agreement (EPA);
 - Ratify and implement harmonized standards and grades, including sanitary and phytosanitary standards, within and across RECs by 2010;
 - Construct and maintain critical infrastructure to facilitate the movement of strategic agricultural products across national boundaries at minimal cost;
 - Request the AUC in collaboration with the RECs and development partners to develop continental and regional market information systems and to support the development of the same at national level by 2008 (African Union, 2010).

These efforts notwithstanding, Mkandawire (2009:2) noted that;

- Africa is characterized by poor economic performance in the last three decades;
- 32 out of 35 countries with low HDI are in Africa;
- 1/3 of the entire population of Africa currently live in chronic hunger – do not have enough food to eat;
- 45 per cent of Africa's population live under a dollar a day;
- In Africa, the number of food emergencies have tripled since the 1980s;
- Africa is the only continent where food aid delivery requirement is increasing (to rural populations; and
- Things could get even worse with the global environmental changes.

In 2012, the United Nations Development Programme (UNDP) reported that;

With more than one in four of its 85 million people undernourished, Sub-Saharan Africa remains the world's most food-insecure region. There are more than 15 million people at risk of malnutrition in its Sahel region alone – stretching from the Atlantic Ocean to the Red Sea – and an equal number in the Horn of Africa remain vulnerable after last year's (2011) food crisis in Djibouti, Ethiopia, Kenya, and Somalia (UNDP, 2012:32).

The implication of this assertion is that food insecurity and hunger are widespread in sub-Saharan Africa. This is largely due to the fact that 85-90 per cent of agriculture is rain-fed and accounts for 35 per cent of the region's gross national product (GNP), 40 per cent of exports and 70 per cent of employment. Domestic food production accounts for about 80 per cent of the region's consumption. The yield of roots and tubers in Africa is the lowest in comparison to the other regions of the world (McGranahm et al 1999; World Bank 2000; Baron, 2002; UNEP 2002).

This situation has in the recent years led to political and civil unrest in many African countries (Weely Trust, 2012; Lagi, Bertrand & Bar-Yam). According to Bellemare (2011), the second food crisis began at the end of 2010 and saw food prices increase by 40 per cent between January 2010 and February 2011. Once again, this rapid rise in food prices was associated with political unrest throughout the world, but it was perhaps most prominently associated with the so-called Arab Spring of 2011; a series of events which began with food riots in Algeria and in Tunisia in early January 2011, which led to the collapse of the Ben Ali regime in Tunisia and of the Mubarak regime in Egypt, and which is still unfolding in Syria and Yemen. The reasons for the situation are not farfetched. Basically, there is a fundamental issue beyond the rhetoric of unfavourable climatic conditions and natural disasters as being responsible for food crisis in Africa which are often espoused by state actors. Fundamentally, government policy programmes and institutions on food security in Africa suffer from multiplicity of problems. These include the absence of the political will on the part of African states and statesmen to confront the problem, political crisis and instability, political corruption and institutional inadequacies such as inadequate human resources, poor implementation of programmes, among other challenges. For instance, studies in Africa have shown that government

policies and programmes on food security are not accompanied with sincerity of purpose (Onikoyi, Jr, 2012; Ojo, 2012). Thus, state policies and programmes die before they are initiated.

Similar problems are associated with state institutions saddled with the responsibility of ensuring food security. With the preponderance of universities of agriculture and related research institutes in Africa, solutions to food crisis and insecurity should be readily and steadily proffered. Because these universities and research institutes are not adequately funded, their research efforts in this direction have not been rewarding. In 2000, global agricultural Research and Development (R&D) spending was US\$36.3 billion, of which 37 per cent was conducted by the private sector and 63 per cent, or about US\$23 billion, by the public sector. 93 per cent of the private research was conducted in developed countries. On the other hand, public agricultural R&D grew faster in the developing world, and is increasingly concentrated in China, India and Brazil. In stark contrast, public agricultural research in Sub-Saharan Africa grew at only about one per cent per annum in the 1990s, and in 2000 was around US\$1.6 billion. Sub-Saharan Africa has the lowest share of private agricultural R&D spending in the world—only 1.7 per cent of already low public spending. Of total agricultural research spending, donors provide about 40 per cent (in some countries 60 per cent). Only five African countries—Nigeria, South Africa, Botswana, Ethiopia and Mauritius—are paying the recurrent budget of their NARS from national sources. Collectively these data point to a disturbing development—a growing divide regarding the conduct of (agricultural) R&D—and, most likely, a consequent growing technological divide in agriculture. The measures also underscore the need to raise current levels of funding for agricultural R&D throughout the region while also developing the policy and infrastructure needed to accelerate the rate of knowledge creation and accumulation in Africa over the long haul (Pardey et al 2006; ODE, 2008).

On the other hand, political crisis and instability has been an enduring feature of the post-colonial African society. Scholarly literature has offered various reasons for this phenomenon – the Cold War, ethnic antagonisms and rent-seeking behaviour, among others. Political crisis and instability in Africa manifest in the form of violent change of government, armed insurgency, cross-border raids, inter-ethnic and religious crises and outright civil war. In Africa, there have been civil

wars in Nigeria, Liberia, Sudan, and since the early 1990s the African Great Lakes region – defined here as the Democratic Republic of Congo (DRC), Burundi, Rwanda, and Uganda – has been convulsed by genocide, civil wars, and inter-state conflict. This situation does not give room for continuity of regimes and their policies. Consequently, as regimes change at a high rate of rapidity, and as crises intensify state policies in all sectors of the economy are abandoned (Kron, 2011; Ong’ayo, 2008; Ake, 1973; Kieh, Jr. 2012).

Another factor that has fuelled food crisis and insecurity in Africa is political corruption. In Uganda, 7 officials of National Agricultural Advisory Services, NAADS, a government agency that oversees the management of food security and development programmes were arrested for the mismanagement of 9, 0000 US Dollars (20 million Shillings) while officials of Savings and Credits Cooperative Society, SACCO, established to help war widows organise agricultural and business projects in Uganda were accused of embezzling public funds worth 34,285 US Dollars (Oketch, 2009). In Zaire (now Democratic Republic of Congo), out of the US\$2 billion received in foreign aid during the over three decades of mal-administration of Mobutu Sese-Seko, about 50 per cent of the money ended up in private pockets (Anthonio-Costa, 2003). In Kenya, Transparency International, TI, reported that corruption constituted a major risk in food assistance in its “Analysis of the 2011 Drought Response in Kenya” (TI-K, 2012). In Somalia, the U.N. budgeted \$1.5 billion in 2012, partly to prevent a return of famine. But a large amount of food sent by the U.N. to the Somali capital during last year's famine never reached the starving people it was intended for. Some of the World Food Program supplies went to the black market, some to feed livestock. One warehouse full of rations was looted in its entirety by a Somali government official. And across the city, feeding sites handed out far less food than records indicate they should have (Hourelid, 2012). In Egypt, Yussef Wali (former Agriculture Minister) was sentenced to 10 years in prison in 2011 for a deal that saw thousands of hectares of public lands worth 208 million Egyptian Pounds appropriated (Collard, 2012).

3.1 Prospects for Green Revolution in Africa: Case Study of Selected Countries

In the light of the current food security challenges facing Africa, what prospects are there for food security revolution? Despite the challenges, the prospects are high. Africa has the vastest arable land in the world and the percentage of the population of citizens employed in agriculture and the contribution of agriculture to GDP in African countries are encouraging as shown in Table 1.

Table 1: Importance of Agriculture to the National Economies

Country	Contribution of Agriculture to GDP (%)	Population Employed/Involved in Agriculture (%)
Benin	40	70
Burkina Faso	45	85
Congo	8	52
Mauritanian	22	NA
Morocco	15-20	40
Namibia	11	79
Sudan	40	80
Tanzania	50	85
Zimbabwe	11	71

Source: FAO Corporate Document Repository, 2011.

Also, according to the Permanent Interstate Committee for Drought Control in the Sahel (CILSS, September, 2011), the return of normal rainfall since August 2011 has enabled the definitive start of the growing season in Western Mali; Eastern and Northern Senegal; Southern Mauritania; Western Niger; the Sahelian zone of Chad; and Northern Nigeria². Also individual countries have initiated various policies and programmes to enhance the prospects of green revolution in Africa.

In 2000, the government of **Malawi** commissioned a study, financed by the European Commission, which was to form the basis for the new food security policy. The study concluded that a maize buffer stock of

² These are zones that were mostly affected by rainfall irregularities during the drought between 2008 and early 2011 (See CILSS, September, 2011).

between 30,000 and 60,000 metric tons would be sufficient to address a localized disaster. The size of the buffer stock was based on the use of early warning systems (which would signal an impending crisis six to nine months ahead), on the logistics of importing maize, and on the high cost of maintaining a maize buffer stock, which was generally about 20 percent of the value of the stocks themselves. Instead of a large physical buffer, the study recommended the build up of international reserves to finance any maize imports needed to prevent food shortages. The government of Malawi subsequently adopted these recommendations, which implied a substantial reduction from the large end-1999 stock to the level of 60,000 metric tons. Implementation also required a change in the NFRA's deed of trust to eliminate the possibility of price support interventions and to specify that the NFRA would engage only in disaster relief operations. These measures were supported by the World Bank's Third Fiscal Restructuring and Deregulation Program, approved by the Bank Board in December 2000 (IMF, 2002).

In **Nigeria**, successive governments since independence in 1960 have come up with various food security policies programmes such as the Green Revolution Programme (GRP) of the early 1960s, the Agricultural Development Project (ADP), the River Basin and Rural Development Authorities (RBRDA) of the 1970s, the Directorate for Food, Road and Rural Infrastructure (DFRRI), Operation Feed the Nation (OFN), Integrated Rural Development (IRD) of the 1980s, Family Economic Advancement Programme (FEAP), Better Life Programme (BLP), and Family Support Programme (FSP) of the military era in the 1990s which targeted urban and rural women. According to ECOWAS and NEPAD (2010), the Federal Ministry of Agriculture and Water Resources in Nigeria has developed the Nigerian Agriculture Investment Plan. The vision of the programme is to ensure sustainable access, availability and affordability of quality food to all Nigerians and for Nigeria to become a significant net provider of food to the global community. To complement the overall 8 percent growth target in the economy for 2010 – 2020, the government has set a target of 10 percent annual growth rate for the agricultural sector, compared to the 6 percent annual growth rate agreed to under the CAADP.

In **Sierra Leone**, the Agenda for Change which is the country's Second Poverty Reduction Strategy places priority on energy, infrastructure and

agriculture for national development efforts up to 2012. The government intends to “make agriculture the engine for socio-economic growth and development” (RSL, 2009:3).

In **Ethiopia**, agriculture is the mainstay of the economy. It accounts for 50% of the GDP, generates about 90% of export earnings, and supplies about 70% of input requirements of agro-based domestic industries. To boost food production, the government initiated plans to revitalise the agricultural sector. The emerging policy was entrenched in the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), covering from 2006-2010 (Ndikumana, 2010).

These efforts have also been complemented by foreign donor agencies, the United States and European countries through substantial aid fund to Africa. For instance, Weekly Trust in May 2012 reported that the United States Government announced a \$3 billion plan to boost food security in Africa.

Zambia has vast agriculture potentials. In the 1960s, its hybrid maize production reached its peak and majority of the Zambian population still depends on agriculture for livelihood. Taking cognisance of the role of agriculture on economic development and poverty reduction, the Zambian government initiated a number of policies and programmes to promote green revolution in the country. One of such major policies was the Strategic Plan for Agriculture embedded in the Zambian Fifth National Development Plan. The mission of the policy was to facilitate and support the development of a sustainable and viable agriculture sector. The targets of the policy include ensuring that 90% of households are food secure; increasing agricultural foreign exchange earnings from 5 to 20% by 2015; improving productivity growth from 2% to 7-10%; and raising agriculture contribution from less than 20% to 30% by 2015. The policy focuses on significant private sector participation, increased financial inflow, and infrastructural development and support services. The new agricultural policy also emphasized a shift from maize towards oilseeds, legumes, cassava, wheat, paddy rice, sorghum, etc (Zambian Ministry of Agriculture and Co-operatives, 2004).

4. Challenges of Food Security in Africa: The Way Out

Despite these prospects highlighted above, much needs to be done. This requires the adoption of a new approach to all efforts towards food security. One of the new approaches is to ensure the enthronelement of good governance in Africa. Studies have shown that countries in which there is good governance reap the benefits through more stable and sustainable economic growth (ODE, 2008; OECD/FAO, 2012). Good governance here involves discouraging corrupt or inefficient practices, efficient and effective management of public resources by public office holders and promoting sustainable food security and agro-oriented public policies. Also, a more enlightened role for government also implies working side by side with NGOs, farmers' associations and the private sector in concerted efforts to articulate policies and improve on agricultural productivity. This is because effective, efficient, and sustainable policies that are well adapted to the local context can help countries maximize the prospects of food security in their respective countries.

Secondly, environmental conservation and enhancement plans are essential to building a lasting national food security system. In addition to the usual elements of conserving land, water and biological diversity and controlling pollution, such plans should be integrated with efforts to reduce the loss of high-potential arable land to other uses, to improve food security and to use integrated planning approaches and processes in order to assess population-supporting capacity, so that planning national investment in food and agriculture can be directed most efficiently (Rosegrant, Cline, Weibo Li, Sulser & Valmonte-Santos, 2005).

Thirdly, a restructuring and revamping of existing institutional mechanisms in Africa are needed to ensure food security³. This will encourage Research and Development (R&D) in agriculture, provision of agricultural extension services to farmers and smallholders and enhance or facilitate their access to technologies. Research should also be geared towards mitigating the causes and effect of climate change and environmental degradation on agricultural activities in Africa.

³ This entails human capacity development and adequate funding of state owned institutions.

Fourthly, new actors in global development—the private sector, philanthropic organizations, and emerging economies—have important roles to play in ensuring food security and reducing hunger in Africa and other developing countries. Emerging countries such as Brazil, China, and India can provide alternative experiences and technologies that may help African states increase their productivity and ensure food security. Information sharing between these emerging economies and African countries can be supported through the development of databases, information systems, and platforms for collaboration. Thus, beneficial partnership between Africa and the development community is recommended.

Finally, to end political crisis and instability which have impacted negatively on efforts at ensuring the eradication of hunger and food insecurity in Africa, global arrangements between African states and the international community to ensure the enthronelement and consolidation of democratic principles, must be reached.

4.1 Conclusion

That Africa is faced with chronic hunger; food insecurity and economic crisis is well established. It is also obvious that beyond the natural phenomenon of unfavourable climatic conditions, food insecurity and hunger in Africa are caused by variables such as institutionalized and political corruption, political crisis and instability, the lack of the political will on the part of state actors to ensure proper implementation of policies and institutional inadequacies. But the prospects for a reversal of this trend through ‘green revolution’ are reasonably high.

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Evidence of Global Financial Shocks Transmission: Changing Nature of Stock Markets Integration during the 2007/2008 Financial Crisis

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The study aims to empirically examine the nature of integration among the Malaysian stock market with two of the world's biggest stock markets, namely the US and Japan, during the global financial crisis in 2007/2008. By assessing the changes in the nature of integration among these markets during the crisis, the study aims to find evidence on the international transmission of the financial shocks through the global stock markets. The study covers the period from September 1, 2006 to May 30, 2009. In efforts to capture the changing nature of integration among the stock markets, the sample period is divided into three sub-periods, namely the pre-crisis period, during crisis period I and during crisis period II. In methodology, the study relies on the recent empirical tests of cointegration, impulse response functions and variance decomposition analysis. The study finds that the nature of integration among these markets changes over the three periods due to the crisis. In particular, the markets are shown to be highly integrated at the initial stage of the crisis. However, as information became clearer and it is evident that the crisis is prolonged, investors opt for other types of investment than the equity markets, resulting in all the markets to perform independently.

1. Introduction

Studies documenting increasing integration among the global financial markets are abundant, often focusing on the integration of the national stock markets. There seems to be a tendency towards a general consensus that the international links among the stock markets have been increasing over the past decades, particularly those in the major financial centers (see, for example, Goldstein and Michael, 1993; Blackman and Holden, 1994; and Hanna et al., 1999). This trend is

largely attributed to the increased efficiency in the financial markets that facilitate capital flows across the globe. As suggested by Blackman and Holden (1994), stock markets are more segmented in the 1970s compared to the 1980s due to restrictions in capital flows, high transaction costs and information difficulties in the earlier period. The study by Hanna et al. (1999) on the nature of integration among six developed equity markets, namely the UK, France, Germany, Italy, Japan and Canada in the 1990s further lend support to these findings as the results reveal that these stock markets are highly integrated with each other, thus fail to offer any diversification benefits to the investors.

While integration among the global stock markets has increased, deeper investigations reveal the time-varying aspect of the stock market integration. Many studies have shown that the nature of integration among the stock markets could be changing over different sample periods. The study by Bekaert and Harvey (1995) which focuses on twelve emerging stock markets finds the time-varying integration among these stock markets. In particular, the study finds that several of the stock markets are segmented in one part of the sample and become integrated in another part of the sample. The different nature of the stock market integration is attributed to the regulatory changes over the sample periods, including the lifting of capital market restrictions to foreign investors. In the case of the major ASEAN countries, Click and Plummer (2005) find that the stock markets of the major ASEAN countries become increasingly integrated in the post-1997 financial crisis compared to before the crisis period as member countries intensify their efforts towards financial sector integration in advent of the macro-economic integration.

The recent US 2007 sub-prime crisis has renewed the research interests to understand the impact of financial crisis on the stock market integration. For the case of the US 2007 crisis, to our knowledge, there are limited studies focusing on the impact of the US financial crisis on other stock markets due to the recent nature of the crisis. Against this backdrop, the objective of this study is to analyze the transmission of the US 2007 sub-prime crisis to other stock markets and determine how the nature of integration among these stock market changes due to the crisis. By focusing on the nature of integration among the Malaysian stock market with two of the world's biggest stock markets, namely the US and Japan stock markets during the 2007 US financial crisis, the study

aims to find evidence of the international transmission of the financial shocks through the global stock markets. In efforts to capture the changing nature of integration during this period, the whole sample period from September 1, 2006 to May 30, 2009 is divided into three sub-periods, namely, the pre-crisis period starting from September 1, 2006 to July 25, 2007; during crisis period I starting from July 27, 2007 to June 30, 2008, and during crisis period II from the period July 1, 2008 to May 30, 2009.

The rest of this study is organized as follows. The next section reviews selected studies on stock market integration with the intention of identifying major issues and area for further exploration. Section 3 deals with the methodology adopted by this study. Section 4 presents the results of the empirical tests. Section 5 concludes and highlights the implications of the major findings.

2. Stock Market Integration and Transmission of Financial Shocks

Stock market integration captures substantial research interests due to the many important implications that it conveys. First, information regarding stock market integration suggests the potential benefits that can be gained by diversifying investments in the markets under consideration. In a risk-return framework, an investor can increase return or reduce risk, or both, by diversifying his investment portfolio in stock markets that are segmented. A classic study by Grubel (1968) which analyzes the stock markets in ten developed countries show that an investor in the New York Stock Exchange can increase his annual returns by as much as 68 percent while keeping his risk constant by diversifying in the international stock markets. Similarly, Levy and Sarnat (1970) increase the sample to 28 markets, comprising of both the developed and emerging markets and discover that the inclusion of the emerging markets increases the diversification benefits substantially, particularly for the US investors. Thus, information about stock market integration is crucial to investors in capital budgeting and making investment strategy.

Second, the degree of stock market integration also signals the extent of financial sector integration, which reflects the vulnerability of the countries to experience “financial contagion”. Thus, information about stock market integration or segmentation is equally important to the

policymakers. The degree of stock markets integration signals the extent of financial sector integration, which reflects the vulnerability of the countries to experience “financial contagion”. As two stock markets could be highly integrated due to strong economic ties such as trade and investment as well as due to macroeconomic policy harmonization, adverse development in the financial sector in one country could well be transmitted to the other country (a systemic shock). One such example of the financial contagion was the experience of the developing Asian countries during the financial crisis in 1997/1998. The crisis which started with the de-valuation of the Thai baht was transmitted throughout the region due to the strong trade and investment links among the countries during the period. Therefore, the need to understand clearly the nature of stock markets integration is crucial to the policymakers so that pre-emptive measures can be undertaken to prevent the systemic shocks.

Transmission of financial shocks through the global equity markets is a form of financial contagion. A study by Ibrahim (2005) shows that an increasing integration among the national stock markets implies that international financial instabilities are easily transmitted to domestic financial markets, a phenomenon called ‘financial contagion’. The degree of linkages or integration among the stock markets provides important implications for the potential benefits of the international portfolio diversification and financial stability of a country. An increasing integration among the national stock markets further implies that international financial instabilities are easily transmitted to domestic financial markets. Highly open economies with extensive international trade are more vulnerable to external shocks than countries with large proportion of domestic demand.

Similarly, the efforts to liberalise the financial sector could result in the economy to be vulnerable to financial shocks. Indeed, some studies showed that financial sector integration facilitate the transmission of shocks across the countries during crises. Kaminsky and Reinhart (1999) show how the crisis in Asia spread during the second half of 1997 by using daily interest rate and exchange rate data for Indonesia, Malaysia, the Philippines, South Korea and Thailand. The study finds that the propagation of shocks across national borders during the crisis was attributed to the behaviour of foreign banks, which began to drastically curtail their lending to the affected Asian countries following the Thai

devaluation, thus spreading and amplifying the crisis throughout the region. The large exposure of European banks to South Korea and their subsequent retrenchment further deepens the regional liquidity crunch. In short, the study finds that a reversal in lending of Japanese and European banks, which were lending heavily to emerging Asia, as one of the main reasons for the spread of the crisis. In short, this study suggests that financial sector links between the emerging Asian countries have played an increasingly important role in the 1990s in transmitting disturbances across national boundaries.

The study by Dunis and Shannon (2005) examines the integration between the emerging markets in South East Asia (Indonesia, the Philippines and Malaysia) and in Central Asia (Korea, Taiwan, China and India) with the established markets (the United States, the United Kingdom and Japan). By employing the techniques such as VAR and Kalman filters, the results indicated that all seven emerging markets in South East Asia and Central Asia exhibit greater integration with the Japan stock market rather than with the other two established markets. Thus the influence of the United States stock market on the emerging economies seems to diminish over more recent years. Consistent with the findings of Dunis and Shannon (2005), another study by Mohd Yusof and Abd Majid (2006) find that between the United States and Japan stock markets, the latter seems to significantly lead Malaysia's stock market after the 1997 Asian financial crisis. By employing similar techniques such as cointegration, variance decomposition and impulse response function, they investigated the dynamic interdependence of Malaysia stock market in these two established stock markets. According to the authors, the reason for Malaysia stock market is more integrated with Japan stock market could be partly due to an increasing trend of bilateral trade between these two countries over the years.

It is important to note that, there is a good side of stock markets integration in the context of regional economic cooperation such as ASEAN. Theoretically, an integrated stock market is considered as more efficient than a segmented stock market since it enables investors in the member countries to allocate capital in markets that are highly productive. Integrated stock markets in the region allow for free capital flow facilitated by lower cost of capital and transaction cost, improve liquidity and increase economic activities among the member countries. This investment option is even more relevant as ASEAN member

countries are striving to reduce the dependency on bank loans following the Asian financial crisis 1997/1998 (Click and Plummer, 2005). A highly integrated stock markets in the context of the ASEAN economies will go a long way in supporting the effort of establishing the ASEAN Investment Area (AIA) by 2010 as envisioned by the ASEAN leaders in October 1998.

3. Methodology

In achieving the objective of assessing the changing nature of integration among the US, Japan and Malaysian stock markets, this study relies on several empirical tests. This section focuses on the empirical framework and data issues by providing justifications for the tests that are adopted and discussing their suitability in the context of this study.

3.1 Empirical Framework

The empirical approach of this study is based on the standard methods of co-integration and vector auto-regression (VAR) framework. These methods have been widely adopted by studies in financial economics since due to their simplicity, particularly in terms of the nature of the variables. In particular, the VAR does not require for the a-priori distinction between exogenous and endogenous variables. Since the distinction is often subjective, it is wise to treat similarly (Sims, 1980). Since the technique sets no restrictions regarding the structural relationships of the variables, the mis-specification problems can be avoided.

Co-integration Test

The test of co-integration is conducted to examine the existences of the long-run relationships among the variables. The results from cointegration tests enable us to model short run dynamic interactions among the variables within our VAR system. If the variables are found to be non-stationary and non-cointegrated, the dynamic interactions among the variables are assessed according to the standard VAR model with variables expressed in first difference. Conversely, if the variables are found to be co-integrated, error correction models should be employed and accordingly this justifies the use of VAR model in levels.

To test for the cointegration, the maximum likelihood approach of Johansen-Juselius (JJ) cointegration test is used in this study. Essentially, JJ is based on VAR model as follows:

$$\mathbf{Y}_t = \boldsymbol{\delta} + \Pi_1 \mathbf{Y}_{t-1} + \Pi_k \Delta \mathbf{Y}_{t-k} + \boldsymbol{\varepsilon}_t \quad (1)$$

where $\mathbf{Y}_t$ is an $n \times 1$ vector of non-stationary variables integrated of the same order, $\boldsymbol{\delta}$ is an $n \times 1$ vector of constant, Π_1 is an $n \times n$ matrix of coefficients, $\boldsymbol{\varepsilon}_t$ is an $n \times 1$ vector of white noise error term and k is the order of autoregression. As our study investigates market integration among three markets, therefore n is equal to three.

The long-run information matrix Π in this equation is the key to Johansen's cointegration test because its rank r determines the number of cointegrating vectors. If $\text{rank}(\Pi) = 0$ returns to a VAR model in the first differences and the components in $\mathbf{Y}_t$ are not cointegrated. On the other hand, if Π is a full rank n , all component in $\mathbf{Y}_t$ are stationary. In a more general case when $1 < \text{rank}(\Pi) < n$, the number of cointegrating vectors is equal to r , the rank of matrix Π . Since the rank of a matrix is equal to the number of eigenvalues λ_i (or characteristic unit roots) that are significantly different from zero, Johansen proposed two statistics to test the rank of the long-run information Π , namely:

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \quad (2)$$

$$\lambda_{\text{max}}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (3)$$

where λ_i are estimated eigenvalues (characteristic roots) ranked from largest to smallest. The λ_{trace} in the equation (2) is called the Trace statistics, which is a likelihood ratio test statistics for the hypotheses that are at most r cointegrating vectors. The λ_{max} in the equation (3) is called the Maximal Eigenvalue statistic that tests the hypothesis of r cointegrating vectors against the hypothesis of $r - 1$ cointegrating vectors. The rank of Π is equal to the number of eigenvalues that are different from zero. If eigenvalues λ_i 's are all zero, then the λ_{trace} and λ_{max} will be zero. To test for the number of cointegrating vectors, this study employs Johansen and Juselius's (1990) and Osterwald-Lenum's (1992) λ_{trace} and λ_{max} statistics that are adjusted for the degree of freedom.

Since our model considers the possibility of the past level of parameters to have an effect on current changes in other parameters, the lagged values have to be incorporated in the models. In this study, the Akaike (1974) Information Criterion (AIC) is used to determine the lag length incorporation in all the tests of this study.

Impulse Response Functions and Variance Decomposition Analysis

The impulse response functions (IRF) and variance decomposition analysis (VDC) derived from VAR are relevant and suitable for this study in order to analyze the impact of the crisis on the selected stock markets. Conventionally, VAR studies such as Sims (1980) employ variables in log level. The problem is that the results from such a specification may be spurious and misleading if log level variables are non-stationary. Transforming the variables into first differences to render the variables stationary before running VAR, however, introduces misspecification problem in the case that the variables under consideration are cointegrated. For proper specification of the VAR model as to avoid spurious regression or misspecification problems, integration and cointegration tests outlined in the previous step are necessary. In particular, the findings that the variables are non-stationary and are not cointegrated suggest the use of VAR model in first differences. However, if they are cointegrated, a vector error correction model or a level VAR can be used (Engle and Granger, 1987). This study therefore uses the VAR model in first differences and level, respectively for cointegrated and non-cointegrated stock markets in its IRFs and VDCs analyses.

The IRFs allows for the analysis of the dynamic interaction among stock markets. A major concern when conducting the IRF analysis is the identification problem such that innovation in one market may be contemporaneously correlated to other markets, resulting in shocks in one stock market may work through the contemporaneous correlation with innovations in other markets. Since isolated shocks to individual market cannot be identified due to contemporaneous correlation, the responses of a stock market to innovations in another market cannot be adequately represented (Lutkepohl, 1991). The common approach in solving this identification problem is to employ Sims' (1980) empirical strategy by orthogonalizing the innovations by using the Cholesky factorization. The approach, however, requires a pre-specified causal

ordering of the markets which turn out to be its major disadvantage. The results from impulse response analysis may be sensitive to the ordering of the markets particularly when contemporaneous correlations of error terms in the VAR are high. To overcome this shortcoming, this study adopts the generalized IRF developed by Pesaran and Shin (1998). The generalized IRFs fully account for the historical patterns of correlations among the different shocks and are unique and invariant to alternative orderings of the stock markets.

Meanwhile, the VDC is used in this study to assess the dynamic interactions between the stock markets. This analysis would reveal the contribution of the US and Japanese stock indices in explaining the forecast error variance of the Malaysian stock indices, vice versa.

3.3 Data

Stock market data, namely the US Standard & Poors 500 Index for the US (SPX), the Tokyo Stock Price Index for Japan (TOPIX) and the Kuala Lumpur Composite Index for Malaysia (KLCI) are obtained from the *Bloomberg* database, www.econstats.com, *Datastream* database, and websites of the Malaysian, US, and Japanese stock markets. The study uses daily closing indices of the three stock markets, covering the period from September 1, 2006 to May 30, 2009. In line with the objective of empirically explore changes in the cross-market linkages among the stock markets due to crisis, the study divides the data into three sub-periods as follows:

- (i) Pre-crisis period starting from September 1, 2006 to July 25, 2007;
- (ii) During crisis period I starting from July 27, 2007 to June 30, 2008;
- (iii) During crisis period II from the period July 1, 2008 to May 30, 2009.

4. Results and Discussions

4.1 Descriptive statistics

The results from the descriptive statistics show changing characteristics of the stock markets due to the US financial crisis. In the pre-crisis period, all the three stock markets recorded positive average daily returns as shown by the positive means for all three stock markets. Of

the three stock markets, the Malaysian stock market registered the highest mean of 0.001, followed by the US stock market at 0.0004, and the Japanese stock market at 0.0002. In terms of volatility, the Japanese stock market was the most volatile as reflected by its highest standard deviation at 0.0075, followed by the Malaysian stock market at 0.0072, and the US stock market at 0.005. In line with the convention “high risk, high return”, the Japanese stock market recorded the highest maximum of and the lowest minimum during the period.

In the crisis period, all stock markets recorded negative average daily returns. In addition, all the markets are relatively more volatile during the crisis period compare with the pre-crisis period, with volatility is generally higher in crisis period II. The Malaysian market has been the most calm during the crisis period, registering the lowest standard deviations in both crisis periods I and II. In particular, in the crisis period I, the Japanese stock market is shown to be the most volatile as reflected by its highest standard deviation of all the three stock markets (Japan at 0.0144, US at 0.0108, and Malaysia at 0.0107). However, in the crisis period II, the results show that the US market has been the most volatile, recording the highest standard deviation of 0.025 (followed by Japan at 0.023 and Malaysia at 0.01). In general, the crisis has resulted in increased volatility of the US stock market.

The degree of peakedness is measured by kurtosis is shown in Table 1. All series displayed excess kurtosis, which indicate that the distribution of the stock markets is leptokurtic or there are more variances of the observations. This is further supported by the Jacque-Bera statistic which suggests that the distribution of stock returns cannot be adequately approximated by the normal distribution.

4.2 Correlation matrix

Table 2 shows the correlation matrix among the Malaysian, the US and Japanese stock markets in the pre- and during crisis periods. The correlation matrix provides useful information about the short-run integration or co-movements among the three stock markets. Given that the focus of the study is to assess any changes in the nature of the correlation due to the crisis, the table is extended to include the information regarding the correlation among the markets in the three periods under review.

Table 1: Descriptive Statistics of Stock Returns

		Mal	US	Japan
Pre-crisis	Mean	0.0011	0.0004	0.0002
	Median	0.000	0.000	0.000
	Maximum	0.0260	0.0189	0.0265
	Minimum	-0.0475	-0.0353	-0.0348
	Std. Dev.	0.0072	0.0054	0.0075
	Skewness	-1.363	-1.1963	-0.6581
	Kurtosis	12.176	10.7601	6.4964
	Jarque-Bera	1248.553	898.4821	190.1663
During crisis I	Mean	-0.0004	-0.0004	-0.0007
	Median	0.000	0.000	0.000
	Maximum	0.0426	0.0415	0.0459
	Minimum	-0.0998	-0.0325	-0.0587
	Std. Dev.	0.0107	0.0108	0.0144
	Skewness	-2.5805	-0.0583	-0.4441
	Kurtosis	26.0723	5.0569	5.006
	Jarque-Bera	7895.418	59.9519	67.9786
During crisis II	Mean	-0.0004	-0.0011	-0.0013
	Median	0.000	0.000	0.000
	Maximum	0.0406	0.1096	0.1286
	Minimum	-0.0368	-0.0947	-0.1001
	Std. Dev.	0.0099	0.0250	0.0228
	Skewness	0.2032	-0.0664	-0.0221
	Kurtosis	5.9537	6.6420	8.7153
	Jarque-Bera	119.2666	178.1933	438.277

As shown in Table 2, there are significant correlations between the Malaysian and US stock markets as well as the Japanese stock market in the pre-crisis period. However, there is no significant correlation between the US and Japanese stock markets. This result suggests that the Malaysian stock market is highly sensitive to the development in both the US and Japan stock markets in such a way that there is no significant diversification benefit in these markets. However, investors can enjoy the benefits of diversifying their portfolios in the US and Japanese stock markets in the pre-crisis period.

Table 2: Correlation of the Stock Returns

		Mal	US	Japan
Pre-crisis	Malaysia	1.000		
	US	0.187***	1.000	
	Japan	0.537***	0.078	1.000
During crisis I	Malaysia	1.000		
	US	0.007	1.000	
	Japan	0.459***	0.082	1.000
During crisis II	Malaysia	1.000		
	US	0.158***	1.000	
	Japan	0.538***	0.120**	1.000

Note: *, ** and *** denote significant at the 10%, 5% and 1% levels, respectively.

In the crisis period I, there seems to be a de-coupling effect between the Malaysian and the US stock markets since the correlation between the two markets has now turned insignificant. This could reflect the confidence of the investors on other stock markets in other parts of the world such as Malaysia and Japan at the initial stage of the crisis. Consequently, due to the insignificant correlation between the US-Malaysian and US-Japan stock markets, the Malaysian and Japanese stock markets provide diversification benefits for the US investors. The Malaysian and Japanese stock markets remained significantly correlated in crisis period I, possibly due to the geographical proximity. This finding concurs well with several studies that emphasize the importance of geographical proximity of the markets in influencing the integration of equity markets (see, for example, Abd. Majid et al., 2008; Ibrahim, 2000; Azman-Saini et al., 2002; Daly, 2003).

As the crisis deepened, in crisis period II, all the stock markets showed significant correlation among each other. The integration nature of the Malaysian stock market and those of the US and Japan have returned as in the pre-crisis period. In addition, there is also a significant correlation between the US and Japan stock markets. It could be implied that as information became clearer and the market participants are given more time to react to the crisis, investors realize that the prolonged financial crisis would gradually become an economic crisis which would continue to depress the equity market. Negative investor sentiment results in a

“flight to quality” from the equity market to saver investment options, resulting in a down market throughout the stock markets across the globe.

4.3 Cointegration Results

The co-integration results show the existence of long-run equilibrium relationship among the stock markets under review. The results indicate that the stock markets share a long-run equilibrium only during the height of the crisis, namely in crisis period I. As shown in Table 3, both the Max-Eigen Statistics and Trace Statistics tests results show that the null hypothesis of no co-integration is rejected at the 1 percent level of significance only in crisis period I, but not in the pre-crisis period or crisis period II. This suggests the aggregate behaviour of the investors who became vigilant in all stock markets following the news of the sub-prime crisis. However, the results show the non-existence of long-run equilibrium in the non-crisis period (pre-crisis) and in during crisis period II indicate that the stock markets do not share a long-run equilibrium.

Table 3: Cointegration Results

	Null Hypothesis	Trace Statistics	Max-Eigenvalue Statistics
Pre-crisis	$r \leq 0$	19.815	11.752
	$r \leq 1$	8.063	6.705
	$r \leq 2$	1.358	1.358
During crisis I	$r \leq 0$	41.784***	34.257***
	$r \leq 1$	7.526	5.540
	$r \leq 2$	1.986	1.986
During crisis II	$r \leq 0$	19.687	14.350
	$r \leq 1$	5.337	3.860
	$r \leq 2$	1.477	1.477

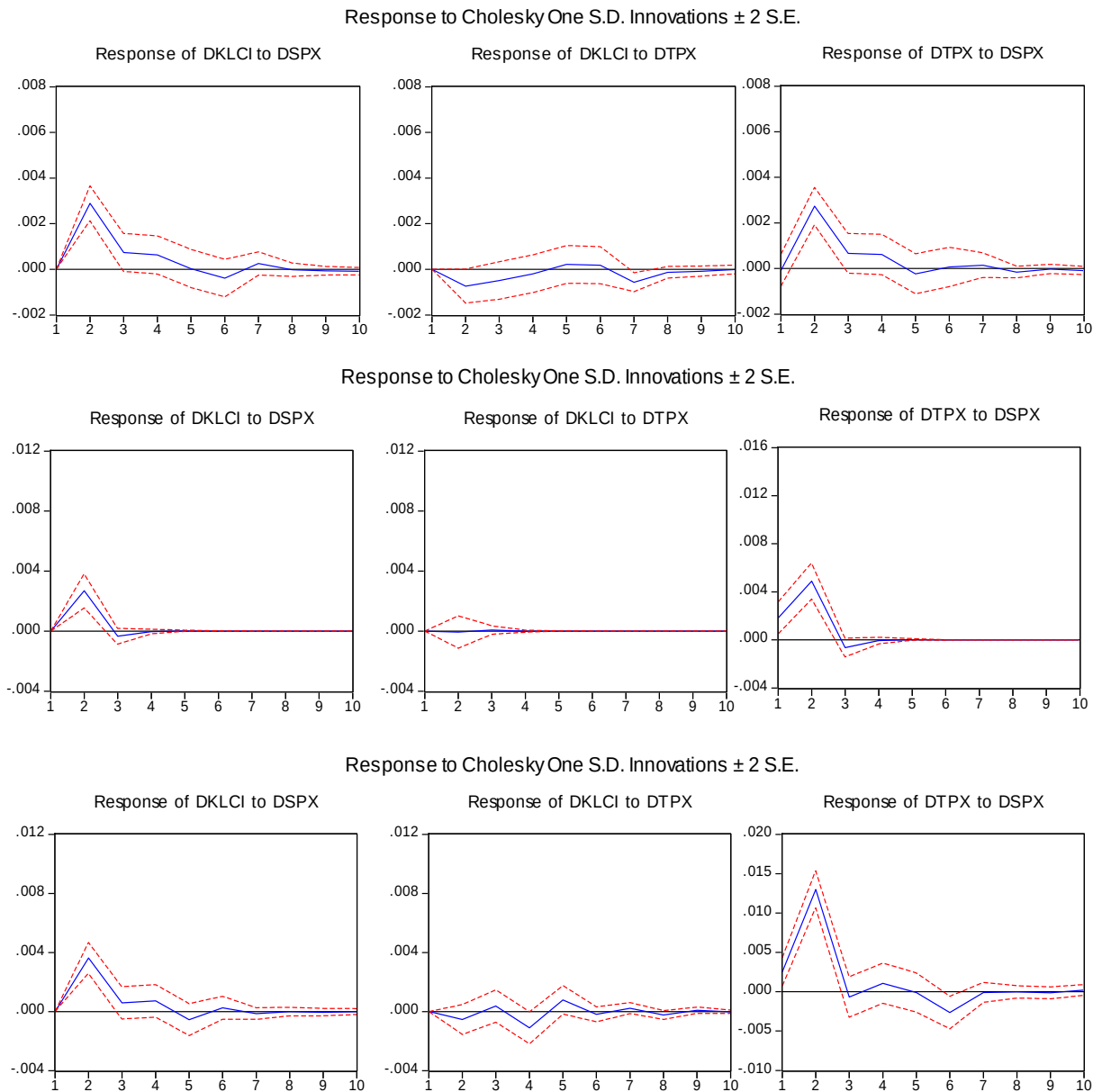
Notes: *, ** and *** denote significant at the 10%, 5% and 1% levels, respectively. r denotes the number of co-integrating vectors. The optimal lag length is determined based on the Akaike Information Criteria (AIC). Since the study utilizes daily data, the maximum lag-length considered in the study is 30.

4.4 Impulse Response Functions

To achieve the objective of determining the impact of shocks of the major stock markets on the Malaysian stock market, the impulse response functions (IRF) is a suitable test since it allows the analysis of the responses of one stock markets to shocks (or changes) in the other stock markets. An IRF measures the time profile of the effect of shocks at a given point in time on the (expected) future values of variables in a dynamical system (Pesaran and Shin, 1998). The approach is well-suited because not only that it allows for the relative strength of various shocks to be quantified in terms of their contributions to variations in a particular variable of interest, but it also enables the pattern and direction of the transmission of shocks to be traced. To provide some idea of uncertainty surrounding the estimated response, based on Sims and Zha (1995), one standard deviation of confidence bands have been obtained by Monte Carlo integration methods with 1,000 replications.

The IRF results also suggest that the sub-prime crisis has significant impact on the integration nature of the stock markets. As shown in Figure 1, there are significant positive responses of the Malaysian stock market to shocks in the US market in all three sub-periods. However, the IRF results suggest that the Malaysian stock market responded negatively and significantly to shocks in the Japanese market in the pre-crisis period, and became insignificant in the crisis periods I and II. Meanwhile, the Japanese market is shown to respond positively and significantly to shocks in the US market throughout the three periods of analysis. It is also interesting to note that the magnitude of responses of the Japanese stock market to the shocks in the US market is getting bigger in crisis period II compared to in crisis period I.

Figure 1: Impulse Response Functions of the Malaysian, US and Japanese Stock Markets in Pre-Crisis, During Crisis I and II Periods



4.5 Variance Decompositions

Lastly, the VDC analysis is used to assess the dynamic interactions between the stock markets under consideration. In this study, we focus on the contribution of the US and Japanese stock markets in explaining the forecast error variance of the Malaysian stock market.

As reported in Table 4, the Malaysian stock market is relatively endogenous in the pre-crisis period and in the crisis period II. This is well-reflected by the VDC results which suggest that around 80 percent of the variations in the Malaysian stock market are explained by innovations in itself in both periods. In contrast, in crisis period I, the Malaysian stock market was highly exogenous as only around 35 percent of its variations are contributed by innovations in itself at the 24-month horizon. Innovations in the US market contribute more than 45 percent of the variations in the Malaysian stock market during the height of the crisis (crisis period I) and the Japanese market contribute about 19 percent. Both the US and Japanese stock markets exert significant impact on the Malaysian market at the initial stage of the crisis.

Another point to note is the contribution of the innovations in the Japanese market in explaining the forecast error-variance of the Malaysian stock market. The role of the Japanese stock market in influencing the Malaysian stock market has been rather subdued in the pre-crisis period and crisis period II. However, during the initial stage of the crisis (i.e. crisis period I), innovations in the Japanese market contribute significantly in explaining the forecast error variance of the Malaysian market.

In general, the VDC results suggest that as information became evident that the crisis will be sustained for quite some time, the market reaction returned to its earlier level.

Table 4: Variance Decompositions of Stock Markets

		Mal	US	Japan
Pre-crisis	1	100.000	0.000	0.000
	2	82.902	16.058	1.040
	4	81.081	17.382	1.537
	6	80.836	17.495	1.669
	12	80.183	17.489	2.328
	18	80.182	17.489	2.329
	24	80.182	17.489	2.329
During crisis I	1	100.000	0.000	0.000
	2	95.683	4.049	0.268
	4	88.999	9.438	1.564
	6	81.191	15.226	3.583
	12	58.997	30.571	10.432
	18	43.941	40.444	15.615
	24	34.643	46.371	18.985
During crisis II	1	100.000	0.000	0.000
	2	86.074	13.618	0.307
	4	84.299	14.033	1.668
	6	83.545	14.169	2.287
	12	83.438	14.166	2.397
	18	83.437	14.166	2.397
	24	83.437	14.166	2.397

5. Conclusions

This study aims to empirically examine the nature of integration of the Malaysian stock market with two of the biggest stock markets in the world, namely the US and Japan, during the 2007 US financial crisis. By assessing the changes in the nature of integration among these markets during the crisis, the study aims to find evidence of the international transmission of the financial shocks through the global stock markets. As such, the study focuses on three sub-periods, namely the pre-crisis period, during crisis period I and during crisis period II.

The study finds that the nature of integration of the three markets over the sub-periods under review changes due to the crisis, thus, providing the empirical evidence on the transmission of the US financial shocks throughout the global stock markets. In particular, the stock markets are shown to be highly integrated at the initial stage of the crisis. For example, as shown by the results of the cointegration test, the three stock markets are found to be cointegrated only during crisis period I. There are increased market activities in all three markets in the initial stage of the crisis. Market panic results in investors to shift their funds to the developing or the emerging countries' market to avoid the impact of the crisis on their investments. There are also evidence that geographical proximity is a relevant factor being considered by the investors during a financial crisis. However, as information later became clearer that the crisis will be prologed, activities in each market depends on the domestic factors. In addition, given more time, investors might opt for other types of investments than the equity markets, resulting in all the markets to perform independently.

Furthermore, the results highlight the vulnerability of a country to international financial shocks. As shown clearly by the variance decompositions and impulse response function results, shocks originating from the US are highly significant in explaining the variances in the Malaysian financial sector. This could be attributed to the strong trade and investment dependency of the Malaysian economy on the US. As a result of the strong ties, the Malaysian financial sector is highly susceptible to shocks from the US. This finding has important macroeconomic policy implications such that developing and highly open economies such as Malaysia should strive towards diversifying their export markets as well as investment sources so as to reduce the vulnerability of the economy from international financial shocks.

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