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Aid and Trade—A Donor's Perspective

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Abstract

Foreign aid is given for a combination of economic, political, and humanitarian motives. While its impact on economic development in recipient countries has been the main focus of research recently, we concentrate on the question to what extent it also promotes donor countries' exports. We examine this issue using Germany as a case study where the positive impact of aid on exports has been found to be extremely high. Using more advanced methods, we compute an average return (between EUR 1.49 to EUR 1.72) of one EUR of aid spent, well below previous findings, but still surprisingly large and robust.

Keywords: bilateral aid, donors' exports, time series properties of panel data, ECM and DOLS estimation in a panel context

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Aid and Trade—A Donor's Perspective

1. Introduction

The primary objective of German bilateral foreign aid[5] is to contribute to efforts to overcome worldwide poverty, underdevelopment, and distress. Nonetheless, German development agencies and the German taxpayer are also interested in learning about the impact of aid on Germany's economy. The investigation of this issue is even more important as the German government is not only willing, but even obliged under an EU agreement to noticeably increase its official development aid in the years to come. The EU agreement aims to fulfill the UN goal of 0.7 per cent in the year 2015 (rich countries should spend at least 0.7 per cent of their GNP on official development aid [ODA]). This would imply for Germany that 0.5 per cent of German GNP should be spent on development aid in 2010. Currently, the German government spends 0.35 per cent of its GNP on ODA (9 billion US$) implying that German ODA will have to increase substantially over the next eight years.

In 1999, a study investigated the impact of German bilateral aid on German exports. Amazingly, they found, based on 1976-to-1995 data, that one Deutschmark spent on bilateral ODA would increase export revenues by 4.3 marks; this effect was quite unrelated to the practice of tying aid to exports and was, in any case, much larger than the aid flow, itself Since this figure appears remarkably high, this paper re-examines these findings for Germany based on 1962-to-2005 data to get a clearer understanding of the impact of Germany's bilateral aid on German export revenues. This study uses a more complex model and more modern estimation techniques compared to most other studies in this literature, including the previous estimation. It differs from earlier 'aid and trade' studies in two respects: First, compared to the 1999 study, it utilises a set of control variables that are indispensable for

[5] In the following we will call it just *aid*.

obtaining plausible and reliable results. Second, it takes the time-series properties of the analysed data into account, thus avoiding the problem of spurious correlations in non-stationary data[6].

The organisation of the paper is as follows: In Chapter 2 an overview of the aid and trade literature will be given. Chapter 3 contains the econometric model and the estimation techniques. In Chapter 4 the empirical results are presented and Chapter 5 concludes.

2. Overview of Related Literature

In recent decades, a great research effort has been devoted to investigating the effects of developmental assistance on the economic performance of the recipient countries (for example, Burnside and Dollar, 2000) and to clarify the recent debate on 'aid for trade' (Morrisey, 2006). Very little attention has been devoted to the reverse issue of quantifying the impact of aid on donors' export revenues. While this is not (and should not be) the main motivation for giving aid, it would nevertheless be worthwhile to examine this. A finding that aid flows promote exports would suggest that giving aid (if it also promotes development in the recipient country) can be a 'win-win' situation for both parties and might also reduce taxpayer reluctance to devote resources to aid.

The Arvin and Baum (1997) and Arvin and Choudry (1997) studies evaluated the relationship between bilateral aid and bilateral exports with and without tying of the aid to donors' contracts of sale. They showed that aid without tying was roughly as export-promoting as tied aid. They explained this phenomenon by the effects of the recipient countries' good will and/or parallel trade agreements and trade concessions. On these grounds, a formal tying of aid is no longer recommendable (Jepma, 1991; Arvin and Baum, 1997; Arvin and Choudry, 1997). Benefits for donors through tying are usually insubstantial, whereas tying noticeably reduces the benefit of aid for recipients (Jepma, 1991; Wagner, 2003). Consequently, tying

[6] Driven by pure correlations over time.

has been stepwise reduced, partly due to pressure from the Development Assistance Committee [DAC].

The relationship between aid and exports was examined in various country studies which neglect, however, the possible occurrence of spurious regressions.[7] Therefore, a word of caution is needed regarding the results, since the figures have been derived from trending series. Non-stationarity of the series and/or autocorrelation of the disturbances have not been (sufficiently) taken into account even though some studies' authors tried to reduce spuriousness in the regressions by averaging over time and plugging in a time trend, or by utilising data in five-year intervals.

Vogler et al. (1999) found that one mark spent on ODA would increase exports by 4.3 marks, using data for the period 1976 to 1995 for Germany's aid and trade relationship. The authors included 43 recipient countries in the study but the average impact of aid on trade was calculated for only 23 of those countries. A study done by Nilsson (1997) on the aid and trade relationship of EU countries and developing countries showed that one US dollar's worth of aid increased exports by $2.60 (the average for EU countries) and by $3.20 (figure for Germany). The period of study ran from 1975 to 1992. The author utilised a common intercept for all the EU countries, three-year averages, and a time trend. Studying the aid and trade relationship between OECD donors (especially Japan) and recipient countries, Wagner (2003) computed the impact of one US dollar of aid to be approximately $2.30, utilising pooled data for the years 1970, 1975, 1980, 1985, and 1990 to minimise distortions from autocorrelation.[8]

A totally different approach was followed by Lloyd, McGillivray, Morissey, and Osei (2000), Arvin, Cater, and Choudry (2000), and Osei, Morissey, and Lloyd (2004). The authors tested

[7] Spurious regression results occur when either autocorrelation of the disturbances is not taken into account or regressions with non-stationary series are run. Autocorrelation and non-stationarity of the series are interlinked, as they result from memory of the series.

[8] This procedure may reduce autocorrelation, but is unable to eliminate it. In the presence of autocorrelation, the residuals in 1990 will still be correlated with the residuals of 1985 and earlier years.

Granger causality and cointegration[9], getting mixed results for the aid and trade relationship. For some country pairs the authors could not find an aid-trade link, for other country pairs the aid-trade link existed, and for still others, they could identify a bi-directional relationship. This bi-directional relationship eventually led us to control for possible endogeneity of the aid variable.

Finally, a few of the studies which focused on quantifying the impact of the donors' aid on trade utilised the gravity model of trade (Nilsson 1997; Wagner, 2003). We also believe that the gravity model is well suited to study the impact of aid on trade since it allows controlling for the impact of regular factors on trade such as income (production capacity and income variety effect), population (absorption and economies of scale effect), and distance in a world where trade agreements, exchange rates, and aid can also influence trade.

We deviate from most of those studies by exploiting the time-series properties of the series in a more appropriate manner. We find that a superficial analysis or neglect of the time-series properties changes the regression results substantially. Therefore, we do control for trends and memory in the series, thus avoiding spurious regression result; utilising the study period from 1962 to 2005 allows us to do so. In addition, we can distinguish between the short-term and the long-term impact of aid and trade by applying a fully dynamic error correction model [ECM]. We also control for the endogeneity of aid by estimating the aid-export relationship with Dynamic Ordinary Least Squares [DOLS] and Dynamic Feasible Generalized Least Squares [DFGLS].

This study also differs from a preceding study done by our research group which uses Germany as a case study and utilises the same original data set as this study. Whereas the pre-study (or companion study) tries to improve and update the estimation methods for the standard static and dynamic 'aid and trade' models?[10], this paper models the dynamics in a

[9] The requirement for testing cointegration, that all variables must be integrated of the same order, (in other words,, I(1) or I(p)), was not fulfilled with respect to the majority of the countries examined.
[10] This is the Koyck lag model, also called the autoregressive distributed lag model (ARDL).

different way and gives serious consideration to the time series approach to panel regressions. Furthermore, we exclusively look at countries that have an established co-operation treaty with Germany making them the most important recipients of German aid[11], whereas the companion paper concentrates on finding the aid-and-trade relationship for all developing countries with available data and the most important sub-groups of that data. The subdivision of the sample in the companion paper aims at determining whether various countries demonstrate different degrees of goodwill towards Germany as donor country. The companion study is not, however, about whether aid-tying conditions differ among country groups given that Germany's aid-donation level ranks below average in total amount compared to other EU countries since (only seven per cent of Germany's ODA was tied in 2005).

3. Model and Estimation Techniques

3.1 Modelling the Aid-Trade Link

In this paper, we focus exclusively on the effect of aid on the donor's exports. Analogous to the welfare implications of bilateral transfers for donor and recipient countries, which were debated by Keynes (1929), Ohlin (1929), and Djajic, Lahiri, and Raimondos-Moller (2004), and nicely summarised by Lahiri (2005), we expect that, in the context of an intertemporal model of trade, development aid will lead to an increase in the donor's exports mainly due to the presence of habit formation or goodwill effects. In the presence of habit-formation effects, aid given today shifts preferences of the recipient in favour of the donor's export goods in the future. In order to evaluate this effect empirically, we have chosen the gravity model of trade as a basic framework.

[11] A complete list of these so-called BMZ countries can be found in the appendix.

The gravity model is currently the most commonly accepted framework for modelling bilateral trade flows. According to the underlying theory, trade between two countries is explained by the nominal incomes and the populations of the trading countries, the distance between the economic centres of the exporter and importer, and by a number of other factors aiding or hindering trade (colonial history, common language, and so on.) between them. In 1979, Anderson provided a theoretical foundation for the gravity equation based on the concept of product differentiation in the American Economic Review. Our version of the gravity model goes back to Bergstrand (1985), who derived the gravity model from a general equilibrium model of trade. If trade flows are perfect substitutes for one another and not differentiated by origin, then the gravity model functions correctly without a price term, as in Equation 1, below. Under realistic assumptions, however, a price term must be added to avoid misspecification (see Equation 2, below). This price term takes care of the imperfect substitutability of trade flows and/or large and persistent deviations in national price levels from purchasing power parity [PPP]. The bilateral exchange rate can be used as a proxy for prices.

According to the original gravity model of trade, the volume of exports between pairs of countries, X_{ij}, is a function of their income (Y_i, Y_j), their populations (POP_i, POP_j), their geographical distance from one another, $(DIST_{ij})$, and a set of dummies (F_{ij}):

$$X_{ij} = \alpha_0 \ Y_i^{\alpha_1} Y_j^{\alpha_2} POP_i^{\alpha_3} POP_j^{\alpha_4} DIST_{ij}^{\alpha_5} F_{ij}^{\alpha_6} \ u_{ij} . \qquad (1)$$

In line with Bergstrand, Equation 1 was augmented to accommodate the role played by exchange rates, our proxy for prices. Income transfers, namely bilateral and multilateral aid, are added, as well, giving us

$$X_{ij} = \alpha_0 \; Y_i^{\alpha_1} Y_j^{\alpha_2} POP_i^{\alpha_3} POP_j^{\alpha_4} EXRN_{ij}^{\alpha_5} BAIDG_{ij}^{\alpha_6} EUAIDG_{ij}^{\alpha_7} DIST_{ij}^{\alpha_8} F_{ij}^{\alpha_9} \; u_{ij} . \qquad (2)$$

Equation 2 is a reduced form of a partial equilibrium subsystem of a general equilibrium trade model with nationally differentiated products. Y_i (Y_j) indicates the GDPs of the exporter (importer), POP_i (POP_j) are exporter (importer) populations, $EXRN_{ij}$ stands for the bilateral exchange rate between countries i and j, $BAIDG_{ij}$ measures the amount of gross bilateral aid going from Germany to developing country j, $EUAIDG_{ij}$ measures the amount of gross EU aid that is given to developing countries, $DIST_{ij}$ measures the distance between the two countries' capitals (or economic centres), and F_{ij} represents all other factors aiding or preventing trade between pairs of countries, such as adjacency, language, isolation (such as for islands), or belonging to a certain trading bloc. u_{ij} is the error term.

Since we will work in the fixed effects framework[12], all factors that are cross-section specific and do not vary over time (distance, adjacency, language, island), will interfere with the cross-section-specific intercepts and cannot be directly estimated. These factors thus lead to

$$X_{ij} = \beta_{ij} \; (Y_i \; Y_j)^{\beta_1} POP_i^{\beta_2} POP_j^{\beta_3} EXRN_{ij}^{\beta_4} BAIDG_{ij}^{\beta_5} EUAIDG_{ij}^{\beta_6} u_{ij} . \qquad (3)$$

This model is usually linearised[13] and then estimated in its log-log form,

[12] The Hausman test rejected the random-effect model due to correlation between the random-country effect and the error term.

[13] Santos Silva and Tenreyro (2006) suggested estimating the non-linear model with the Pseudo Poisson Maximum Likelihood technique [PPML] pointing to Jensen's inequality (a problem linked to the error term that arises in the linearisation process) and a better ability to deal with heteroskedasticity. However, empirical applications of the PPML technique to real trade data were less promising. Heteroskedasticity remained a problem and the model assumptions proved.difficult to fulfill.

$$\ln X_{ijt} = \mu_{ij} + \beta_1 \ln Y_{it} Y_{jt} + \beta_2 \ln POP_{it} + \beta_3 \ln POP_{jt} + \beta_4 \ln EXRN_{ijt}$$
$$+ \beta_5 \ln BAIDG_{ijt} + \beta_6 \ln EUAIDG_{ijt} + u_{ijt} \quad , \qquad (4)$$

where ln denotes variables in natural logs. X_{ijt} are the exports from country i to country j in period t in current US dollars (hundreds of million US$). Y_{it}, *and* Y_{jt} indicate the GDP of countries i and j, respectively, in period t at current PPP US$ (in billions). POP_{it}, and POP_{jt} denote the population of countries i and j, respectively, in period t in thousand inhabitants.

$BAIDG_{ij}$ measures gross bilateral aid[14] flowing from Germany (i) to country j in millions of US$. $EUAIDG_{ij}$ stands for gross EU aid allocated to country j in millions of US$. μ_{ij} represent the specific effects associated with each bilateral trade flow. They serve as controls for all omitted variables that are specific for each trade flow and that are time invariant.

A high level of income in the exporting country indicates a high level of production (which then increases the availability of goods for export), and a high level of income in the importing country implies strong demand. Therefore, we expect β_1 to be positive. The co-efficient estimate for the population level of the exporters, β_2, may be negatively or positively signed, depending on whether the country exports less if it is large (absorption effect) or whether a large country exports more than a small country (economies of scale). The co-efficient of the importer population, β_3, also has an ambiguous sign, and for similar reasons. Another factor that may influence the co-efficient estimates for population is the composition effect that influences supply and demand. Each country produces and exports a different mix of commodities (supply) and the mix of goods demanded also differs for each country. The co-efficient estimate of the bilateral exchange rate (which is in quantity quotation), β_4, is expected to have a negative impact on exports, as appreciation in the exchange rate decreases the export level. The co-efficient of bilateral aid, β_5, is expected to be positive, reflecting the

[14] According to DAC, gross ODA comprises total grants (position 201) and loans extended (position 204).

income-transfer effect of aid. The co-efficient of multilateral aid, β_6, can be either positive or negative depending on whether the recipient countries prefer to import from known channels or instead choose to diversify their import channels.

Equation 4 represents the static model, which model allows conclusions for the long-term equilibrium to be drawn. Use of this model, however, can lead to spurious regression results when the variables substituted into it reflect a deterministic or stochastic time trend. Estimating Equation 4 with pooled least squares and fixed effects results in an R^2 of 0.96 and a Durbin-Watson statistic [DW] of 0.54, which is remote from the ideal of 2.00. As R^2 exceeds the DW, we have an indication of a spurious relationship and of spurious regression co-efficients.

3.2 Data Sources, Variables, and German Co-operation Countries

Official Development Aid data are from the OECD Development Database on Aid from DAC members[15]. Bilateral exports are obtained from the UN COMTRADE database. Data on income and population variables are drawn from the World Bank (World Development Indicators Database 2006). Bilateral effective exchange rates are from the IMF statistics. Distances between capitals have been computed as great circle distances using data on straight-line distances in kilometres; latitudes and longitudes were obtained from the CIA World Fact Book.

In the Appendix, A.2 is a list of partner countries of German Development Co-operation (BMZ countries). See also http://www.bmz.de/en/countries/laenderkonzentration/tabelle.html. These countries will be the main focus of the analysis, as the BMZ has a bilateral aid relationship only with them.[16]

3.3 Estimation Issues

Since spurious correlations are to be avoided, alternative estimation methods will rely on an error correction model [ECM] or a long-run model with built-in leads and lags to control for endogeneity of the explanatory variables. Error correction models allow one to draw inferences that are not driven by spuriousness. All a priori stationary variables are excluded from the ECM as they do not contribute to the long-term equilibrium. Only if the series is integrated to the same order and co-integrated in the long-term (such that the residual of Equation 4 is stationary) can these variables enter the model. Stock (1987) and Pesaran et al.

[15] www.oecd.org/dac/stats/idsonline.

[16] Other developing countries might also receive German development assistance that is provided via NGOs, disaster relief, scholarships for students from these countries, or funding for foundations active in these countries. We would not expect that these aid flows much affect exports from Germany.

(2001) suggested using an ECM based on an ARDL[17], leading to a dynamic error correction model.

The dynamic error correction model is given by

$$\Delta \ln X_{ijt} = \mu_{ij} + \sum_{p=0}^{p=k} \beta_{1p} \Delta \ln Y_{it-p} Y_{jt-p} + \sum_{p=0}^{p=k} \beta_{2p} \Delta \ln POP_{it-p} + \sum_{p=0}^{p=k} \beta_{3p} \Delta \ln POP_{jt-p} + \sum_{p=0}^{p=k} \beta_{4p} \Delta \ln EXRN_{ijt-p} + \sum_{p=0}^{p=k} \beta_{5p} \Delta \ln BAIDG_{ijt-p} + \sum_{p=0}^{p=k} \beta_{6p} \Delta \ln EUAIDG_{ij-tp} + \sum_{p=1}^{p=k} \lambda_p \Delta \ln X_{ijt-p} + \lambda \cdot (\ln X_{ijt-1} - b_1 \ln Y_{it-1} Y_{jt-1} - b_2 \ln POP_{it-1} - b_3 \ln POP_{jt-1} - b_4 \ln EXRN_{ijt-1} - b_5 \ln BAIDG_{ijt-1} - b_6 \ln EUAIDG_{ijt-1}) + u_{ijt}$$

(5)

Both short-term ($\beta_{1p},...,\beta_{6p}$) and long-term co-efficients ($b_1,...,b_6$) can be estimated. λ describes the adjustment to the long-term equilibrium. The term $(\ln X_{ijt-1} - b_1 \ln Y_{it-1} Y_{jt-1} - b_2 \ln POP_{it-1} - b_3 \ln POP_{jt-1} - b_4 \ln EXRN_{ijt-1} - b_5 \ln BAIDG_{ijt-1} - b_6 \ln EUAIDG_{ijt-1})$ is the error-correction term and contains the long-term elasticities. The short-run relationship is described by the variables in differences[18], thereby removing their stochastic trend (Hendry, 1995; Mukherjee et al., 1998).

The maximum lag length, k, is determined by the Schwarz criterion. In our case, k is equal to three. Hendry's (1995) general-to-specific method is applied to Equation 6, thus eliminating the least significant variables. We end up with the following ARDL-based ECM:

$$\Delta \ln X_{ijt} = \mu_{ij} + \beta_{10} \Delta \ln Y_{it} Y_{jt} + \beta_{11} \Delta \ln Y_{it-1} Y_{jt-1} + \beta_{20} \Delta \ln POP_{it} + \beta_{40} \Delta \ln EXRN_{ijt} + \beta_{43} \Delta \ln EXRN_{ijt-3} + \beta_{50} \Delta \ln BAIDG_{ijt} + \beta_{61} \Delta \ln EUAIDG_{ijt-1} + \sum_{p=1}^{p=3} \lambda_p \Delta \ln X_{ijt-p} + \lambda \cdot (\ln X_{ijt-1} - b_1 \ln Y_{it-1} Y_{jt-1} - b_2 \ln POP_{it-1} - b_3 \ln POP_{jt-1} - b_4 \ln EXRN_{ijt-1} - b_5 \ln BAIDG_{ijt-1} - b_6 \ln EUAIDG_{ijt-1}) + u_{ijt} \quad (6)$$

[17] Irrespective of whether the regressors are I(0) or I(1), an ARDL can be applied. Pesaran et al. compute the critical values for a cointegration test in the ARDL framework for time series (Pesaran et al., 2001).

[18] Δ means that the variables enter the model in first differences.

However, an increase in the amount of donors' exports resulting from aid given might make it more attractive to the recipient country to give more bilateral aid in turn. Trade can lead to further aid if donors preferably allocate their aid to countries with which they have the greatest commercial links. Since it is therefore debatable whether the variable, *ln BAIDG,* is truly exogeneous, a control for possible endogeneity is called for. Where endogeneity problems arise, estimation of the gravity model by the means of Dynamic Ordinary Least Squares [DOLS] is recommended. DOLS is based on a modified version of Equation 4 that includes past, present, and future values of the change in the regressors (Stock and Watson, 1993, 2003). When estimating Equation 7,

$$\ln X_{ijt} = \alpha_{ij} + \chi_1 \ln Y_{it} Y_{jt} + \chi_2 \ln POP_{it} + \chi_3 \ln POP_{jt} + \chi_4 \ln EXRN_{ijt}$$
$$+ \chi_5 \ln BAIDG_{ijt} + \chi_6 \ln EUAIDG_{ijt} + \sum_{p=-k}^{p=+k} \delta_p \Delta \ln Y_{it} Y_{jt} + \sum_{p=-k}^{p=+k} \varepsilon_p \Delta \ln POP_{it} +$$
$$\sum_{p=-k}^{p=+k} \phi_p \Delta \ln POP_{jt} + \sum_{p=-k}^{p=+k} \varphi_p \Delta \ln EXRN_{ijt} + \sum_{p=-k}^{p=+k} \gamma_p \Delta \ln BAIDG_{ijt} + \sum_{p=-k}^{p=+k} \eta_p \Delta \ln EUAIDG_{ijt} + u_{ijt} \qquad (7)$$

consistent regression co-efficients can be obtained. In this case, the Schwarz criterion suggested taking two leads and two lags (k=2).

If the dependent variable and the regressors are co-integrated, which co-integration must be tested beforehand, then the DOLS estimator is efficient in large samples. Moreover, statistical inferences about the co-integration co-efficients, $\chi_1,...,\chi_6$, and the co-efficients $\delta_p, \varepsilon_p, \phi_p, \varphi_p, \gamma_p, \eta_p$ in Equation 7, based on HAC standard errors, are valid. This is because the t-statistic constructed using the DOLS estimator with HAC standard errors has a standard normal distribution in large samples. And if the regressors were strictly exogenous, the co-efficients, $\chi_1,...,\chi_6$, in Equation 7, would be the long-term cumulative multipliers, that is, the long-term effect on exports of a change in the explanatory variables. If the regressors are not strictly exogenous, then the co-efficients are not given this interpretation.

3.4 Requirements for Non-Spurious Estimation

The dynamic ECM requires the change variables to be integrated of the same order (for example, I(1)) and to have a long-run relationship (such that the long-run relationship has to be stationary (I(0)).

Table 1 shows the test results for the variables. After inspecting the graphs, an intercept and trend were assumed and a lag length of four was chosen. According to the ADF-Fisher Chi-Square test, which allows for individual unit roots, all variables that enter the regression model are I(1).

Table 1: Results from the ADF-Fisher Panel Unit Root Test

Variable tested	Null hypothesis	Unit root test utilised	Probability	Observations	Variable is integrated
Lx	Individual unit root process	ADF-Fisher Chi-square 142.79	0.33	2279	I(1)
Lyy	Individual unit root process	ADF-Fisher Chi-square 72.10	1.00	2198	I(1)
Lpopg	Unit root process	ADF test statistic 86.34	1.00	2847	I(1)
Lpopj	Individual unit root process	ADF-Fisher Chi-square 92.60	1.00	2831	I(1)
Lexrn	Individual unit root process	ADF-Fisher Chi-square 96.19	0.97	2185	I(1)
Lbaidg	Individual unit root process	ADF-Fisher Chi-square 89.04	0.99	2210	I(1)
Leuaidg	Individual unit root process	ADF-Fisher Chi-square 141.55	0.27	2282	I(1)

However**,** words of caution are required. Clearly, unit root tests that assume individual unit roots (for each cross-section)[19] are to be preferred over unit root tests that assume a common unit root process[20], given that the first ones are much more flexible. Nonetheless, the available panel unit root tests can lead to implausible results, especially when the number of cross-sections is large. Cross-section correlation of the series is controlled best by the ADF-Fisher panel unit root test (Maddala and Wu, 1999). For example, as to the aid and trade data utilised, we know from the unit root test results at the country level (pure time series Phillips-Perron Fisher unit root test, the ADF test, and the Im, Pesaran, and Shin test) that our series are non-stationary (integrated of order 1, I(1) variables) in the vast majority of countries. In our experience, the ADF-Fisher unit root test best reproduced the results obtained on an individual level, whereas the PP-Fisher unit root test concludes far too often that the series are stationary when they are, in fact, non-stationary on a country level (an individual level). The results of the Im, Pesaran, Shin (IPS) test lie somewhere in between the ADF-Fisher and the PP-Fisher unit root tests. These varying results have to do with the way the null and the alternative hypotheses are formulated.[21] In the alternative hypothesis, statements are made on whether either all or a significant portion of the cross-sections is stationary.

When testing for co-integration, that is to say, the existence of a long-run relationship in the aid and trade equation, we follow residual-based co-integration tests (Kao, 1999). The idea of a residual-based co-integration test goes back to Engle and Granger (1987), who applied it to time series. As to regressions with time series, if the residual (u_t) of a regression is built around variables with the same order p of integration (in other words, the variables ~ I(p) are stationary, such that $u_t \sim I(0)$), it is said that the I(p) variables are co-integrated, and therefore a long-run relationship does exist. However, these tests not only tend to suffer from

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[19] Such as the Im, Pesaran, and Shin unit root test, the ADF- Fisher Chi-Square unit root test, and the PP-Fisher Chi-Square unit root test.

[20] Such as the Levin, Lin, and Chu unit root test and the Breitung unit root test.

[21] H_0: All of the individuals of the panel have a unit root (the series has a unit root in all cross-sections); H_1: The series is stationary in all cross-sections or according to the IPS test, H_0: The series has a unit-root in all cross-sections, H_1: Some, but not all, of the fractions of the individuals are (trend) stationary.

unacceptably low power when applied to series of moderate length, but also require special critical values (for example, Kapetanios's critical values)[22] to test for stationarity of the residuals (Kapetanios, 1999).

Pooling data across individual members of a panel when testing for co-integration is therefore advantageous. Pooling increases the power of the unit root test by providing considerably more information regarding the co-integration hypothesis[23]. But testing for co-integration in a panel setting is also more complicated since two types of co-integration can be present and must be taken into account: first, between series over time (the type prevailing in time series) and second, between cross sections[24] (the type potentially existing in a panel setting) (Banerjee et al., 2004; Breitung and Pesaran, 2005; Urbain and Westerlund, 2006). We choose Pedroni's panel co-integration test which belongs to the single equation approaches[25] (Pedroni, 1999, 2004). It involves estimating the hypothesised co-integrating regression separately for each country (73 countries) and then testing the estimated residuals for stationarity with adequate critical values using seven test statistics. Four of these statistics pool the autoregressive co-efficients across different countries while performing the unit root test and thus restrict the first order autoregressive parameter to being the same for all countries. Pedroni (1999) refers to these statistics as panel co-integration statistics. The other three statistics are based on averaging the individually estimated autoregressive co-efficients for each country. Accordingly, these statistics allow the autoregressive coefficient to vary across countries and are referred to as *group mean panel co-integration statistics*. Both panel

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[22]MacKinnon's critical values cannot be used when testing the non-stationarity of residuals. In this case, adjustments for the number of regressors in the regression equation are necessary and different critical values result.

[23] H_0: The variables of interest are *not* co-integrated for each member of the panel and $H_{1;}$ For each member of the panel, there exists a single co-integrating vector, although this co-integrating vector does not have to be the same for each member (Pedroni, 1999).

[24]Cross-sectional correlation can be addressed by the Seemingly Unrelated Regression (SUR) technique, but only if T is large and substantially larger than N, (N must be quite small). In our case, SUR would not work. Westerlund (2007a, 2007b, and 2007c) develops a more general solution to cross-unit correlation. He allows for cross-sectional dependence by assuming that the correlation can be modelled using a common factor structure.

[25] It also belongs to the first generation panel co-integration tests. The first generation panel co-integration tests assume cross-sectionally-independent panels (Wagner and Hlouskova, 2007).

co-integration statistics and the group mean panel co-integration statistics test the null hypothesis H_0: ‘All of the individuals of the panel are not co-integrated.’ For the panel statistics, the alternative hypothesis is H_1: ‘All of the individuals of the panel are co-integrated’, while for the group mean panel statistics, the alternative is H_1: ‘A significant portion of the panel members are co-integrated’ (Pedroni, 2004).

Pedroni’s test revealed (see Table 2) that the residuals of all countries were stationary and the variables, *lx, lyy, lpopg, lpopj, lexrn, lbaidg,* and *leuaidg,* are co-integrated in the majority of cases and therefore in long-run equilibrium.[26] The error when rejecting the null hypothesis of ‘no co-integration’ is 0.00 and 0.03, respectively, looking at the panel PP statistic and the panel ADF statistic, and 0.00 and 0.02, respectively, when looking at the group mean panel co-integration statistics (group PP and group ADF statistics).

A weakness in the Pedroni (1999, 2004) approach is that it requires the long-run co-integrating vector for the variables in levels being equal to the short-run adjustment process for the variables in their differences (Westerlund, 2007b). If this is empirically incorrect, residual-based (panel) co-integration tests may suffer from a significant loss of power (Westerlund, 2007b). A simulation study of Wagner and Hlouskova (2007) showed that amongst the single-equation tests for the null hypothesis of no co-integration (Pedroni-type tests), the panel and mean-group tests of Pedroni, applying the ADF principle, perform best, whereas all other single-equation tests (Breitung, 2002; Westerlund, 2005) are in part significantly undersized and have very low power in many circumstances. For $T<=25$ there is practically no acceptable power. In simulations, Pedroni’s test statistics are the least affected by the presence of cross-unit co-integration. In contrast, system-based (VAR-based or Johansen-type) co-integration tests (Larsson, Lyhagen, and Löthgren, 2001; Breitung, 2005) perform very poorly for small values of T, but are also inadequate when N is too large, as in a simulation study done by Wagner and Hlouskova (2007).

[26] The program and the results are available upon request.

Table 2: Results from the Panel Co-integration Test[27]

Panel co-integration test

	Panel co-integration statistics		Group mean panel co-integration statistics	
Pedroni (1999)	Statistic	Prob.	Statistic	Prob.
Variance ratio	-1.39	0.92		
PP rho statistics	12.02	1.00	15.64	1.00
PP *t*-statistics	-6.72***	0.00	-9.76***	0.00
ADF *t*-statistics	-1.84**	0.03	-2.02**	0.02

*** indicate a rejection of the null hypothesis of no co-integration at the 1 per cent level. All test statistics are asymptotically normally distributed. The panel rank test has a critical value of 2.326 (1.645) at the 1 per cent (5%) level. The Fisher test has a critical value of 121.8 (110.9) at the 1 per cent (5%) level. The number of lags was determined by the Schwarz criterion. Sample: 1962-2005; included observations: 3212.

Overall, both the panel unit root test and Pedroni's panel cointegration test justify estimating the aid and trade relationship by OLS, either in an ECM model or in a DOLS set-up. In both cases, co-integration is a prerequisite to engaging in estimation.

4. Empirical Findings on the Impact of Aid on Trade

As discussed earlier, we estimated the aid and trade relationship by means of an augmented gravity model which allows to control for other factors influencing exports, and by applying both the ECM and the DOLS techniques. The results obtained by the dynamic ARDL-based ECM (Equation 5) are given in Table 3.

A 1-per cent increase in bilateral aid increases exports by 0.15 per cent in the ARDL-based ECM, resulting in a long-term return of bilateral aid of EUR 1.72, respectively[28]. The short-

[27] H_0: The variables of interest are *not* co-integrated for each member of the panel, and $H_{1:}$ For each member of the panel, there exists a single co-integrating vector, although this co-integrating vector does not have to be the same for each member (Pedroni, 1999).

run impact of bilateral aid on exports is much smaller (as expected). In the ARDL-based model, the elasticity of aid is 0.06. The ECM specification points to the short-run relevance of bilateral exchange rates and their long-run irrelevance[29] and to the importance of exporter and importer incomes.

The estimated co-efficient for the EU official gross development aid is negative and significant in Table 3. One reason for this could be that most EU programmes are dominated by non-German interests so that German exports are crowded out and Germany's EU partners profit in terms of exports, instead. In the short run, Germany's population increase (excess absorption) can lead to a decrease in exports and the importer's population growth (import substitution and economies of scale) may eventually result in a long-term decrease in exports.

Table 3: The Impact of Bilateral Aid in the ECM Estimation

1963-2005	**Dynamic ECM (BMZ countries) Equation 5**	
Variable	**Long-run coefficient**	**t-statistic**
LYY	0.74***	9.77
LPOPG	-0.28	-0.86
LPOPJ	-0.95***	-3.28
LEXRN	-0.00	-0.04
LBAIDG	**0.15*** **	3.17
LEUAIDG	-0.17***	-3.11
EC Term	-0.27***	-15.31
L.r. Return on EUR 1.00 bilateral aid	**EUR 1.72**	
	Short-run coefficient	**t-statistic**
D(LYY)	0.60***	11.47
D(LPOPG)	-0.49***	-2.72
D(POPJ)	----	----
D(LEXRN)	-0.07***	-2.40
D(LBAIDG)	0.06***	-1.64
D(LEUAIDG)	------	5.41
S.r. return on EUR 1.00 bilateral aid	**EUR 0.69**	----
Fixed effects	Yes	
Adj. R^2	0.23	
Log likelihood	-194.29	
DW statistic	1.96	

[28] Multiplying through with the mean of exports ($229,000,000 US) over the mean of bilateral aid ($18,23444 US) for the period from 1962 to 2005 yields a return of US$ 1.72 in the long run and of US$ 0.69 in the short-run. .

[29] A *beggar-thy-neighbor* policy (through currency devaluation) can only work in the short-run, not in the long run.

F-statistic	7.82	
Prob(f-stat)	0.00	

Table 4 presents the results that are obtained by means of a DOLS estimation. First, we estimate a regular DOLS[30] (Equation 7) and then a DFGLS (Dynamic Feasible Generalized Least Squares), controlling for autocorrelation[31].

Table 4: The Impact of Bilateral Aid in the DOLS Estimation

1965-2003	**DOLS (BMZ countries) Equation 7**		**DFGLS (correction of autocorrelation) (BMZ countries) Equation 7**	
Variable	**Long-run coeff.**	**t-statistic**	**Long-run coeff.**	**t-statistic**
LYY	0.87***	37.77	0.82***	16.64
LPOPG	-0.53***	-3.13	-0.43	-1.44
LPOPJ	-1.18***	-8.99	-1.32***	-5.12
LEXRN	-0.04***	-4.37	-0.04***	-2.14
LBAIDG	**0.19*****	7.34	**0.13*****	2.88
LEUAIDG	-0.24***	-9.31	-0.08	-1.41
L.r. return on bilateral aid	**EUR 2.18**		**EUR 1.49**	
2 leads and 2 lags	Yes		Yes	
Fixed effects	Yes		Yes	
Adj. R^2	0.96		0.98	
Log likelihood	-842.50		-158.08	
DW Statistic	0.62		2.01	
F -statistic	409.60		786.69	
Prob (F-stat.)	0.00		0.00	

The results obtained by estimating Equation 7 with and without controlling for autocorrelation are rather similar. Control for autocorrelation is based on the Cochrane-Orcutt procedure in

[30] Not reporting the short-run co-efficients.
[31] Not reporting the short-run co-efficients.

which the correlation co-efficient, ρ , of the disturbances is estimated in the first step. Then, all series (including, of course, the residuals) are transformed into (stationary) ‘soft’ first or ‘quasi’ first differences before applying DOLS. This procedure will be called DFGLS.

We find that the assertion by applied economists that using leads and lags in the DOLS approach takes care of the problem of autocorrelation is overly optimistic. That the DW statistic is 0.62 (Table 4, second column) clearly indicates the presence of autocorrelation. The DFGLS estimators correcting for autocorrelation (DW=2.01) are more conservative and free of spuriousness. The bilateral-aid elasticity drops from 0.19 to 0.13. According to the superior DFGLS estimator, a EUR 1.00 increase in bilateral aid increases exports by EUR 1.49.

4. Conclusions

The augmented gravity model allows controlling for a variety of factors that influence export flows, thus reducing the aid-export elasticity found in studies without control variables. Panel unit root and panel co-integration tests enable us to obtain non-spurious regression results based on either error correction models or the Dynamic Ordinary Generalized Least Squares technique. We find that the elasticity of bilateral aid estimated by means of an ECM and DFGLS lies in an interval between 0.13 and 0.15, translating into a EUR return in the range of EUR 1.49 to EUR 1.72. The study clearly shows that Germany’s bilateral aid increases its own level of exports, thus giving further support to the objective of eventually reaching the 0.7 per cent UN goal of official development assistance. In contrast to earlier studies, the impact of bilateral aid is well below the previously computed impact of EUR 4.30 or EUR 3.20 for Germany.

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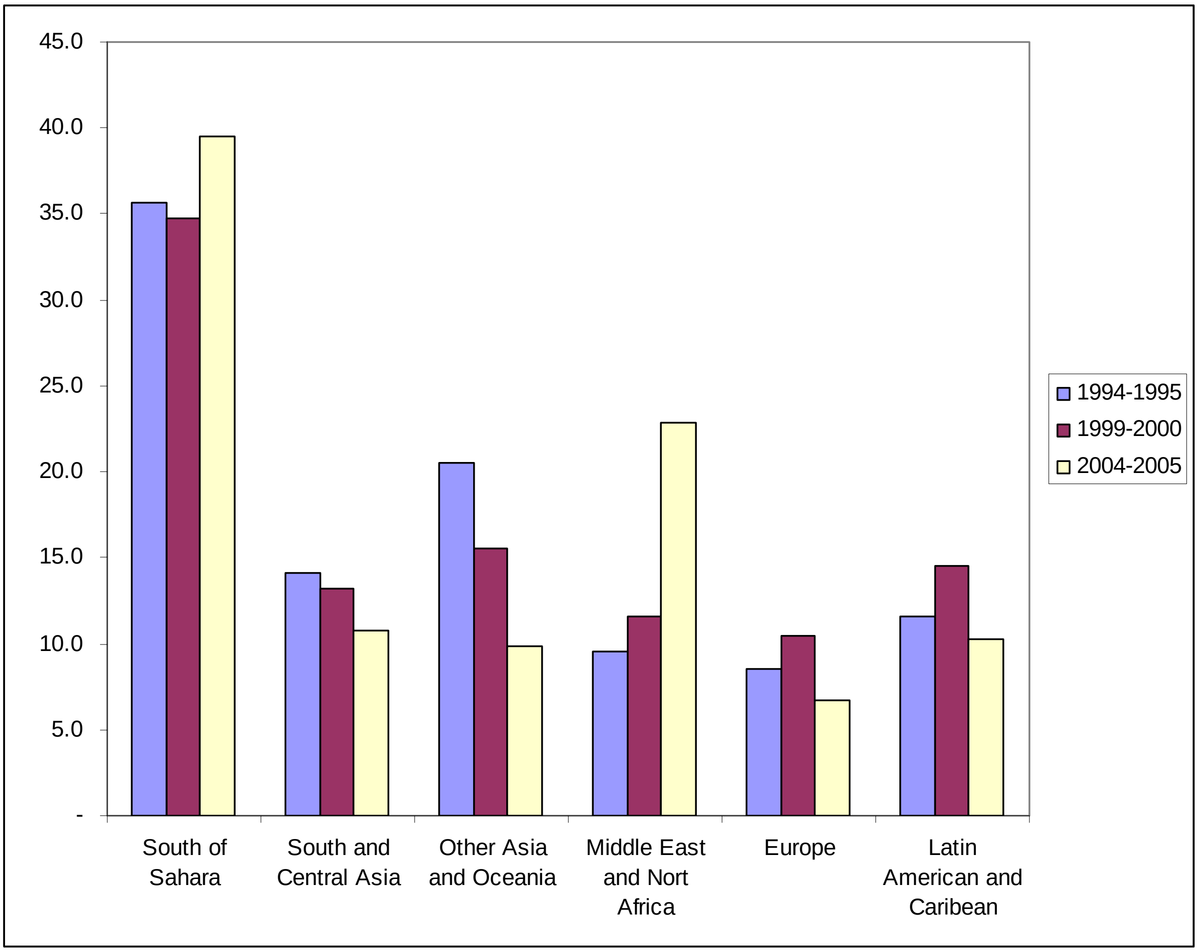
Appendix:

A.1. Regional distribution of German ODA in per cent



Source: OECD (http://www.oecd.org/dataoecd) and own elaboration.

A2. Country classifications

Countries	BMZ co-operation countries of German development co-operation
1	Afghanistan
2	Albania
3	Algeria
4	Armenia
5	Azerbaijan
6	Bangladesh
7	Belarus
8	Benin
9	Bolivia

10	Bosnia-Herzegovina
11	Brazil
12	Burkina Faso
13	Burundi
14	Cambodia
15	Cameroon
16	Chad
17	Chile
18	China
19	Colombia
20	Congo, Dem. Rep.
21	Costa Rica
22	Croatia
23	Dominican Republic
24	Ecuador
25	Egypt
26	El Salvador
27	Eritrea
28	Ethiopia
29	Georgia
30	Ghana
31	Guatemala
32	Honduras
33	India
34	Indonesia
35	Iran
36	Jordan
37	Kazakhstan
38	Kenya
39	Kyrgyz Republic
40	Laos
41	Lebanon
42	Lesotho
43	Madagascar
44	Malawi
45	Mali
46	Mauritania
47	Mexico
48	Moldova
49	Mongolia
50	Morocco
51	Mozambique
52	Myanmar
53	Namibia
54	Nepal
55	Nicaragua
56	Niger
57	Nigeria
58	Pakistan

59	Paraguay
60	Peru
61	Philippines
62	Rwanda
63	Senegal
64	Serbia and Montenegro
65	South Africa
66	Sri Lanka
67	Sudan
68	Syria
69	Tajikistan
70	Tanzania
71	Thailand
72	Tunisia
73	Turkey
74	Uganda
75	Ukraine
76	Vietnam
77	Zambia

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