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GLOBAL FINANCIAL CRISIS AND FOREIGN DEVELOPMENT ASSISTANCE SHOCKS IN LEAST DEVELOPING COUNTRIES

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This paper evaluates whether the exogenous component of the global financial crisis affects OECD-DAC EU donor countries ODA disbursements to the LDCs and how it impacts on LDCs economic prosperity. Using both static and dynamic panel techniques, we find that global financial crisis in OECD-EU donor countries are causes for the significant downside of ODA flows to the LDCs. Consequently it adversely affects through the various transmission channels (e.g., ODA disbursements, remittances, bilateral financial flows, export growth) to the LDCs economic growth. Our results also explore that due to countercyclical role of ODA flows from the donors' largely affect to the LDCs economic development process negatively. The robustness checks using alternative estimation technique supports our original estimation results in every context.

Keywords: Financial Crisis, ODA, Economic Growth, OECD-EU Donors, LDCs
JEL classification: F35, F39, O5, O11

1. INTRODUCTION

Foreign development assistance, widely known as Official Development Assistance (ODA), is the most prominent development tool employed by the developed countries in its attempts to promote prosperity in the developing countries. Since the Second World War, ODA has become an institutionalized part of foreign policy of donors which accounts for an important source of many developing countries' fiscal income (Grant and Nijman, 1998). Several studies (Ang, 2010; Burnside and Dollar, 2000; Easterly, 2003; Easterly, Levine, and Roodman, 2004; Hansen and Tarp, 2001; Karras, 2006; Rajan and Subramanian, 2005) have already widely witnessed the impact of ODA on the Least Developed Countries' (LDCs) economic growth. Some researchers have asserted that ODA flows also affect the foreign direct investment (FDI) inflows into developing countries, as donors always encourage the improvement of the recipient countries' FDI

[*] All remaining errors are our own.

(Kimura and Todo, 2010; OECD, 2004). But the ODA's impact on developing countries' growth remains a subject for further investigation, because developing countries in particular LDCs directly demand foreign aid for their economic development.

The recent financial crisis in the advanced economies has collided LDCs heavily resulting in reduced private financial flows and foreign aid, minimized workers' remittances and cut consumption demand; and accordingly prices of the export goods goes down. Consequently, these shocks have dwindled LDCs income growth rate by about 7 percent between 2007 and 2009 (Dang, Knack and Rogers, 2009). In addition, ODA is mostly connected with the development activities through some important sectors such as infrastructure, health, education etc. Therefore, it is important to investigate how financial crisis exerts an influence upon ODA disbursement. If it proves to affect it then, it will be essential to investigate whether a sudden cut of ODA disbursements will aggravate the problems already imposed by the crisis and further hinder the development process of these poor economies as a whole. Bulir and Hamann (2008), Treasurry (2005), Birdsall (2004), OECD (2003) and many others highlighted that volatility and unpredictability of ODA shocks is a severe macroeconomic management problem to the LDCs.

There is a few studies (Bulir and Hamann, 2008; Dang *et al*., 2009; Frot, 2009; Mendoza, Jones and Vergara, 2009; Minoiu, Zanna and Dabla-Norris, 2010; Mold, Prizzon, Frot and Santiso, 2010) that examine the effects of the financial crisis on donor countries ODA flows. Dang *et al*. (2009) points out that crisis affected donor countries have reduced their ODA flows by an average of 20 to 25 percent and bottom out only about a decade after the banking crisis; Roodman (2008), Frot (2009) argue that the recent financial crisis will slump the ODA flows. This is supported by the reduction of ODA disbursements following to the Nordic financial crisis in 1990's. He reports that Nordic banking crisis reduce donors' aid disbursements by 13 percent. Conversely, Pallage and Robe (2001), Mold *et al*. (2010) claims that the financial crisis and donor countries economic growth does not impact on ODA disbursements and which may not have any negative impact on the developing economics. However, the empirical evidences, methodologies and analyses of the above studies are not sufficiently rigorous.

This research rigorously examines whether the exogenous component of the global financial crisis affects OECD-DAC EU donor countries ODA disbursements to the LDCs and how does it impact on LDCs economic prosperity. Methodologically, our research uses two econometric techniques: firstly, static panel estimators and secondly, dynamic panel generalized method of moments (GMM) estimators. We also run various specification tests to check the validity of the models and subsequently employ the alternative econometric techniques to check the robustness of our models. We comprise various yearly data for 17 OECD-DAC EU donor countries and 53 LDCs between 2004 and 2010. Our results suggest that global financial crisis in OECD-EU donor countries declines their ODA effort to the LDCs. Consequently it adversely affects through the

various transmission channels (e.g., ODA disbursements, remittances, bilateral financial flows, export growth) to the LDCs economic development.

The remainder of the dissertation is organized as follows: Section 2 lays out the stylized facts of global financial crisis and FDA shocks in least developing countries; Section 3 presents data and empirical strategy, while Section 4 discuss and presents the static and dynamic panel estimation results, and Section 5 contains the conclusion.

2. STYLIZED FACTS

2.1. Global Financial Crisis and Development Assistance Shocks

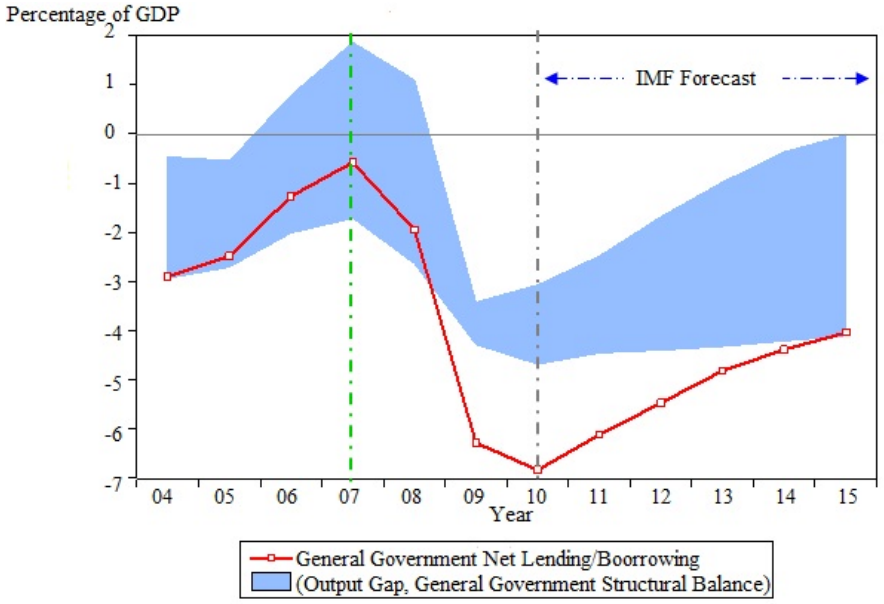
The current global financial crisis was initially triggered through the bursting of the United States housing bubble in 2007. Soon after, in September 2008 the EU financial turmoil erupts and contagion over the EU member countries, referred to is now as the so called global financial crisis. Reinhart and Rogoff (2009) shows that, aftermath of this severe financial crises in rich countries asset markets are collapsed and prolonged, output and employment level declines profoundly and government debt tends to explode. Consequently, to mitigate and tackle the crises, OECD-DAC in particular EU countries adopt the fiscal austerity measures, which are potentially affecting of their ODA flows to the LDCs. Some donors have already cut their aid expenditure in terms of aid volumes[1] and aid programming (te Velde and Massa, 2009),[2] while OECD (2010) estimates to meet the donors' 2010 ODA commitments at least 10-15 billion US$ must be added to their ODA spending plans.

However, Sèna Kimm (2011), Jones (2011), Dang *et al*. (2010), Faini (2006) explore how the fiscal conditions of OECD donors affects their aid effort to the developing countries. They finds that crisis affected donor countries reduce their aid flows by an average of 20 to 25 percent. Additionally, they reports that aid flows is related to donors' fiscal situation. Whereas Mendoza *et al*. (2009) shows that financial and economic crisis has a negative link to the ODA disbursements by using USA ODA disbursements from 1967-2007. Conversely, Mold *et al*. (2010) demonstrates crisis does not hit with force on aid flows. Since limited numbers of studies have dealt with the supply side perspective of donor ODA flows, these different empirical works did not sufficiently uncover the real picture of OECD-DAC ODA flows to the most ODA recipient low income counties after financial crises, while they consider all OECD-DAC donors ODA flows to the developing countries (including the emerging economies) as a whole. Therefore, there is

[1] E.g., Ireland by 24 percent, Italy 56 percent, Greece 32 percent, Denmark 11 percent and the Netherlands 11 percent.

[2] E.g., Germany, France, Norway, Denmark and the Netherlands are changing their aid allocations program to the different countries.

no supporting evidence in this regard, which makes our research more essential. Here we consider only crisis affected regions' OECD-DAC donor countries and their supply side determinants of ODA disbursements only to the LDCs.



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Source: Authors calculation using IMF Economic outlook database.

Notes: This graph depicts the output gap, general government fiscal balance and general government lending/browning in the Euro area from 2004 to 2010 (from 2011 to 2015 is the IMF forecast). Evidence shows that the Euro area suffers deep economic recession from 2007 and onward, which is the causes of global financial crisis.

Figure 1. Scenario of Intensified Financial Stress in Euro Area

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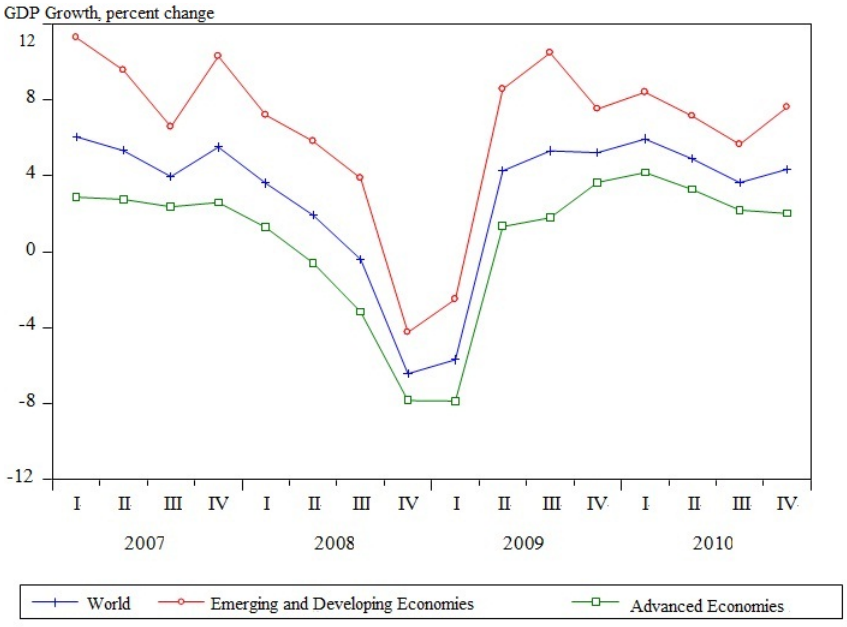
Data exhibits that OECD-DAC EU donor countries' major economic indicators (e.g., ODA flows to the LDCs, public debt, output gap and government fiscal balance) appear to show a strong relationship between these variables. It figures out that 17 OECD-EU donors' countries (e.g., Austria, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Sweden and United Kingdom) net ODA flows reduced substantially since 2007 whereas it grew gradually to LDCs before 2007.[3] Thence, crisis affected donor countries public debt and general government fiscal balance tend to explode in 2008 (Reinhart and Rogoff, 2009).

[3] See Appendix.

2.2. Development Assistance Shocks and Least Developing Countries

In the decade prior to the global financial catastrophe, bilateral ODA disbursements to the developing countries consistently increased; as a result the crisis raised big concerns that ODA supply would decline (Dang *et al*., 2009; Frot, 2009; Minoiu *et al*., 2010). However, LDCs are now experiencing the magnitude of the global financial turmoil, which hit hard primarily their private capital flows, ODA and remittances, trade revenue and many others macroeconomic variables. These transmission channels primarily evolve through reduced ODA disbursements, export growth, private capital flows and workers' remittances flows to the LDCs, which put them from frying pan into the fire. Consequently, these transmission mechanisms have induced broad adverse macroeconomic effects on growth, investment, poverty, inequality, public and private debt of the LDCs. Bulir and Hamann (2008) demonstrates that aid dependent countries heavily suffered from the external shocks and due to the widespread liquidity constraint they are less able to absorb those shocks.



Source: Authors calculation using IMF World Economic Outlook database.

Notes: This graph reflects the quarterly GDP growth rate from 2007 to 2010 of global economies, emerging and developing economies and advanced economies. It shows that the financial crisis in advanced economies rapidly affects to the emerging and developing countries GDP growth rate through various transmission channels. Although developing countries, in particular the LDCs may not have played any role for this big recession, but they are severely affected through the global market actions.

Figure 2. GDP Growth by Country Groups

Furthermore, ActionAid (2009) estimates that low income countries' export growth decline almost 25 percent in side-by-side financial resources to around US$ 300 billion (Cali, Massa and te Velde, 2008; Naudé and Research, 2009). Dang *et al*. (2009) show that developing countries income growth rate is reduced by about 7 percent between 2007 and 2009. In terms of ODA, the Doha Monetary Consensus meeting in 2008[4] revealed that most of the OECD-DAC donors could not meet their aid commitment[5] to the developing countries (Cali *et al*., 2008; Naudé and Research, 2009). Subsequently, foreign direct investment (FDI) flows decreased by 10 percent in 2008 (UNCTAD, 2009) as well as workers remittance flows being reduced considerably. Thus, it is obvious that developing countries, particularly LDCs economic growth and development are in difficulty after the financial crisis and economic recession of 2008 and 2009 in donor countries.

LDCs are already harshly affected by the global financial crisis and affixed ODA cuts put them more miserable situations, where over 50 percent people lives under the poverty line.[6] Materially, LDCs are far behind to reach United Nation's prescribed Millennium Development Goals (MDG) of reducing extreme poverty, hunger and child mortality; improving education, health, environment, and gender equality etc. Thus ODA shocks bring potentially a big threat to their development and prosperity. Notably, the LDCs' (e.g., Bangladesh, Benin, Burundi, Cambodia, Central African Rep., Chad, Kenya, Haiti, Laos, Lesotho, Liberia, Mali, Mauritania, Mozambique, Senegal, Sudan, Togo, Tajikistan, Vanuatu, Vietnam, Yemen etc.) worker remittances, debt forgiveness reduction, export growth and bilateral financial flows decline substantially since the financial crisis of EU donor countries. Moreover, data demonstrates that net ODA disbursements from OECD-DAC EU donor countries, debt forgiveness reduction, net bilateral financial flows, export growth and foreign direct investments have a strong link with the LDCs per capita economic growth. Thus this factual argument confirms us to investigate how do ODA and other financial shock affect to the LDCs.

There is a few numbers of studies that account for the effects of the financial crisis on donor countries ODA flows. However, the empirical evidences, methodologies and analyses of these studies are not sufficiently rigorous. The paper of Roodman (2008) and Mold *et al*. (2010) are more discussion oriented and provides less empirical evidence regarding their hypotheses. Furthermore, Roodman (2008) does not show any further analysis of ODA disbursements of donor countries after the effects of Nordic financial crisis. Frot (2009) estimates panel data of donor countries using vector autoregression (VAR) model but it fails to express actual evidence of the recent global financial crisis.

[4] OECD-DAC follows up international conference on financing for development to review the implementation of the monetary consensus in Doha, Qatar, December 2008.

[5] In 2002, monetary consensus on financing for development OECD-DAC donor countries have agreed to provide at least 0.7 percent of their GNP as aid to the developing countries.

[6] See UNFPA (2011).

Besides, they do not verify their specification using alternative estimations for robustness checks and sensitivity of the results. Minoiu *et al*. (2010) and Dang *et al*. (2009) estimate panel data using fixed effects estimation. The weakness of their paper is the credibility of specification as they only employed fixed effects techniques. Since, endogeneity is a big issue for panel data analysis, they ignores the necessary specification tests to examine the correlation between regressors and unobserved country-specific effects. Moreover, they do not carry out any other estimation techniques even for the robustness checks of their obtained specifications. Furthermore, Mendoza *et al*. (2009) uses only U.S. ODA disbursements data (1967-2007) for their estimations and ignores the other OECD donor countries, thus their results does not portrait the comprehensive effects on ODA flows to the recipient countries. Most importantly, none of these researches account for the impact of ODA shocks to the LDCs, where the world poorest people are living.

3. DATA AND EMPIRICAL STRATEGY

To analyze these issues we employ a robust econometric technique, which directly deals with the potential biases induced by omitted variables, simultaneity and unobserved country specific effects. Methodologically, we have used both static and dynamic generalized method of moment (GMM) panel estimation procedure. We have set up two models: (1) for OECD-EU donor countries and (2) for LDCs. We assemble the panel data set of 17 countries from donor perspective and 53 countries from recipient perspective. To address the question concerning the first model, the dependent variable is the log of net ODA disbursements, whereas for second model, it is the per capita gross domestic product (GDP) growth. The explanatory variables of both model contains a large set of variables, which serves as conditioning information.

3.1. Data

We consider two panel data sets from the complementary points of view of the donor countries and of the recipient countries. Our sample covers the period 2004-2010. For our first panel we limit sources counties to the 17 OECD-DAC EU donor countries, since EU donor countries are severely affected by the financial crisis. And for our second panel we limit sources to the 53 Least Developed Countries, whose economic development is largely, depends upon Foreign Development Assistance (FDA) received from donor countries.

3.1.1. Donor Countries Data

Our first hypothesis is to examine whether the exogenous component if the financial crisis affects OECD-EU donor countries ODA disbursements to the LDCs. Data for

OECD-EU donor countries are taken from EuroStat, OECD-DAC, database,[7] which are the standard sources used in empirical research. Our data set represents strongly balanced panel of 119 observations and 17 countries for the period 2004-2010 each.

We considered Net Official Developed Assistance (ODA) disbursement instead of ODA commitments by each donor to the developing countries, as there was a wide gap between ODA commitments and ODA disbursements by each donor in the data sets. For banking crisis data, we used a database developed by Luc Leaven.[8] From this, we considered the banking crisis events after 2004, since most of the EU donor countries were affected by the financial crisis after this time period. We suspect banking crisis in a donor country is one of the major channels to reduce the ODA disbursements irrespective of its effect on the other macroeconomic variables. We also assay budget deficit and public debt (DPD), output gap (DOG), general government fiscal balance (DGGFB), trade openness (TOP), GDP per capita (GDPC), population (Pop), real effective exchange rate (RER), rate of inflation (INF) and rate of unemployment (UE) data, which affect to the ODA flows to LDCs.[9]

3.1.2. Developing Countries Data

To address our second research hypothesis- investigate how ODA and other financial flows shock affect to the LDCs., we consider 53 Least Developing Countries (LDC).[10] In fact, we restrict our attention only to LDCs, since these world's most poor cohort countries are facing several challenges due to the global financial crisis, which include huge debt burden, very limited inflows of FDI, low rate of ODA and remittance inflows, less participation in export and so on.

For our strongly balanced panel for 53 LDCs represents 371 observations for the time period 2004-2010. We used data from various sources, including the Penn World Tables 7.0,[11] OECD-DAC, Global Development Finance Report (2012), World Bank, IMF-International Financial Statistics, WIDER, ILO-Labor market statistics, Migration and Remittances Factbook (2011) and Emergency events database.[12] For this Panel dataset, GDP per capita growth rate is treated as a dependent variable. We consider net total ODA flows rather than ODA commitments from the OECD-EU donor countries to the ODA recipient countries. Since, European Union (EU) member countries are severely affected by global financial crisis, thus we also restrict our attention only to the

[7] See Appendix for detailed descriptions of variables and sources.

[8] See http://www.luclaeven.com/Data.htm.

[9] See Appendix for detail of summary statistics.

[10] Treated as low income and lower middle income countries according to the World Bank's classifications in 1990s.

[11] See http://pwt.econ.upenn.edu/.

[12] See Appendix Table A3 for detailed descriptions of variables and sources.

OECD-EU donor countries ODA flows. The other explanatory variables include net FDI inflows, export growth, debt forgiveness or reduction, total external debt stocks, corruption index, inequality (GINI index), total population, net bilateral financial flows, net multilateral financial flows, macroeconomic management rating, numbers of natural disasters affected, exchange rate, workers' remittances, infant mortality rate and fiscal policy rating also taken into consideration, which serves as conditioning information.

3.2. Empirical Strategy

The aim of this research is to show how financial crisis within an OECD-EU donor countries effect on country's ODA disbursements to the LDCs over time. Notably, we investigate how ODA flow shock affects the LDCs' economic development process. To estimate the corresponding model, we employ two types of estimation techniques; static panel estimation and dynamic GMM panel estimation.

3.2.1. Static Panel Estimation

We start with Pooled Ordinary Least Squares (POLS) estimation. According to orthogonality condition, the OLS estimators are consistent when all explanatory variables are uncorrelated with the error term. However, there is a possibility to violate this assumption if explanatory variables are correlated with the error term and/or unobserved country specific effects i.e., endogeneity problem.

Consider traditional cross-country regressions, our empirical models are as follows:

$$\ln NDODA_{i,t} = \alpha + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t}, \quad (1)$$

$$RGDPCG_{i,t} = \xi + \psi' Z_{i,t} + \rho_i + \varepsilon_{i,t}, \quad (2)$$

where Eq. (1) and (2) represent 17 OECD-EU donor countries and 53 LDCs respectively. In Eq. (1), ln*NDODA* is the logarithm of Net ODA disbursed by each donor considered as dependent variable and *X* represents the set of explanatory variables (donor countries public debt, output gap, general government fiscal balance, log of population, log of trade openness, log of real effective exchange rate, log of inflation rate, log of unemployment rate and banking crisis dummy). $\varepsilon_{i,t}$ is an independently distributed error term with $E[\varepsilon_{i,t}] = 0$ and the subscripts *i* and *t* denotes country and time period respectively. η_i is an unobserved country specific effects which are uncorrelated with error term $\varepsilon_{i,t}$.

In Eq. (2), *RGDPCG* is the ODA recipient countries' GDP per capita growth treated as a dependent variable in this model. Where *Z* consists the vector of explanatory variables (ODA total net disbursement from each countries, net foreign direct

investment inflow, debt forgiveness or reduction, total external debt stocks, worker's remittance, GINI index, export growth, corruption index, total population, net bilateral financial flow, net multilateral financial flow, fiscal policy index, macroeconomic management index, exchange rates, infant mortality rate and affected by natural disaster). ρ_i and $\varepsilon_{i,t}$ represents country specific effects and error terms respectively.

When we execute pooled OLS (POLS) regression, we do not consider unobserved country specific effects for our models, Eq. (1) and (2). Thus, heterogeneity of the countries can appear of the estimated parameters. As a result, we estimate the models which incorporate unobserved country specific effects by Fixed Effect (FE) and Random Effect (RE) techniques. However, incorporating the country specific effects has several benefits, e.g., it allows accounting for specific effects. Later we use Breusch and Pagan's LM test to test the relevancy of unobservable country specific effects. This test helps us to decide between RE and POLS. If we reject the null hypothesis[13] POLS is not the appropriate technique for estimation and vice versa. Additionally, we also use the Hausman test[14] to examine the correlation between regressors and unobserved country specific effects. The Hausman test allows us to test for the misspecification between FE and RE estimation. Furthermore we estimate FE and RE with AR (1) disturbance. To test for AR (1) disturbance we perform Baltagi-Wu locally best invariant test. Since, several literature suspects the possibility of endogeneity of foreign aid in the growth regressions (Alesina and Dollar, 2000; Boone, 1994, 1996; Burnside and Dollar, 2000; Burnside and Dollar, 2004; Hadjimichael *et al*., 1995; Hansen and Tarp, 2001), we consider the endogeneity of ODA and employ Two-Stage Least Square (2SLS) technique for FE, RE and Baltagis's Error Components 2SLS (EC2SLS)[15] RE estimator. Lastly, we use the Hausman test to compare these estimators' results.

3.2.2. GMM Estimators for Dynamic Panel Models

Since, the static linear panel model does not permit us to analyze the possible dynamism, we use the dynamic panel estimators that were pioneered by Holtz-Eakin, Newey and Rosen (1988), Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998) and Bond *et al*. (2001). Our two panels consist of data from 70[16] countries over the time period 2004-2010. Since we use yearly data, our panel

[13] H_0: Irrelevance of unobserved country specific effects and H_A: Relevance of unobserved country specific effects.

[14] H_0: No correlation exists between regressors and unobserved country specific effects and H_A: Correlation exists between regressors and unobserved country specific effects.

[15] Baltagi (1984) shows Monte Carlo experiments on a two-Eq. simultaneous model with error components and demonstrates the efficiency gains in terms of mean squared error in performing EC2SLS (see Baltagi, 2005).

[16] First panel data set consists of 17 DAC-OECD countries and second panel of 53 least developing

permits seven observations for each country. In dynamic framework, Eq. (1) and (2) can be written in following specifications;

$$\ln NDODA_{i,t} = \alpha + \gamma_1 \ln NDODA_{i,t-1} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t}, \tag{3}$$

$$RGDPCG_{i,t} = \xi + \lambda_1 RGDPCG_{i,t-1} + \psi' Z_{i,t} + \rho_i + \varepsilon_{i,t}. \tag{4}$$

For $i = 1,...,N$, and $t = 2,...,T$, where $(\eta_i + \varepsilon_{i,t})$ and $(\rho_i + \varepsilon_{i,t})$ have the standard error component structure;

For Eq. (3), $E[\eta_i] = 0$, $E[\varepsilon_{i,t}] = 0$, $E[\varepsilon_{i,t}\eta_i] = 0$, for $i = 1,...,N$, and $t = 2,...,T$, and $E[\rho_i] = 0$, $E[\varepsilon_{i,t}] = 0$, $E[\varepsilon_{i,t}\rho_i] = 0$, for $i = 1,...,N$, and $t = 2,...,T$ is for Eq. (4).

Now, we take the first difference to eliminate country specific effects of Eq. (3) and (4),

$$\begin{aligned} \ln NDODA_{i,t} - \ln NDODA_{i,t-1} = {} & \alpha + \gamma_1 (\ln NDODA_{i,t-1} - \ln NDODA_{i,t-2}) \\ & + \beta' [X_{i,t} - X_{i,t-1}] + (\varepsilon_{i,t} - \varepsilon_{i,t-1}), \end{aligned} \tag{5}$$

$$\begin{aligned} RGDPCG_{i,t} - RGDPCG_{i,t-1} = {} & \xi + \lambda_1 (RGDPCG_{i,t-1} - RGDPCG_{i,t-2}) \\ & + \psi' [Z_{i,t} - Z_{i,t-1}] + (\varepsilon_{i,t} - \varepsilon_{i,t-1}). \end{aligned} \tag{6}$$

In fact for both Eq. (5) and (6), the lagged dependent variable $(\ln NDODA_{i,t} - \ln NDODA_{i,t-1})$ and $(RGDPCG_{i,t} - RGDPCG_{i,t-1})$ are correlated with error term $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ which implies that the regressors are likely endogenous. Thus, we need to use instruments to deal with Eq. (5) and (6). According to econometric assumptions, the error term is not serially correlated and the regressors are weakly exogenous.[17] Therefore, the dynamic panel GMM estimator employs the following moment conditions based on difference estimator for Eq. (3);

$$E[\ln NDODA_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } t = 3,...,T, \ s \geq 2, \tag{7}$$

$$E[X_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } t = 3,...,T, \ s \geq 2. \tag{8}$$

countries (LDCs).

[17] Assuming that the regressors are not correlated with future error terms.

Similarly for Eq. (4) is;

$$E[RGDPCG_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ , for } t = 3,...,T \text{ , } s \geq 2 \text{ ,} \tag{9}$$

$$E[Z_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \text{ , for } t = 3,...,T \text{ , } s \geq 2 \text{ .} \tag{10}$$

Which can be written in following matrix form as;

$$M = \begin{pmatrix} y_{i1} & 0 & 0 & \cdots & 0 & \cdots & 0 \\ 0 & y_{i1} & y_{i2} & \cdots & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & y_{i1} & \cdots & y_{i,T-2} \end{pmatrix}.$$

Here, M is the instruments matrix corresponding to the endogenous variables, where $y_{i,t-s}$ refers to $\ln NDODA_{i,t-s}$ for Eq. (7) and $RGDPCG_{i,t-s}$ for Eq. (9).

However, the first differenced estimator is criticized in terms of bias and imprecision. Thus, to reduce potential biases and imprecision, Blundell and Bond (1998) suggest that, when regressors have short time period, we can use a new estimator that combines a system in the difference estimator with the estimator in levels, which is called the Blundell and Bond system GMM. The difference operator in Eq. uses the same instrument as above and the instruments for the levels are the lagged difference of the regressors. The econometric assumption here is that the difference in the regressors and the country specific effect are uncorrelated. Therefore the stationary properties are:

For Eq. (3);

$$E[\ln NDODA_{i,t+p}\eta_i] = E[\ln NDODA_{i,t+q}\eta_i] \text{ and } E[X_{i,t+p}\eta_i] = E[X_{i,t+q}\eta_i] \forall p \text{ and } q \text{ .}$$

The additional moment conditions for the levels are

$$E[\Delta \ln NDODA_{i,t-s}(\eta_i + \varepsilon_{i,t})] = 0 \text{ , for } s = 1 \text{ ,} \tag{11}$$

$$E[\Delta X_{i,t-s}(\eta_i + \varepsilon_{i,t})] = 0 \text{ , for } s = 1 \text{ .} \tag{12}$$

For Eq. (4);

$$E[RGDPCG_{i,t+m}\rho_i] = E[RGDPCG_{i,t+n}\rho_i] \text{ and } E[Z_{i,t+m}\rho_i] = E[Z_{i,t+n}\rho_i] \forall \text{ , for } m \text{ and } n \text{ .}$$

The additional moment conditions for the levels are;

$$E[\Delta RGDPCG_{i,t-s}(\rho_i + \varepsilon_{i,t})] = 0 \text{, for } s = 1, \tag{13}$$

$$E[\Delta Z_{i,t-s}(\rho_i + \varepsilon_{i,t})] = 0 \text{, for } s = 1. \tag{14}$$

Now we can use GMM technique for both models to estimate consistent and efficient parameter by employing the moment conditions given in Eq. (7), (8), (11) and (12) for the OECD-EU donor countries model and those in Eq. (9), (10), (13) and (14) for LDCs model.

Finally, to check the validity of the instruments in the system-GMM estimator, we implement two specification test, which is suggested by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). First, the Sargan test of over-identification to check the validity of the instruments and second the Arellano-Bond test to check the hypothesis that error term is serially uncorrelated.

4. ESTIMATION RESULTS AND DISCUSSION

This section presents the estimation results of our research, which aims to answer our two prime objectives: firstly, whether the exogenous component of the global financial crisis affects OECD-EU donor countries ODA disbursements to the LDCs and secondly, how it impacts on LDCs economic prosperity. We estimate Eq. (1) and (2) on the data set described above by using static panel methods and Eq. (3) and (4) by using dynamic panel GMM estimation.

4.1. Static Panel Estimation Results

To analyze of our hypotheses, first we employ static panel estimation techniques in Eq. (1) and (2). Tables 1 and 2 depict the estimation results of OECD-EU donor countries (Eq. 1) and LDCs (Eq. 2) respectively. In both tables columns 1 to 8 shows different estimation results Column 1 contains pooled OLS (POLS) results. As we cannot consider unobserved country specific effects in POLS we therefore execute within group-fixed effect (FE) and generalized least square (GLS)-random effect (RE) estimation, presented in columns 2 and 3 respectively. Columns 4 and 5 demonstrate the FE and RE result considering AR (1) disturbance. Since we have considered the possible endogeneity problem in our models, thus for Eq. (1), we suspect general government fiscal balance is endogenous and use public debt, log of unemployment rate, log of inflation and banking crisis dummy as instruments for that. For the Eq. (2), we consider the endogeneity of ODA and used FDI inflows, export growth rate, debt forgiveness or reduction, GINI index, population, exchange rate and workers' remittances as instruments for it. In both Tables (1 and 2), column 6 and 7 contains 2SLS-FE and 2SLS-RE estimation results. Finally, column 8 show Baltagi's error components 2SLS-RE estimation results to check the robustness of our models.

In Table 1, the empirical model is related with a log of net ODA disbursements to a set of explanatory variables. All variables are in log except public debt (DPD), output gap (DOG), government fiscal balance (DGGFB) and banking crisis dummy (bc-dummy). The explanatory variables (all columns) consist of the probability of global financial crisis induced macroeconomic indicators on ODA disbursements from OECD-EU donor countries. Pooled OLS results show that public debt (DPD), output gap (DOG), population (Lpop), GDP per capita (Lgdpc), trade openness (Ltop) and real exchange rate (Lrer) all have a significant positive effect on ODA flows with estimated elasticity of -0.0115, -0.035, 1.30, 0.955, 1.23, and 0.363 respectively. The positive coefficient refers that variables have positive effects on ODA disbursements and vice versa.

Since the POLS estimation does not control for the country specific effects, we carried out FE and RE. Our RE estimation results (column 3) reported the similar results as POLS. Additionally, to check the relevance of country specific effects, the LM test indicates that we reject null hypothesis, implying POLS is not the appropriate technique to show the relationship between ODA flows and its determinants. In column 2, FE estimation shows most of the variables coefficients are statistically insignificant, except public debt (-0.014) and population (7.056). However, the Hausman test does not reject the null hypothesis with *p-value* 0.9053, so RE appears to be appropriate for this model.

Furthermore, column 4 reports FE estimation with AR (1) disturbance. The result implies that public debt has statistically negative significant effect on ODA flows, meaning that ODA donors tend to give less ODA to the LDCs in the period of financial crisis. Although the results of the other variables are remains statistically insignificant, although the coefficients represent a major effect on the donors' ODA disbursements. RE estimation with AR(1) reported in column 5 shows that there is a very strong significant relationship between ODA disbursements and its determinants. This means that public, debt output gap, general government fiscal balance and banking crisis dummy have a significant negative influence on ODA disbursements, whereas population, GDP per capita, trade openness and real exchange rate shows a significant positive relationship as estimated in POLS. To test for AR (1) disturbance for both FE and RE, we perform Baltagi-Wu locally best invariant (LBI) test. The value of Baltagi-Wu LBI statistic far below 2 implies that correction for serial correlation is needed (Baltagi, 1984, 2005; Kögel, 2004). For our model Baltagi-Wu LBI statistic value (2.1977) indicates that correction for serial correlation is not necessary.

To further check the robustness of the relationship, column 6 and 7 estimates the regression considering 2SLS for both FE and RE. We suspect general government fiscal balance (DGGFB) are endogenous and chose public debt (DPD), log of unemployment rate (Lue), log of inflation (Linf) and banking crisis dummy as instruments for this. The results indicate that general government fiscal balance has a negative effect on ODA disbursements by -0.02 in FE and -0.04 in RE. However, the Hausman test result (0.359), which does not reject the null hypothesis, suggests to us 2SLS-RE is appropriate estimator than 2SLS-FE. We estimate EC2SLS-RE to further deal with the endogeneity

problem reported in column 8. The EC2SLS-RE coefficient values are similar to those reported by 2SLS-RE, which implies DPD and DGGFB have significant negative effect, whereas population (Lpop) and trade openness (Ltop) have significant positive effect on OECD-EU donor countries ODA flows. To test for the misspecification between the 2SLS-FE and EC2SLS-RE, we again conduct a Hausman test. Since under the Hausman test our *p-value* is 0.4415, we accept the null hypothesis, which allows us to reject 2SLS-FE in favor of the EC2SLS-RE model.

To compare all estimators for Eq. (1), we found RE is appropriate for our model. The results show that OECD-EU donors' output gap, public debt and general government fiscal balance have significant negative impact on their ODA disbursement to the LDCs after the global financial crisis in all specifications. The results also revealed that population, GDP per capita, trade openness and real exchange rate have significant positive effects, which imply that the LDCs are more favorable in terms of donors GDP per capita and trade openness. Notably, the banking crisis dummy showed a statistically insignificant coefficient, which has a large negative effect (all most -0.09 in every specifications) in our model.

As before, Table 2 shows the results for the different estimator of Eq. (2) reporting POLS, FE and RE estimates, where the dependent variable is GDP per capita growth rate (RGDPCG). The POLS estimation results suggest that net bilateral financial flows (NFF_Bi), net multilateral financial flows (NFF_Mu), Workers remittances and ODA flows have statistically significant strong negative impact on per capita growth rate of LDCs with estimated elasticity, whereas ODA changes by -0.003 percent. Additionally, other explanatory variables (e.g., macroeconomic management rating (MMR), fiscal policy rating (Fpr), affected by natural disaster (AND)) have significant effect on growth rate as well. In testing the relevancy of the country specific effect, the LM test rejects the null hypothesis with 1 percent significance level, implying this country specific effect needs to be considered. The FE estimation coefficient shows that debt forgiveness or reduction (DFoR), NFF_Bi, NFF_Mu, ODA and Wrr have strong negative effect on growth rate, on the other hand total external debt stocks (TEDS), corruption index (CI) and affected by natural disaster (AND) have significantly positive impact on growth. To test for the misspecification between the FE and RE, the Hausman test suggests accepting the null hypothesis in favor of RE estimation. Furthermore, to check the serial correlation, we conduct FE and RE estimation considering AR (1) disturbance, shown in columns 4 and 5. Column 5 shows almost the same coefficient value as we get in RE (column 3). However, the Baltagi-Wu LBI statistic value (2.2512) for both FE-AR(1) and RE-AR(1) estimation indicates that correction for serial correlation is not necessary.

As several literature (Alesina and Dollar, 2000; Boone, 1994, 1996; Burnside and Dollar, 2000, 2004; Hadjimichael *et al*., 1995; Hansen and Tarp, 2001) suspect the possibility of endogeneity of foreign aid in the growth regressions we consider the endogeneity of ODA and employ 2SLS technique for FE, RE and EC2SLS, displayed in columns 6-8. We chose debt forgiveness or reduction (DFoR), population (Pop), net bilateral financial flows (NFF_Bi) and workers' remittances (Wrr) as instruments for

ODA. In column 6, 2SLS-FE coefficients shows that OECD-EU donors' ODA flows has significantly negative effect by -0.00237 percent on LDCs' economic growth, which indicates that the global financial crisis leads to ODA fall and subsequently its negative effect on LDCs growth. Other variables have strong significant effects (e.g., NFF_Mu, AND, TEDS, MMR and infant mortality rate (INF_Mor)). Columns 7-8 contain relatively similar results and all deterrent variables are significant with slightly less elastic in absolute value than those reported by 2SLS-FE. However, the Hausman test with *p-value* 0.0002, between 2SLS-FE and 2SLS-RE suggest for rejecting null hypothesis in favor of 2SLS-FE. Alternatively, Hausman test with *p-value* 0.0001 based on the contrast between 2SLS-FE and EC2SLS-RE reject the null hypothesis, which supports 2SLS-FE estimation as well.

Table 1. Static Panel Estimation Results of OECD-EU Donor Countries

Estimation method	(1)POLS	(2) FE	(3) RE	(4) FE AR(1)	(5) RE AR(1)	(6) 2SLS-FE	(7) 2SLS-RE	(8) EC 2SLS-RE
DPD	-0.0115**	-0.0138*	-0.0115**	-0.0129*	-0.0100*	-	-	-
	(0.00562)	(0.00711)	(0.00562)	(0.00763)	(0.00560)	-	-	-
DOG	-0.0350*	-0.0249	-0.0350*	-0.000960	-0.0373*	-0.0208	-0.0400**	-0.0360**
	(0.0186)	(0.0226)	(0.0186)	(0.0229)	(0.0198)	(0.0199)	(0.0165)	(0.0159)
DGGFB	-0.00533	-0.00520	-0.00533	0.000389	-0.00566	-0.0201**	-0.0172***	-0.0149***
	(0.00412)	(0.00551)	(0.00412)	(0.00562)	(0.00393)	(0.00793)	(0.00509)	(0.00437)
Lpop	1.300***	7.056*	1.300***	0.704	1.343***	7.475**	1.510***	1.429***
	(0.202)	(4.022)	(0.202)	(0.613)	(0.172)	(3.682)	(0.222)	(0.213)
Lgdpc	0.955**	0.603	0.955**	0.0885	0.872**	0.131	0.275	0.360
	(0.397)	(0.685)	(0.397)	(0.574)	(0.405)	(0.612)	(0.376)	(0.353)
Lue	0.236	0.191	0.236	0.359	0.133	-	-	-
	(0.256)	(0.318)	(0.256)	(0.344)	(0.266)	-	-	-
Ltop	1.230**	0.417	1.230**	0.184	1.419***	0.417	1.728***	1.582***
	(0.542)	(0.953)	(0.542)	(0.894)	(0.483)	(0.878)	(0.541)	(0.527)
Lrer	0.363*	0.0460	0.363*	-0.744	0.385**	0.218	0.229	0.262
	(0.211)	(0.924)	(0.211)	(0.609)	(0.174)	(0.922)	(0.229)	(0.221)
Linf	-0.0372	-3.62e-05	-0.0372	-0.00277	-0.0541	-	-	-
	(0.0621)	(0.0718)	(0.0621)	(0.0707)	(0.0634)	-	-	-
Bcdummy	-0.0886	-0.0968	-0.0886	-0.0653	-0.0922	-	-	-
	(0.108)	(0.113)	(0.108)	(0.0982)	(0.108)	-	-	-
R^2	0.7858	0.3317	0.7858	0.1748	0.7937	0.3433	0.7507	0.7618
LM test	-	-	133.25***	-	-	-	-	-
Baltagi-Wu LBI test	-	-	-	2.1977	2.1977	-	-	-
Hausman test (*p-value*)			0.9053		-		0.3590	0.4415

Observations	111	111	111	94	111	111	111	111
Donor countries	17	17	17	17	17	17	17	17

Notes: Dependent variable is log of net ODA (LNDODA). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) POLS, Pooled OLS estimation; (2) FE, Within group fixed effect estimation; (3) RE, GLS random effect estimation, (4) FE AR(1), Within group fixed effect estimation with AR(1) disturbance; (5) RE AR(1), GLS random effect estimation with AR(1) disturbance; (6) 2SLS-FE, Two-step least square fixed effect estimation; (7) 2SLS-RE, Two-step least square random effect estimation; (8) EC2SLS-RE, Baltagi error component 2SLS-RE.

Taking together the results in Table 2, the LDCs' per capita economic growth is affected by the negative impact of ODA flows with an estimated elasticity of about -0.003 percent from OECD-EU donors in our all specifications. Additionally, net bilateral financial flows, net multilateral financial flows (EU-institutions), debt forgiveness or reduction and workers' remittances also have similar significant negative impact on the LDCs economic growth. This implies the economic progress by LDCs is highly affected through the above transmission channels due to the global financial crisis. The results also discovered that LDCs' export growth rate is negatively affected by all most -0.007 percent in all given specifications to the per capita GDP growth that implies LDCs' export growth rate is substantially reduced although this result is not statistically significant.

4.2. Dynamic Panel GMM Estimation Results

Since our static linear panel model from both donor and recipient countries' point of view does not permit us to analyze the possible dynamism, we employ the dynamic panel GMM estimators in this regard.

4.2.1. Results of OECD-EU Donor Countries

The dynamic panel GMM estimation result shows the impact of global financial crisis on ODA disbursements. Table 4.3 and 4.4 present the results using Arellano and Bond (1991) difference and Blundell and Bond (1998) system GMM estimators respectively. This analysis has considered LNDODA as a dependent variable with a lagged dependent variable and set of other explanatory variables (Eq. (3)). We also present Sargan test[18] and Arellano-Bond serial correlation test[19] in Tables 3 and 4. Arellano and Bond (1991) difference GMM estimation results, considering all lags, are presented in columns 2 of Table 3. The results suggest that the exogenous component of

[18] H_0: Instrumental variables are not correlated with error terms.

[19] He terms $(\varepsilon_{i,t})$ are *iid* with variance (σ^2) for respective first difference. Thus, we have to use the appropriate test whether the $\varepsilon_{i,t}$ in first differences are AR(2) or not (Lachenmaier and Rottmann, 2011).

the global financial crisis exerts a large negative impact on OECD-DAC EU ODA flows although most of the coefficients are not statistically significant. In column 3, we considered all lags with year dummy to control for any shocks that are common for all countries. Comparing the column 2 and 3 coefficients, the results are not significantly different. Thus, we use 2SLS estimator considering all lags (column 4) and coefficients are now showing more statistically significant results. Although the Sargan test supports the validity of our estimation, the Arellano-Bond AR (2) test rejects the null hypothesis and implies that there is second order serial correlation, which is not desirable. Next, we consider all lags with year dummy (column 5) and employed 2SLS. The coefficients of the lagged dependent variables is showing large negative effects (-0.914) including other variables. The negative lagged value of the dependent variable suggests that there is no dynamic effect. Furthermore, to get more consistent results we estimate AB-GMM considering maximum one lag (column 6) and maximum one lag with year dummy (column 7). The coefficients values are almost identical and statistically insignificant.

Table 2. Static Panel Estimation Results for LDCs

Estimation method	(1)POLS	(2) FE	(3) RE	(4) FE AR(1)	(5) RE AR(1)	(6) 2SLS-FE	(7) 2SLS-RE	(8) EC 2SLS-RE
FDInf	0.0384	0.0400	0.0384	0.0410	0.0383	0.0661	0.0388	0.0402
	(0.0512)	(0.0449)	(0.0512)	(0.0403)	(0.0519)	(0.0567)	(0.0543)	(0.0542)
ExG	-0.00614	-0.00690	-0.00614	-0.00780	-0.00576	-0.0102	-0.00610	-0.00617
	(0.00721)	(0.00553)	(0.00721)	(0.00473)	(0.00730)	(0.00699)	(0.00807)	(0.00806)
DFoR	-1.52e-10	-5.40e-10*	-1.52e-10	0	-1.32e-10	-	-	-
	(4.14e-10)	(3.27e-10)	(4.14e-10)	(2.80e-10)	(4.20e-10)	-	-	-
TEDS	4.64e-10***	8.72e-10***	4.64e-10***	-1.11e-10	4.33e-10***	1.29e-09***	3.14e-10***	3.18e-10***
	(8.97e-11)	(9.69e-11)	(8.97e-11)	(1.15e-10)	(9.03e-11)	(1.09e-10)	(6.31e-11)	(6.29e-11)
CI	1.602**	2.267*	1.602**	-0.0890	1.576**	-0.236	1.409*	1.410*
	(0.766)	(1.213)	(0.766)	(1.122)	(0.759)	(1.502)	(0.723)	(0.722)
GINI	0.00323	-0.150	0.00323	-0.0842	-0.000773	-0.162	-0.0510	-0.0485
	(0.0619)	(0.190)	(0.0619)	(0.180)	(0.0606)	(0.240)	(0.0562)	(0.0562)
Pop	5.40e-08*	3.07e-07	5.40e-08*	5.84e-08	5.62e-08*	-	-	5.40e-08*
	(2.93e-08)	(1.89e-07)	(2.93e-08)	(1.93e-07)	(2.92e-08)	-	-	(2.93e-08)
NFF_Bi	-3.41e-09***	-2.13e-09**	-3.41e-09***	-1.27e-10	-3.41e-09***	-	-	-3.41e-09***
	(1.14e-09)	(1.01e-09)	(1.14e-09)	(8.59e-10)	(1.17e-09)	-	-	(1.14e-09)
NFF_Mu	-5.40e-09***	-2.30e-09	-5.40e-09***	-2.26e-09*	-5.56e-09***	-7.85e-09***	-8.17e-09***	-5.40e-09***
	(1.64e-09)	(1.42e-09)	(1.64e-09)	(1.32e-09)	(1.67e-09)	(1.67e-09)	(1.69e-09)	(1.64e-09)
MMR	-1.446*	-1.211	-1.446*	-0.258	-1.481*	1.790*	-1.050	-1.446*
	(0.836)	(0.860)	(0.836)	(0.809)	(0.843)	(1.049)	(0.847)	(0.836)
AND	0.378**	0.276**	0.378**	0.220*	0.382**	0.810***	0.490***	0.378**
	(0.155)	(0.133)	(0.155)	(0.126)	(0.156)	(0.159)	(0.157)	(0.155)
Oda	-0.00302***	-0.00355***	-0.00302***	-0.000182	-0.00299***	-0.00237***	-0.00122*	-0.00302***
	(0.000868)	(0.000772)	(0.000868)	(0.000723)	(0.000882)	(0.000624)	(0.000696)	(0.000868)

XR	-3.15e-05	-0.000209	-3.15e-05	-8.78e-05	-1.95e-05	-0.000192	-3.00e-05	-3.15e-05
	(0.000134)	(0.000339)	(0.000134)	(0.000340)	(0.000132)	(0.000427)	(0.000123)	(0.000134)
Wrr	-1.63e-09***	-3.52e-09***	-1.63e-09***	4.13e-10	-1.57e-09***	-	-	-1.63e-09***
	(2.41e-10)	(3.15e-10)	(2.41e-10)	(4.82e-10)	(2.42e-10)	-	-	(2.41e-10)
INF_Mor	0.0183	0.0151	0.0183	0.137**	0.0183	0.176***	0.0198	0.0183
	(0.0188)	(0.0617)	(0.0188)	(0.0660)	(0.0185)	(0.0650)	(0.0173)	(0.0188)
Fpr	2.452***	1.252	2.452***	0.713	2.526***	-0.787	1.928**	2.452***
	(0.875)	(0.991)	(0.875)	(0.903)	(0.878)	(1.233)	(0.859)	(0.875)
R^2	0.897	0.0526	0.897	0.0030	0.0939	0.346	0.0953	0.0932
LM test	-	-	56.48***	-	-	-	-	-
Baltagi-Wu test	-	-	-	2.2512	2.2512	-	-	-
Hausman test	-	0.9262			-		0.0002	0.0001
Observations	371	371	371	318	371	371	371	371
No. of LDCs	53	53	53	53	53	53	53	53

Notes: Dependent variable is GDP per capita growth rate (RGPCG). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Dynamic Panel Estimation Results for OECD-EU Donor Countries (Arellano and Bond 1991 Difference GMM Approach)

Estimation method	(1) POLS	(2) AB-GMM	(3) AB-GMM	(4) AB-GMM (2S)	(5) AB-GMM (2S)	(6) AB-GMM (1L)	(7) AB-GMM (1L)	(8) AB-GMM (1L,2S)	(9) AB-GMM (1L,2S)
LLNDODA	0.651***	-0.260	-0.205	-0.332**	-0.914*	0.00222	-0.123	-0.182	-0.797*
	(0.0677)	(0.202)	(0.196)	(0.148)	(0.508)	(0.369)	(0.234)	(0.180)	(0.442)
DPD	-0.00290	-0.0196**	-0.0224*	-0.0168***	0.0732	-0.0181*	-0.0175	-0.0143***	0.0464*
	(0.00283)	(0.00926)	(0.0118)	(0.00454)	(0.0514)	(0.0102)	(0.0125)	(0.00359)	(0.0243)
DOG	-0.00158	-0.0146	-0.00154	-0.0406***	-0.118*	-0.0179	0.00255	-0.00769	-0.101***
	(0.0179)	(0.0282)	(0.0432)	(0.0154)	(0.0681)	(0.0311)	(0.0451)	(0.0166)	(0.0377)
DGGFB	-0.00199	-0.00313	-0.00154	-0.00309	-0.0167	-0.00384	-0.00276	-0.00132	-0.0195
	(0.00186)	(0.00700)	(0.00744)	(0.00319)	(0.0184)	(0.00786)	(0.00778)	(0.00206)	(0.0163)
Lpop	0.515***	7.388	9.586	9.560	-46.99	4.592	10.27	4.361**	-40.20
	(0.116)	(5.951)	(6.448)	(10.68)	(79.26)	(7.084)	(6.701)	(1.951)	(58.34)
Lgdpc	0.457*	0.463	3.114*	-0.0527	21.92**	0.819	3.541*	1.057***	17.95***
	(0.242)	(0.805)	(1.785)	(1.400)	(9.417)	(0.901)	(1.905)	(0.331)	(6.807)
Lue	0.108	0.521	0.611	0.111	1.590	0.606	0.619	0.652***	1.679
	(0.155)	(0.438)	(0.460)	(0.378)	(1.751)	(0.502)	(0.484)	(0.203)	(1.618)
Ltop	0.612***	0.956	2.664	2.175*	5.309	0.641	3.112*	0.281	8.622**
	(0.229)	(1.090)	(1.814)	(1.250)	(5.793)	(1.195)	(1.861)	(0.811)	(3.377)
Lrer	0.150**	-0.128	0.210	-0.569	-6.051	0.106	0.225	-0.397	-2.374
	(0.0686)	(0.978)	(1.221)	(0.880)	(9.690)	(1.057)	(1.242)	(0.378)	(5.005)

Linf	-0.0104	-0.0762	-0.0207	-0.0807***	-0.000376	-0.0744	-0.0333	-0.00729	0.00632
	(0.0729)	(0.0796)	(0.0994)	(0.0265)	(0.0807)	(0.0860)	(0.102)	(0.0382)	(0.0636)
Bcdummy	-0.255**	-0.0427	-0.00254	-0.0416	-0.338	-0.113	-0.0121	-0.0862	-0.0653
	(0.107)	(0.120)	(0.157)	(0.0564)	(0.575)	(0.143)	(0.166)	(0.0993)	(0.197)
Year Dummy			yes		yes		yes		Yes
Sargan test (*p*-value)	-	0.1819	0.0759	0.8405	-	0.2397	0.0319	0.1710	-
A-B test AR(1)	-	-	-	0.1229	0.1273	-	-	0.1584	0.1182
A-B test AR(2)	-	-	-	0.0111	0.6363	-	-	0.1195	0.8397
Observations	94	71	71	71	71	71	71	71	71
Donor Countries	17	17	17	17	17	17	17	17	17

Notes: Dependent variable is log of net ODA (LNDODA). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) Pooled OLS; (2) AB-GMM, Arellano and Bond (1991) GMM with all lags; (3) AB-GMM, AB considering all lags with year dummy; (4) AB-GMM(2S), AB-GMM 2SLS considering all lags; (5)AB-GMM(2S), AB-GMM 2SLS considering all lags with year dummy; (6) AB-GMM(1L), AB-GMM considering max. 1 lag; (7) AB-GMM (1L), AB-GMM considering max. 1 lag with year dummy; (8) AB-GMM(1L,2S), AB-GMM 2SLS considering max. 1 lag; (9) AB-GMM (1L,2S), AB-GMM 2SLS considering max. 1 lag with year dummy.

Thus, we estimate again our model using 2SLS considering maximum one lag (column 8) and maximum one lag with year dummy (column 9). The Sargan test is not rejected, so the null hypothesis implies the validity of our estimations and subsequently the A-B AR (2) test supports that there is no serial correlation. However, the results of the coefficients (column 8 and 9) are still not convincing and showing the less significant effect. The Sargan test in column 8 is not determined as we get statistically unexpected (1.000) result, thus we estimate our model considering Blundell and Bond (1998) system GMM estimator for our further investigation.

Table 4. Panel Estimation Results for OECD-EU Donor Countries (Blundell and Bond 1998 System GMM Approach)

Estimation method	(1) System GMM	(2) System GMM	(3) System GMM (2-3L)	(4) System GMM (2-3L)
L.LNDODA	0.585**	0.270	0.339	3.600**
	(0.270)	(2.064)	(0.227)	(1.727)
DPD	-0.00617	0.290*	-0.0151	0.209*
	(0.00807)	(0.172)	(0.0150)	(0.118)
DOG	-0.0538	-1.116	-0.0391	-0.518
	(0.0578)	(1.132)	(0.0298)	(0.468)
DGGFB	0.0225	-0.0866	0.0261	-0.162**
	(0.0328)	(0.128)	(0.0180)	(0.0788)
Lpop	-0.141	1.787	0.174	-1.235
	(1.224)	(4.198)	(0.373)	(1.818)
Lgdpc	2.372	30.34	2.762*	-0.114
	(2.502)	(29.41)	(1.464)	(4.251)
Lue	-0.560	-0.389	0.119	-3.418
	(1.405)	(1.717)	(0.752)	(4.967)
Ltop	-0.715	8.173	-0.518	6.782*
	(2.769)	(12.55)	(0.906)	(3.549)
Lrer	1.006	-12.51	1.730	-16.50*
	(0.730)	(12.95)	(1.162)	(9.124)
Linf	0.0678	-2.837	-0.0423	1.332
	(0.176)	(1.828)	(0.118)	(4.658)
Bcdummy	-0.854	-1.886	-0.689**	-5.276**
	(0.975)	(3.560)	(0.296)	(2.191)
Year Dummy		yes		yes
Sargan test (*p*-value)	0.046	0.121	0.115	0.942
A-B test AR(1)	0.016	0.214	0.012	0.280
A-B test AR(2)	0.406	0.913	0.715	0.712
Observations	94	94	94	94
Donor Countries	17	17	17	17

Notes: Dependent variable is log of net ODA (LNODA). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) System GMM, Blundell and Bond (1998) system GMM considering all lags; (2) System GMM, Blundell and Bond (1998) system GMM considering all lags with year dummy; (3) System GMM (2-3L), Blundell and Bond (1998) system GMM considering max 2-3 lags; (4) System GMM (2-3L), Blundell and Bond (1998) system GMM considering max. 2-3 lags with year dummy.

Table 4 shows the results of system GMM considering all lags, all lags with year dummy, 2-3 lags and 2-3 lags with year dummy in column 1, 2, 3 and 4 respectively. Except column 1, the Sargan test statistics supports the validity of our estimations. Since

the Sargan test does not reject the null hypothesis, the instruments we used are valid. The A-B AR (2) test also suggests accepting the null hypothesis, proposing there is no second order serial correlation of our estimations. The coefficients of the lagged dependent variable validate the importance of including these variables. However, the first 3 specifications (column 1-3) are showing quite similar effects. In column 1, we found a significant effect of the lag dependent variable (0.585), but all our explanatory variables e.g., DPD, DOG, Lpop, Lue, Ltop and Bcdummy indicate statistically insignificant results with an estimated elasticity of -0.006, -0.05, -0.14, -0.57, -0.71 and -0.85 percent respectively. Besides, the Sargan test reject the null hypothesis i.e., the instruments are not valid. Therefore, we carried out further estimation considering all lags with year dummy (column 2). Since our results are quite similar with column 1, we need to consider the further estimation. We therefore use 2SLS estimation considering 2-3 lags with year dummy. In column 4, the test statistics supports both validations of our instruments and there is no second order serial correlation of our model. The coefficient of the lag dependent variable shows the lager importance with an estimated elasticity of 3.60. The positive lagged value of the dependent variable suggests the existence of significant dynamic effects in on the financial crisis and ODA disbursements to the LDCs.

This result also explores that general government fiscal balance (DGGFB), real exchange rate (Lrer) and banking crisis dummy shows significant negative effect on ODA flows. Subsequently, output gap (DOG), and unemployment rate (Lue) also depict considerably negative effects although its not statistically significant.

In short, the finding of the OECD-DAC EU donor countries dynamic panel analysis (Eq. 3) revealed that global financial crisis affects ODA flows to the LDCs. This is also supported by our static panel data analysis (Eq. 1). Our estimation results indicate that OECD-DAC EU donors tended to provide less amounts of ODA to the LDCs in the period of financial turmoil.

4.2.2. Results of Least Development Countries

Table 5 is presented in a similar specification to Table 1; columns 1-9 show (1) PolS (2) AB-GMM estimator considering all lags, (3) AB-GMM estimator considering all lags with year dummy, (4) AB-GMM 2SLS estimator considering all lags, (5) AB-GMM 2SLS estimator considering all lags with year dummy, (6) AB-GMM estimator considering maximum one lag, (7) AB-GMM estimator considering maximum one lag with year dummy, (8) AB-GMM 2SLS estimator considering maximum one lags and (9) AB-GMM 2SLS estimator considering maximum one lag with year dummy respectively.

Columns 2 and 3, the Sargan test rejects the null hypothesis and does not support the validity of our instruments. Therefore, we estimate 2SLS considering all lags (column 4) and all lags with year dummy (column 4). Our results explain in columns 4-5, the test statistics support the validity of our estimations. Since, Sargan test does not reject the

null hypothesis i.e., instruments are statistically validate. The A-B AR (2) test also does not reject the null hypothesis in second order serial correlation, meaning that in second order our model is no serial correlation. The coefficients values are almost identical with other specifications and statistically insignificant. Thus, we estimate again our model using 2SLS considering maximum one lag (column 8) and maximum one lag with year dummy (column 9). The Sargan test is not rejected, so the null hypothesis implies the validity of our estimations and subsequently the A-B AR (2) test supports that there is no serial correlation. However, the results of the coefficients of the explanatory variables e.g., exchange rate (ExR), debt forgiveness reduction (DFoR), net bilateral financial flows (NFF_Bi), worker remittances (Wrr) and ODA (column 8 and 9) are still not convincing and showing the insignificant effect.

Furthermore, we employ Blundell and Bond (1998) system GMM estimator, presents in Table 6. The system GMM considering all lags repot in column 1 indicate that the lag of LDCs GDP per capita growth rate has a significant negative impact. The other explanatory variables e.g., NFF_Bi, NFF_Mu, ODA and Wrr also show negative impact but not statistically significant. The specification 1 satisfies A-B test, which implies that there is no evidence of second order serial correlation, but this estimation do not pass the Sargan specification test, which means that the instruments are correlated with the residuals. Next, we estimate our model considering year dummies. The results (column 2) show that ODA has significant negative effects on LDCs economic growth. The rest of explanatory variables also show relatively similar impact to column 1. This estimation satisfies both Sargan and A-B specification test, which means the instruments are valid and not correlated with residuals as well as the errors in the first difference estimation shows no AR(2) serial correlation.

To further check the relationship, specifications 3 and 4 exhibit system GMM considering maximum 2-3 lags and maximum 2-3 lags with year dummies respectively. Specification 3, all explanatory variables show insignificant but expected effects except lagged dependent variable, total external debt stocks (TEDS) and infant mortality (INF-Mor). Here, this estimation also satisfies the Sargan test but the A-B AR (1) test accept null hypothesis, which is not expected. Next we estimate considering year dummies, now the result (in column 4) supports both specification tests i.e., instruments are valid and there is no second order serial correlation. The coefficients of ODA and lagged dependent variable show the negative significant effects. The rest of explanatory variables portrait the remarkable effects as well and confirm the magnitude of including these variables, although these are not statistically significant.

In summary, the finding of the LDCs dynamic panel analysis (Eq. 4) explored that ODA flows shock impact negatively to the LDCs economic progress. This logic also supported by our static panel data analysis (Eq. 2). Our estimation results indicate that the LDCs economic growth is largely affected through various transmission channels e.g., ODA, net bilateral and multilateral financial flows, export growth rate, exchange rate, FDI inflows and worker remittances.

We therefore conclude that the dynamic system GMM panel estimation considering maximum 2-3 lags is an appropriate estimator and can be relied upon the statistical inference relating to our hypothesis of interest. Moreover, it shows the most resemblance coefficients of the considered explanatory variables as estimated in static panel model before.

Table 5. Dynamic Panel Estimation Results for LDCs
(Arellano and Bond 1991 Difference GMM Approach)

Estimation method	(1) POLS	(2) AB-GMM	(3) AB-GMM	(4) AB-GMM (2S)	(5) AB-GMM (2S)	(6) AB-GMM (1L)	(7) AB-GMM (1L)	(8) AB-GMM (1L,2S)	(9) AB-GMM (1L,2S)
L.RGPCG	0.0989***	-0.0663	-0.0597	-0.0426*	-0.0361**	-0.0423	-0.0380	-0.0803**	-0.0414
	(0.0336)	(0.0479)	(0.0465)	(0.0251)	(0.0163)	(0.0519)	(0.0501)	(0.0357)	(0.0268)
FDInf	0.0301	0.0552	0.0263	0.0819***	0.0629***	0.0519	0.0272	0.0570**	0.0362
	(0.0306)	(0.0541)	(0.0539)	(0.0202)	(0.0201)	(0.0549)	(0.0546)	(0.0245)	(0.0262)
ExG	-0.00457	-0.000354	-0.000814	0.000152	-0.000449	-0.00139	-0.00150	-0.00165	-0.00182
	(0.00516)	(0.00534)	(0.00519)	(0.000892)	(0.000966)	(0.00543)	(0.00526)	(0.00166)	(0.00166)
DFoR	3.87e-11	-1.81e-10	-1.89e-11	-2.40e-10**	-9.91e-11	-6.80e-11	1.32e-10	-1.22e-10	1.19e-10
	(2.89e-10)	(3.27e-10)	(3.54e-10)	(1.05e-10)	(1.11e-10)	(3.36e-10)	(3.63e-10)	(1.29e-10)	(1.73e-10)
TEDS	-1.21e-10**	1.22e-10	1.39e-10	8.88e-11	8.05e-11	8.79e-11	1.02e-10	2.53e-10*	1.35e-10
	(4.85e-11)	(1.69e-10)	(1.70e-10)	(9.17e-11)	(5.87e-11)	(1.86e-10)	(1.87e-10)	(1.42e-10)	(1.16e-10)
CI	0.558	0.554	0.246	0.822	0.919	0.150	-0.241	-0.112	1.054
	(0.360)	(1.674)	(1.615)	(0.771)	(0.893)	(1.709)	(1.654)	(1.317)	(1.239)
GINI	-0.0357***	0.0478	-0.0521	0.0832	-0.00449	0.122	0.00541	0.158**	-0.00530
	(0.0273)	(0.257)	(0.251)	(0.0887)	(0.0464)	(0.260)	(0.255)	(0.0693)	(0.0622)
Pop	1.50e-08	6.55e-08	1.10e-07	6.78e-08	6.70e-08	1.30e-07	1.42e-07	1.25e-07	1.67e-07
	(1.58e-08)	(2.57e-07)	(2.55e-07)	(8.30e-08)	(8.15e-08)	(2.67e-07)	(2.62e-07)	(1.71e-07)	(1.54e-07)
NFF_Bi	1.10e-09	-9.92e-10	-6.93e-10	-5.35e-10	-4.99e-10	-6.86e-10	-4.79e-10	-2.72e-10	7.41e-11
	(7.75e-10)	(1.19e-09)	(1.16e-09)	(5.96e-10)	(3.09e-10)	(1.21e-09)	(1.18e-09)	(7.42e-10)	(4.55e-10)
NFF_Mu	-9.41e-11	-2.56e-09	-1.79e-09	-2.25e-09***	-1.41e-09**	-2.27e-09	-1.43e-09	-2.21e-09***	-1.31e-09
	(1.12e-09)	(1.75e-09)	(1.72e-09)	(7.26e-10)	(5.92e-10)	(1.82e-09)	(1.78e-09)	(8.12e-10)	(1.07e-09)
MMR	-0.576	-1.163	-1.193	0.125	0.0579	-1.199	-1.305	-0.585	-1.263
	(0.472)	(1.157)	(1.126)	(0.667)	(0.812)	(1.175)	(1.146)	(1.097)	(1.165)
AND	0.197*	0.244	0.268*	0.0713	0.0760	0.265*	0.272*	0.294**	0.236*
	(0.100)	(0.157)	(0.155)	(0.0689)	(0.0660)	(0.160)	(0.157)	(0.149)	(0.126)
ODA	0.000601	-0.000581	-7.10e-05	-0.000431	-0.000235	-0.000300	0.000169	-0.000147	0.000459
	(0.000573)	(0.000892)	(0.000901)	(0.000368)	(0.000243)	(0.000960)	(0.000962)	(0.000471)	(0.000515)
XR	1.46e-05	-0.000160	-6.91e-05	6.21e-05	2.33e-05	-0.000263	-0.000195	-2.47e-05	-0.000121
	(5.99e-05)	(0.000538)	(0.000529)	(0.000182)	(0.000169)	(0.000546)	(0.000537)	(0.000236)	(0.000238)
Wrr	-1.34e-10	-5.96e-10	-5.51e-10	-3.75e-10	-2.33e-10	-5.03e-10	-4.80e-10	-1.02e-09	-6.30e-10
	(1.28e-10)	(7.15e-10)	(7.08e-10)	(4.50e-10)	(3.34e-10)	(7.60e-10)	(7.52e-10)	(7.53e-10)	(6.58e-10)

INF_Mor	-0.00418	0.0846	-0.122	0.0355	-0.0769	0.0738	-0.0694	0.0129	-0.0889
	(0.00842)	(0.0865)	(0.141)	(0.0420)	(0.0667)	(0.0897)	(0.143)	(0.0526)	(0.0888)
Fpr	0.575	2.429*	2.560**	1.626**	1.637**	2.374*	2.553**	2.240**	3.050***
	(0.470)	(1.275)	(1.247)	(0.738)	(0.782)	(1.295)	(1.265)	(1.063)	(1.075)
Year Dummy			yes		yes		yes		Yes
Sargan test (*p*-value)	-	0.000	0.052	0.2579	0.7007	0.0019	0.1729	0.0681	0.0059
A-B test AR(1)	-	-	-	0.0079	0.0108	-	-	0.0020	0.6364
A-B test AR(2)	-	-	-	0.7261	0.5920	-	-	0.9452	0.5052
Observations	318	265	265	265	265	265	265	265	265
Donor Countries	53	53	53	53	53	53	53	53	53

Notes: Dependent variable is GDP per capita growth rate (RGPCG). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) POLS, Pooled OLS; (2) AB-GMM, Arellano and Bond (1991) GMM with all lags; (3) AB-GMM, AB considering all lags with year dummy; (4) AB-GMM(2S), AB-GMM 2SLS considering all lags; (5) AB-GMM(2S), AB-GMM 2SLS considering all lags with year dummy; (6) AB-GMM(1L), AB-GMM considering max. 1 lag; (7) AB-GMM (1L), AB-GMM considering max. 1 lag with year dummy; (8) AB-GMM(1L,2S), AB-GMM 2SLS considering max. 1 lag; (9) AB-GMM (1L,2S), AB-GMM 2SLS considering max. 1 lag with year dummy.

Table 6. Dynamic Panel Estimation Results for LDCs
(Blundell and Bond 1998 System GMM Approach)

Estimation method	(1) System GMM	(2) System GMM	(3) System GMM (2-3L)	(4) System GMM (2-3L)
L.RGPCG	-0.292***	-0.190***	-0.332**	-0.257**
	(0.0751)	(0.0495)	(0.139)	(0.109)
FDInf	0.681*	-0.214	1.213	-0.126
	(0.384)	(0.220)	(0.766)	(0.490)
ExG	-0.0303***	-0.0100	-0.0409	-0.00541
	(0.0114)	(0.0125)	(0.0267)	(0.0191)
DFoR	-3.00e-10	-4.42e-10	-1.43e-10	-7.97e-10
	(3.23e-10)	(3.84e-10)	(8.17e-10)	(6.73e-10)
TEDS	1.55e-09***	9.65e-10***	1.86e-09*	1.47e-09**
	(4.45e-10)	(3.26e-10)	(1.05e-09)	(7.32e-10)
CI	11.87*	17.42***	10.94	13.39
	(6.219)	(6.368)	(13.69)	(8.561)
GINI	0.804	0.245	0.547	-0.421
	(0.703)	(0.836)	(1.473)	(1.243)

Pop	-2.97e-07**	8.11e-09	-4.47e-07	-1.05e-07
	(1.43e-07)	(1.52e-07)	(4.44e-07)	(2.95e-07)
NFF_Bi	-1.55e-09	-2.75e-09	-3.24e-09	-6.24e-09
	(2.11e-09)	(1.72e-09)	(4.86e-09)	(3.98e-09)
NFF_Mu	-1.16e-09	-8.39e-10	-7.65e-09	-6.17e-09
	(2.64e-09)	(1.65e-09)	(1.38e-08)	(8.65e-09)
MMR	12.35	-6.900	26.89	-4.427
	(7.772)	(6.225)	(22.82)	(11.63)
AND	0.549**	0.329	0.210	-0.0330
	(0.251)	(0.261)	(0.766)	(0.542)
ODA	-0.00185	-0.00275**	-0.00269	-0.00479*
	(0.00152)	(0.00109)	(0.00343)	(0.00271)
XR	-0.00183	-0.00203*	0.000461	-0.00138
	(0.00136)	(0.00117)	(0.00371)	(0.00246)
Wrr	8.21e-10	-1.19e-09	2.02e-09	-4.49e-10
	(9.58e-10)	(7.42e-10)	(2.71e-09)	(1.56e-09)
INF_Mor	0.217**	0.202**	0.454*	0.324*
	(0.0912)	(0.0899)	(0.253)	(0.196)
Fpr	-3.178	0.641	-6.390	6.365
	(4.690)	(5.833)	(10.80)	(8.454)
Year Dummy		yes		yes
Sargan test (*p*-value)	0.015	0.285	0.815	0.435
A-B test AR(1)	0.020	0.017	0.079	0.022
A-B test AR(2)	0.741	0.356	0.438	0.778
Observations	318	318	318	318
No. of LDCs	53	53	53	53

Notes: Dependent variable is GDP per capita growth rate (RGPCG). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) System GMM, Blundell and Bond (1998) system GMM considering all lags; (2) System GMM, Blundell and Bond (1998) system GMM considering all lags with year dummy; (3) System GMM (2-3L), Blundell and Bond (1998) system GMM considering max 2-3 lags; (4) System GMM (2-3L), Blundell and Bond (1998) system GMM considering max. 2-3 lags with year dummy.

4.3. Robustness Checks

We examine the robustness and the sensitivity of our results using three alternative estimation strategies. For robustness check firstly, we estimate our model employing Maximum Likelihood Estimation (MLE),[20] secondly, Mixed Effects-Maximum Likelihood

[20] Maximum Likelihood Estimation is a method of choosing an asymptotically efficient estimator for the set of parameters, because it can easily illustrate in the setting of a discrete distribution (Green and Zhang, 2003).

Estimation (ME-ML)[21] and finally, Generalized Estimating Equations (GEE)[22] for both static and dynamic models. All robustness checks using different estimation techniques supports our original estimation results.

Table 7 reports a set of robustness checks for OECD-DAC EU donor countries' models (Eq. 1 and Eq. 3). The first robustness check (column 1) presents the MLE results considering the same explanatory variables, which we used in our main specifications. Columns 2 and 4 contain second and third robustness checks using ME-ML estimation and GEE techniques also considering the same explanatory variables respectively. All specifications under static panel coefficients support with our original specifications presented in Table 1. The coefficients of the explanatory variables (columns 1, 2 and 4) are showing the similar and significant effects on ODA disbursements to the LDCs. We also estimate dynamic panel of OECD-DAC EU donors' (Eq. 3) using ME-ML (column 3) and GEE (column 5). The coefficients are showing similar effect as we obtained using dynamic panel specification in Table 3 and 4. In particular, the lagged dependent variable remains positive and significant effect as the specifications in Table 4. The other explanatory variables' coefficients also have similar significant effects with a bit variation. Therefore, we conclude that the qualitative specifications are robust to alternative estimation techniques.

We carried out a set of robustness checks for LDCs (Eq. 2 and 4) as well. Table 8 presents similar robustness checks specification as we used in Table 7. Columns 1-5 shows MLE, ME-LE, ME-LE with lagged dependent variable, GEE and GEE with lagged dependent variable respectively. All specifications with regard to static panel in Table 8 consider the same explanatory variables as we have used in our original specifications for LDCs in Eq. 2 and 4. Columns 1, 2 and 4 portrait very similar results to those present in Table 2 in terms of significance and effect. Export growth rate (ExG), net bilateral financial flows (NFF_Bi), net multilateral financial flows (NFF_Mu), ODA, worker remittances (Wrr) and exchange rate (XR) shows the similar significant negative effects to the estimates before. Specifications 3 and 5 present the dynamic panel estimation employing ME-ML and GEE-FD respectively. Both specifications use the

[21] The Linear Mixed models are described as containing both fixed effects and random effects. As the fixed effects estimation is similar to the standard regression coefficients and is estimated directly, whereas the random effects estimation is not directly estimated but is summarized according to their estimated variances and covariances (Stata, 2011). Therefore, the Mixed effects model refers to the effect of the size parameters as if it was a random sample from a population of effect parameters and estimates the hyper-parameters (generally the mean and variance) treating this population of effect parameters (see Schmidt and Hunter, 1977; DerSimonian and Laird, 1986; Hedges and Vevea, 1998; Konstantopoulos, 2006).

[22] The Generalised Estimating Equations (GEE) suggested by Liang and Zeger (1986), to extend the generalized linear model to allow for correlated observations. The GEE characterized the marginal expectation (average response for observations sharing the same covariates) as a function of covariates (Horton, 2001).

same lagged dependent variable and other explanatory variables as we used in Eq. 4. The results show that most of the explanatory variables are similar effect as in Table 5 and 6, in particular, ExG, NFF_Bi, NFF_Mu, Wrr and XR shows the similar negative effects. Furthermore, the coefficient of ODA and FDInf show a little variation in terms of effect to the estimates before.

To sum up, we carried out numerous sensitivity checks using alternative estimation techniques, such as MLE, ME-ML and GEE. Almost all of our specifications support the robustness of our estimates before. We therefore conclude that our qualitative specifications are robust with regards to the alternative estimation techniques.

Table 7. Robustness Checks of Estimation Results for OECD-EU Donor Countries

Estimation method	(1) MLE	(2) ME-ML	(3) ME-ML	(4) GEE	(5) GEE-LD
L.LNDODA	-	-	0.651***	-	0.800***
	-	-	(0.0633)	-	(0.0443)
DPD	-0.0108**	-0.00704*	-0.00290	-0.0109**	-0.00206
	(0.00518)	(0.00385)	(0.00264)	(0.00511)	(0.00185)
DOG	-0.0366**	-0.0427*	-0.00158	-0.0364**	-0.000151
	(0.0176)	(0.0242)	(0.0167)	(0.0174)	(0.0161)
DGGFB	-0.00540	-0.00696***	-0.00199	-0.00539	-0.00112
	(0.00371)	(0.00254)	(0.00173)	(0.00370)	(0.00113)
Lpop	1.322***	1.426***	0.515***	1.320***	0.310***
	(0.169)	(0.0921)	(0.109)	(0.169)	(0.0746)
Lgdpc	0.909**	0.584*	0.457**	0.914**	0.316**
	(0.373)	(0.323)	(0.226)	(0.368)	(0.159)
Lue	0.182	-0.259	0.108	0.188	0.0719
	(0.246)	(0.212)	(0.145)	(0.238)	(0.100)
Ltop	1.331***	1.671***	0.612***	1.321***	0.381***
	(0.474)	(0.282)	(0.214)	(0.467)	(0.140)
Lrer	0.383**	0.423***	0.150**	0.381**	0.0873**
	(0.173)	(0.0865)	(0.0641)	(0.173)	(0.0422)
Linf	-0.0396	-0.0171	-0.0104	-0.0394	0.0364
	(0.0596)	(0.0899)	(0.0681)	(0.0590)	(0.0649)
Bcdummy	-0.0879	-0.171	-0.255**	-0.0879	-0.264**
	(0.104)	(0.157)	(0.100)	(0.103)	(0.104)
Observations	111	111	94	111	94
Donor Countries	17	17	17	17	17

Notes: Dependent variable is log of net ODA (LNODA). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) MLE, Maximum Likelihood Estimation for static model; (2) ME-ML, Mixed Effects-Maximum Likelihood Estimation for static model; (3) ME-ML, Mixed Effects-Maximum Likelihood Estimation for dynamic model; (4) GEE, Generalized Estimating Equations for static model; (5) GEE-FD, Generalized Estimating Equations for dynamic model.

Table 8. Rubustness Checks of Estimation Results for LDCs

Estimation method	(1) MLE	(2) ME-ML	(3) ME-ML	(4) GEE	(5) GEE-LD
L.RGPCG	-	-	0.0989***	-	-0.0126
	-	-	(0.0326)	-	(0.0300)
FDInf	0.0440	0.0338	0.0301	0.0440	0.0315
	(0.0429)	(0.0490)	(0.0298)	(0.0429)	(0.0326)
ExG	-0.00705	-0.00486	-0.00457	-0.00705	-0.00701
	(0.00542)	(0.00826)	(0.00502)	(0.00542)	(0.00449)
DFoR	-4.33e-10	8.72e-11	3.87e-11	-4.33e-10	-7.97e-11
	(3.16e-10)	(4.74e-10)	(2.81e-10)	(3.16e-10)	(2.50e-10)
TEDS	8.02e-10***	1.74e-10**	-1.21e-10**	8.02e-10***	-6.32e-11
	(9.08e-11)	(7.46e-11)	(4.71e-11)	(8.95e-11)	(6.32e-11)
CI	1.985**	1.243**	0.558	1.985**	0.610
	(0.996)	(0.557)	(0.349)	(0.996)	(0.510)
GINI	0.0181	-0.0604	-0.0937***	0.0181	-0.100**
	(0.113)	(0.0415)	(0.0265)	(0.112)	(0.0421)
Pop	7.74e-08*	3.73e-08	1.50e-08	7.74e-08*	9.11e-09
	(4.02e-08)	(2.35e-08)	(1.53e-08)	(4.01e-08)	(2.04e-08)
NFF_Bi	-2.14e-09**	-3.27e-09***	1.10e-09	-2.14e-09**	-5.44e-11
	(9.30e-10)	(1.23e-09)	(7.53e-10)	(9.27e-10)	(7.22e-10)
NFF_Mu	-2.71e-09**	-6.18e-09***	-9.41e-11	-2.71e-09**	-1.41e-09
	(1.34e-09)	(1.68e-09)	(1.09e-09)	(1.34e-09)	(1.13e-09)
MMR	-1.297	-1.566**	-0.576	-1.297	-0.543
	(0.799)	(0.720)	(0.458)	(0.799)	(0.558)
AND	0.286**	0.415***	0.197**	0.286**	0.248**
	(0.128)	(0.156)	(0.0976)	(0.127)	(0.102)
ODA	-0.00344***	-0.00145	0.000601	-0.00344***	1.56e-05
	(0.000724)	(0.000886)	(0.000556)	(0.000724)	(0.000562)
XR	-0.000169	5.37e-05	1.46e-05	-0.000169	5.52e-06
	(0.000222)	(9.32e-05)	(5.82e-05)	(0.000222)	(9.03e-05)
Wrr	-3.00e-09***	-5.96e-10***	-1.34e-10	-3.00e-09***	-6.58e-11
	(2.58e-10)	(1.98e-10)	(1.25e-10)	(2.49e-10)	(1.78e-10)
INF_Mor	0.00701	0.0113	-0.00418	0.00701	0.00380
	(0.0334)	(0.0129)	(0.00817)	(0.0333)	(0.0128)
Fpr	1.560*	2.573***	0.575	1.560*	0.835
	(0.899)	(0.726)	(0.456)	(0.897)	(0.576)
Observations	371	371	318	371	318
No. of LDCs	53	53	53	53	53

Notes: Dependent variable is GDP per capita growth rate (RGPCG). Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. (1) MLE, Maximum Likelihood Estimation for static model; (2) ME-ML, Mixed Effects-Maximum Likelihood Estimation for static model; (3) ME-ML, Mixed Effects-Maximum Likelihood Estimation for dynamic model; (4) GEE, Generalized Estimating Equations for static model, (5) GEE-FD, Generalized Estimating Equations for dynamic model.

5. CONCLUSION

This research examined the effects of global financial crisis on OECD-DAC EU donor countries ODA disbursements to the LDCs and how it affects to the LDCs' economic development. We employed two econometric techniques to answer these questions empirically. Firstly, static panel estimation using POLS, FE, RE, FE-AR(1), RE-AR(1), 2SLS-FE, 2SLS-RE and EC2SLS-RE techniques, secondly, dynamic panel GMM estimation using both difference and system estimators. Our studies especially designed to deal with the key problems of past literatures considering financial crisis-aid flows and its effect on aid recipient countries economic prospects. The static and dynamic panel GMM results shows very similar story from the complementary points of view of the donor countries and of the recipient countries. As a robustness checks, we also used three alternative estimation techniques: maximum likelihood estimation (MLE), mixed effects-maximum likelihood (ME-ML) and generalized estimating equations (GEE). All robustness checks using these estimation techniques supports our original estimation results.

We find support for our hypotheses that global financial crisis in OECD-EU donor countries declines their ODA effort to the LDCs. Consequently it adversely affects through the various transmission channels (e.g., ODA disbursements, remittances, bilateral financial flows, export growth) to the LDCs economic development. Our findings are robust with the view that the present financial crisis and fiscal instability in the OECD-EU donor countries are causes for the significant downside of ODA flows to the LDCs. Our results also explore that due to countercyclical role of ODA flows from the donors' largely affect to the LDCs economic development process. Because the recent trends of many OECD-EU donor countries reduce ODA flows and concentrate ODA on their countries of interest. Thus, it is obvious that the LDCs are severely vulnerable through the recent global financial turmoil, which is gradually reduces their ODA, worker remittances, bilateral and multilateral financial flows and export growth. Particularly, as ODA is mostly connected with the development activities through some important sectors (e.g., infrastructure, health, education, etc.) of the LDCs', thus a sudden cut of ODA disbursements is aggravate the problems already imposed by the crisis and further hinder the development process i.e., achieving the MDGs of these poor economies as a whole. However, due to data limitation of some LDCs, we do not conduct a comprehensive evaluation of different sectors effects. Further work would be substantially broaden and deepen in this context.

APPENDIX

Table A1. List of Developing Countries and Sample Periods

Country	Years	Country	Years
Afghanistan	2004-2010	Malawi	2004-2010
Angola	2004-2010	Mali	2004-2010
Bangladesh	2004-2010	Mauritania	2004-2010
Benin	2004-2010	Mozambique	2004-2010
Bhutan	2004-2010	Nepal	2004-2010
Burkina Faso	2004-2010	Niger	2004-2010
Brandi	2004-2010	Nigeria	2004-2010
Cambodia	2004-2010	Pakistan	2004-2010
Central African Rep.	2004-2010	Papua New Guinea	2004-2010
Chad	2004-2010	Rwanda	2004-2010
Comoros	2004-2010	Samoa	2004-2010
Congo, Dem.	2004-2010	Sao Tome & Principe	2004-2010
Cote d'Ivoire	2004-2010	Senegal	2004-2010
Djibouti	2004-2010	Sierra Leone	2004-2010
Eritrea	2004-2010	Solomon Islands	2004-2010
Ethiopia	2004-2010	Somalia	2004-2010
Gambia	2004-2010	Sudan	2004-2010
Ghana	2004-2010	Tajikistan	2004-2010
Guinea	2004-2010	Tanzania	2004-2010
Guinea-Bissau	2004-2010	Togo	2004-2010
Haiti	2004-2010	Uganda	2004-2010
Kenya	2004-2010	Uzbekistan	2004-2010
Kyrgyz Republic	2004-2010	Vanuatu	2004-2010
Laos	2004-2010	Vietnam	2004-2010
Lesotho	2004-2010	Yemen	2004-2010
Liberia	2004-2010	Zambia	2004-2010
Madagascar	2004-2010		

Table A2. List of OECD Donor Countries and Sample Periods

Country	Years	Country	Years
Austria	2004-2010	Luxembourg	2004-2010
Belgium	2004-2010	Netherlands	2004-2010
Denmark	2004-2010	Norway	2004-2010
Finland	2004-2010	Portugal	2004-2010
France	2004-2010	Spain	2004-2010
Germany	2004-2010	Sweden	2004-2010
Greece	2004-2010	Switzerland	2004-2010

Ireland	2004-2010	United Kingdom	2004-2010
Italy	2004-2010		

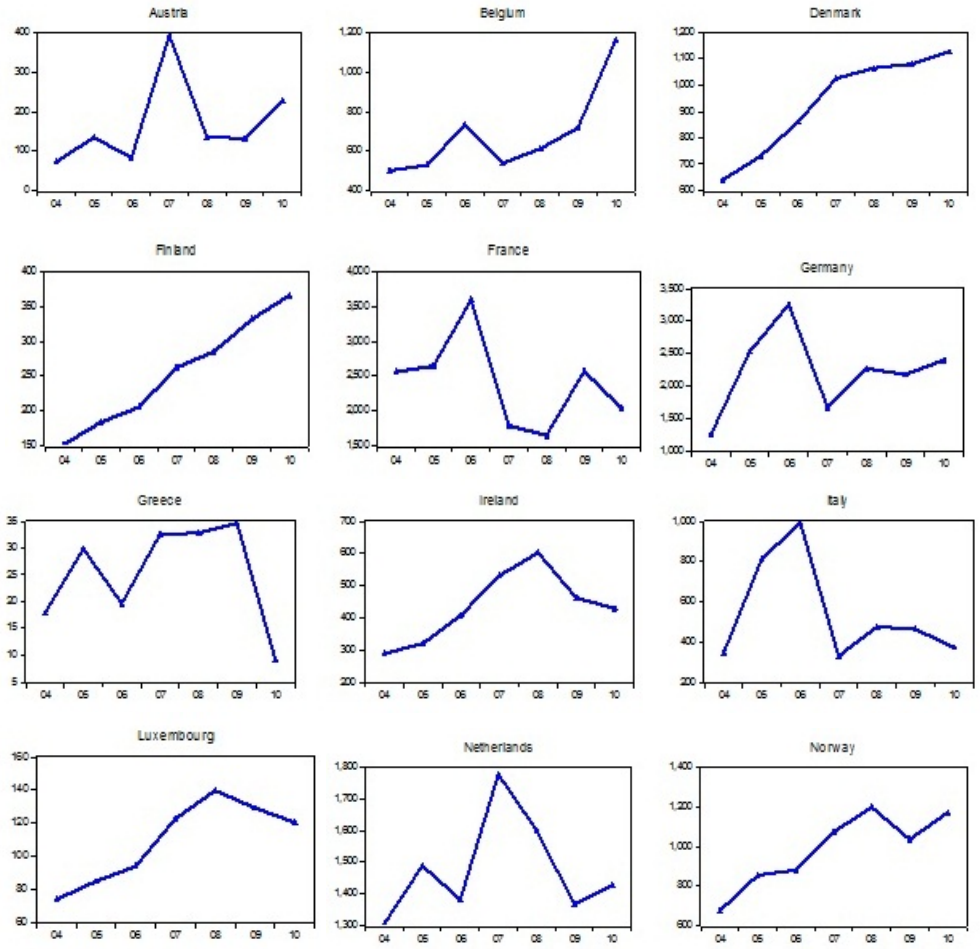
Table A3. Description of the Variables and Sources

Variables	Short Name	Descriptions	Sources
Financial Crisis Variables:			
Aid Recipient Countries GDP per Capita Growth (annual %)	RGPCG	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population.	World Bank National Accounts Data, and OECD National Accounts data files
Donor Countries Public Debt (% of GDP)	DPD	Gross public debt to GDP ratio. Government Net lending (+)/Net borrowing (-) under the EDP (Excessive Deficit Procedure).	Eurostat Database
Donor Countries Output Gap (% of GDP)	DOG	The difference between the maximum output achievable and the actual level of output.	OECD Economic Outlook No. 90
Donor Countries General Government Fiscal Balance	DGGFB	Donor countries general government fiscal balance.	Eurostat Database
Donor Countries Banking Crisis	BC	Banking crisis considered as a dummy variable that takes the value of 1 during the years of banking crises and 0 otherwise.	Luc Laeven and Fabian Valencia (June 2010) Database
Trade Openness (% of GDP)	TOP	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	World Bank National Accounts Data, and OECD National Accounts Data Files
Export Growth Rate	ExG	Annual export growth rate.	World Bank Development Indicators Database
Development Assistance Variables:			
Net Official Development Assistance Disbursed by Each Donor	NDODA	Net official development assistance is disbursement flows (net of repayment of principal) that meet the DAC definition of ODA and are made to countries and territories on the DAC list of aid recipients. Data are in current U.S. dollars.	Development Assistance Committee (DAC) Database, OECD
Debt Forgiveness or Reduction (current US$)	DFoR	Debt forgiveness or reduction shows the change in debt stock due to debt forgiveness or reduction. It is derived by subtracting debt forgiven and debt stock reduction from debt buyback. Data are in current U.S. dollars.	Development Assistance Committee (DAC) Database, OECD

Net Financial Flows, Bilateral (NFL, current US$)	NFFBi	Bilateral debt includes loans from governments and their agencies (including central banks), loans from autonomous bodies, and direct loans from official export credit agencies. Net flows (or net lending or net disbursements) received by the borrower during the year are disbursements minus principal repayments. Data are in current U.S. dollars.	World Bank, Global Development Finance
Net Financial Flows, Multilateral (NFL, current US$)	NFFMu	Public and publicly guaranteed multilateral loans include loans and credits from the World Bank, regional development banks, and other multilateral and intergovernmental agencies. Excluded are loans from funds administered by an international organization on behalf of a single donor government; these are classified as loans from governments. Net flows (or net lending or net disbursements) received by the borrower during the year are disbursements minus principal repayments. Data are in current U.S. dollars.	World Bank, Global Development Finance
Total External Debt Stocks, (DOD, current US$)	TEDS	Total external debt is debt owed to nonresidents repayable in foreign currency, goods, or services. It is the sum of public, publicly guaranteed, and private nonguaranteed long-term debt, short-term debt, and use of IMF credit. Data are in current U.S. dollars.	World Bank, Global Development Finance Database
Other Variables:			
Foreign Direct Investment, Net Inflows (% of GDP) Aid Recipient Countries	FDInf	Foreign direct investment is the net inflows of investment to acquire a lasting management interest in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.	International Monetary Fund, International Financial Statistics and Balance of Payments Databases, World Bank, Global Development Finance, and World Bank and OECD GDP Estimates
Workers' Remittances,	Wrr	Workers' remittances are current transfers by migrants who are employed or intend to	International Monetary Fund,

Receipts (BoP, current US$)		remain employed for more than a year in another economy in which they are considered residents.	Balance of Payments Statistics Yearbook and Data Files
Total Population	Pop	Total population is based on the de facto definition of population.	World Bank Development Indicators Database
Unemployment, Total (% of total labor force)	UnE	Unemployment refers to the share of the labor force that is without work but available for and seeking employment.	International Labour Organization, Key Indicators of the Labour Market Database
Inflation, Consumer Prices (annual %)	INF	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.	International Monetary Fund, International Financial Statistics and Data Files.
Real Exchange Rate	RER	Real effective exchange rates based on consumer price indices (Year 2005=100). An increase denotes depreciation.	OECD Economic Outlook No. 90
Exchange Rate	XR	Local currency exchange rate with Dollar (US$).	International Monetary Fund, International Financial Statistics and Data files
Inequality (GINI Index)	GINI	GINI index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. Thus a GINI index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	WIDER database and World Bank, Development Research Group Database
Financial Sector Rating (1-6)	FSR	CPIA financial sector rating (1=low to 6=high).	World Bank Group, CPIA Database (http://www.worldbank.org/ida)
Corruption Index (1-6)	CI	CPIA transparency, accountability, and corruption in the public sector rating (1=low to 6=high).	World Bank Group, CPIA Database (http://www.worldbank.org/ida)
Macroeconomic Management Rating (1-6)	MMR	CPIA macroeconomic management rating (1 =low to 6=high). Macroeconomic management assesses the monetary, exchange rate, and aggregate demand policy framework.	World Bank Group, CPIA Database (http://www.worldbank.org/ida).

Aid Recipient Countries People Affected by Disasters	AND	Affected by natural disaster i.e., complex disasters, drought, earthquake, epidemic, flood, storm, volcano etc.	Emergency Events Database (http://www.emdat.be/database)
Mortality Rate, Infant (per 1,000 live births)	InMF	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.	World Bank Development Indicators Database
Fiscal Policy Rating	fpr	Fiscal policy assesses the short- and medium-term sustainability of fiscal policy (taking into account monetary and exchange rate policy and the sustainability of the public debt) and its impact on growth.	World Bank Group, CPIA Database (http://www.worldbank.org/ida).



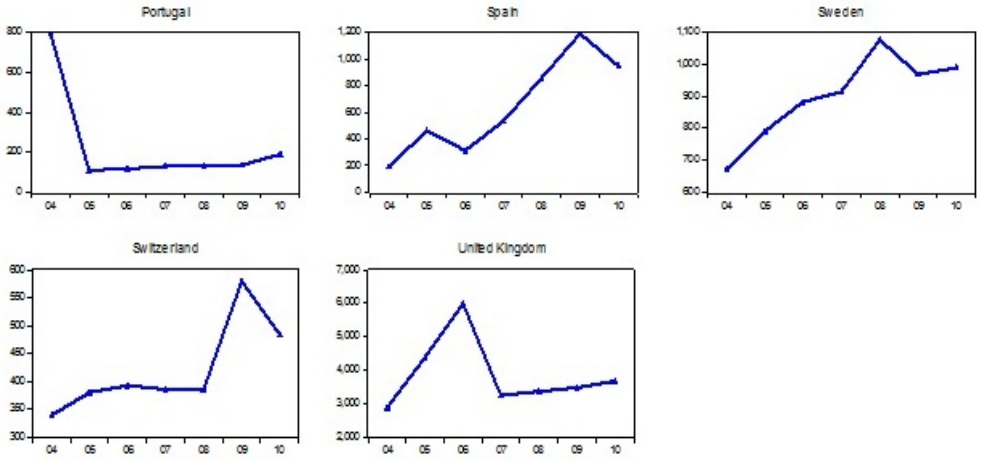


Figure A1. OECD-EU Donor Countries Net Foreign Development Assistance Disbursements to LDCs

Table A4. OECD-EU Donor Countries Summary Statistics

Variable	Variable description	Obs.	Mean	Std. Dev.	Min	Max
LNDODA	Log of net ODA	119	6.23	1.29	2.21	8.70
DPD	Public debt (% of GDP)	119	51.18	29.96	0.82	147.84
DOG	Output gap (% of GDP)	119	-0.24	3.01	-8.90	6.70
DGGFB	General government fiscal balance	119	17.54	58.01	-165.90	115.50
Lpop	Log of total population	119	9.40	1.28	6.14	11.32
Lgdpc	Log of GDP per capita	119	10.66	0.38	9.78	11.68
Lue	Log of unemployment rate	119	1.84	0.40	0.92	3.00
Ltop	Log of trade openness	119	4.50	0.46	3.87	5.77
Lrer	Log of Real exchange rate (with $)	119	0.10	0.82	-0.69	2.04
Linf	Log of inflation	111	0.60	0.68	-2.30	1.55
bcdummy	Banking crisis dummy	119	0.17	0.38	0	1

Table A5. LDCs Summary Statistics

Variable	Variable Description	Obs.	Mean	Std. Dev.	Min	Max
RGPCG	GDP per capita growth (annual %)	371	3.093	6.282	-14.421	101.134
FDInf	Net Foreign Direct Investment (FDI) Inflows (% of GDP)	371	4.570	6.339	-4.578	46.829
ExG	Export Growth (% of GDP)	371	3.95	37.71	-632	193.26
DFoR	Debt Forgiveness or Reduction (current US$)	371	-230000000	948000000	-10900000000	0
TEDS	Total External Debt Stocks, (DOD, current US$)	371	5010000000	7.97E+09	5.632085	56800000000
CI	Corruption index (1=low to 6=high)	371	2.78	0.63	1.5	4.5
GINI	Inequality (GINI Index)	371	41.92	7.79	27.5	64.3
Pop	Total population	371	23700000	36300000	150311	174000000
NFF_Bi	Net Financial Flows, Bilateral (NFL, current US$)	371	25200000	365000000	-4340000000	3370000000
NFF_Mu	Net Financial Flows, Multilateral (NFL, current US$)	371	128000000	270000000	-563000000	2220000000
MMR	Macroeconomic Management Rating (1=low to 6=high)	371	3.72	0.67	2	5.5
AND	Aid Recipient Countries People Affected by Disasters	371	2.52	2.48	0	14
ODA	Net Total ODA Flows from the OECD-EU Donor and EU Institutions (current US$)	371	376.51	621.02	-48.17	8534.94
XR	Exchange Rate	371	1644.14	3740.52	0.90	18612.92
WRR	Workers' Remittances, Receipts (BoP, current US$)	371	884000000	2.69E+09	0	19700000000
INF_Mor	Mortality Rate, Infant (per 1,000 live births)	371	69.73	25.57	12	130
FPR	Fiscal Policy Rating (1=low to 6=high)	371	3.40	0.68	1.5	4.5

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