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Does German Development Aid boost German Exports and German Employment? A Sectoral Level Analysis

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Abstract: This paper uses an augmented gravity model of trade to investigate the link between German development aid and sectoral exports from Germany to aid recipient countries with data from 1978–2011. The findings indicate that in the long run each dollar of German aid is associated with an average increase of US$ 0.83 US of German goods exports. The sectors that benefit the most in terms of exports and employment are machinery, electrical equipment and transport equipment. According to our estimates using input-output analysis and a partial equilibrium framework, the aid-induced gains in sectoral exports are associated with the gross employment of approximately 216,000 people.

Keywords: international trade, foreign aid, Germany
JEL Classification: F10, F35

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1 Introduction

Foreign aid is given to developing countries for a broad set of reasons. Poverty reduction, economic growth and the promotion of human development in the recipient countries are the main aims of development aid, exemplified by the United Nations Millennium Development Goals (MDG). Meanwhile, aid allocation literature examines a number of additional stimuli, such as consolidating historical ties as well as political, economic, and commercial interests (Alesina/Dollar 2000; Fuchs et al. 2014). In 1970, developed countries, and in particular members of the Organization for Economic Cooperation and Development (OECD)-Development Assistance Committee (DAC) pledged to increase levels of aid in order to reach the UN target of 0.7 % of Official Development Aid (ODA) per unit of Gross National Income (GNI). Sixteen of the twenty-two DAC donors have already met or have committed to meet this target by 2015. Germany is one of the countries that has committed to increasing its official development aid to 0.7 % by 2015. However, German ODA levels were below 0.4 % of GNI until 2012 and in 2013 the Development Ministry budget was cut by 87 million Euros compared to 2012. As a result, Germany will move further away from its self-imposed target, first set more than forty years ago.

Given this mix of motivations, donors are also interested in seeing how aid affects their commercial and economic relationships with recipient countries (McKinley/Little 1978; McKinley/Little 1979; Berthélemy/Tichit 2004; Berthélemy 2006). This paper specifically examines whether aid leads to higher exports from donor to recipient countries. A number of authors have already studied the export channel from a multi-donor perspective (Wagner 2003; Osei et al. 2004; Martínez-Zarzoso et al. 2014), and the main results point to a non-negligible positive effect. Martínez-Zarzoso et al. (2009) and Nowak-Lehmann D. et al. (2009) focused on the case of Germany and found that German foreign aid has a positive and significant effect on German exports that is more than proportional in the long run. However, according to results for sub-periods, this effect seems to decrease over time. Both studies used aggregated export flows but slightly different modelling approaches; the first using panel-data methods and the second using a time-series and cointegration approach. Based on the aid-induced export effects estimated in these papers and by means of a macro-econometric model, Albrecht et al. (2007) estimated that around 140,000 jobs were created in Germany as a result of the aid-induced increase in exports, compared to a situation where aid expenditure was reduced. If the savings in aid expenditure were used to lower taxes, the net employment effect of aid fell to around 50,000 (Albrecht et al. 2007). Therefore, the political shift towards

reducing development aid during the economic crisis after 2008 might also change the effect of aid on German exports, and subsequently on German economic activity.

This paper sets itself apart from earlier literature in two main regards. Firstly, it focuses on the effect of aid on *sectoral* exports instead of total exports. In particular, we estimate a sectoral gravity model of German exports to 75 developing countries (Germany's main development partners according to the Federal Ministry for Economic Cooperation and Development (BMZ)) using levels of development aid for the period 1978–2011. In other words, sector-specific aid elasticities will be used to calculate the increase in exports by sector as a result of German bilateral aid. Secondly, we re-visit the export effects of aid, by controlling for endogeneity (feedback effects and reverse causality) of all right-hand-side variables. This technique therefore ensures unbiased estimates of the factors influencing donor exports. In addition, we control for autocorrelation by transforming all variables (Feasible Generalized Least Squares technique) and use robust standard errors. The technique used is called Panel Dynamic Feasible Generalized Least Squares (PDFGLS) and it allows us to work with cointegrated non-stationary series. It is a technique that originates from time series literature (Stock/Watson 1993; Wooldridge 2009) and panel time series literature (Kao/Chiang 2000; Mark/Sul 2003).

To summarize our main results, we find that in the long run each Euro of German aid is associated with an average increase of 0.83 Euros of German goods exports. The effect varies by sector and the sectors that benefit the most are machinery, electrical equipment and transport equipment; three sectors where German exports enjoy a strong position in world markets. By using input-output analysis techniques in a partial equilibrium framework, the gain in exports is then used to estimate the corresponding gross output effects and the related gross employment effects, which are also most pronounced in the three abovementioned sectors. A total of approximately 216,000 jobs are associated with the sectoral exports generated by German bilateral aid. Since these calculations do not take into account general equilibrium effects (e. g. operating via prices and wages) and do not consider alternative spending of the aid funds or the associated employment effects of said spending, these numbers should be considered the upper bounds of the employment effects of aid.[1]

Section 2 contains the theoretical background and reviews recent literature on trade and aid. Section 3 deals with the model specification, data sources and variables. Section 4 presents and discusses the main results and outlines the

1 Note that Albrecht et al (2007) did, as discussed above, consider general equilibrium effects as well as alternative uses of development aid, which reduced the impact of employment by about 33 %.

calculations for the derived employment effects. Lastly, Section 5 presents the conclusions.

2 From aid to donor exports: theory and empirical evidence

2.1 The theoretical link between aid and donor exports

The welfare implications of development aid for donors and recipient countries have long been studied in international trade theory. Although this paper does not focus on the welfare effect of aid, an increase in exports could be regarded as an important intermediate step to increase welfare. The first public discussion on this matter was the Keynes-Ohlin debate on the paradoxical effects of German reparations.[2] Keynes argued that income transfer has a direct effect on the transferring country's welfare, namely a decrease in the transferring country's income, in addition to an indirect effect caused by the increase in the transferring country's exports leading to a decrease in the price of exporting goods, with the subsequent deterioration of the terms-of-trade. Ohlin, however, disagreed with the second effect and argued that the transfer might indeed improve the terms of trade of the transferring country and this effect may compensate the direct effect of the transfer. Leontieff (1936) also raised the issue of potential transfer paradoxes by showing that the distribution of utility gains and losses from a transfer may be perverse (donor-enriching and recipient-immiserizing) due to the change in the terms of trade. Since those preliminary discussions, theoretical literature on transfer paradoxes has been extended to include more general settings (Samuelson 1954; Gale 1974; Jones 1975; Brecher/Bhagwati 1981, 1982; Bhagwati et al. 1983, 1984). The findings indicate that the paradoxes are still possible but, under certain conditions, both donors and recipients can benefit from transfers (weak paradox). More recently, Djajic, Lahiri, and Raimondos-Moller (2004) studied the welfare implications of temporary foreign aid in the context of an intertemporal model of trade and considered the impact of aid on donor and recipient exports. The authors found that the net benefits of an aid transfer may change over time for both the donor and the recipient and that under certain conditions both donor and recipient can benefit from aid.

Recipient countries perceive aid as additional income that will eventually lead to a general increase in demand, and of imports in particular. This is known

2 Keynes (1929a, 1929b, and 1929c) and Ohlin (1929a, 1929b).

as the income effect of aid. More specifically, aid can be used to close the savings-investment and the foreign exchange gap thus overcoming financing constraints (Chenery/Strout 1965). However, it has to be kept in mind that only a fraction of the aid transfer will actually be spent on domestic and foreign goods. Some portion of the aid will be used to administer and allocate aid in the donor countries, including the headquarters operations of the institutions entrusted with administering German aid, including the German Society for International Development (*Gesellschaft für Internationale Zusammenarbeit*, GIZ), the German Ministry for Economic Cooperation and Development (*Bundesministerium für wirtschaftliche Zusammenarbeit* (BMZ)) and the German Development Bank (KfW, *Kreditanstalt für Wiederaufbau*) (Hoffmann 2012). Similarly, a certain portion of aid will never become effective in the recipient country but will be spent in the donor country instead.[3] To clarify, according to the definition of official development aid (ODA), many activities are considered to be aid, from money spent by the donor on refugees from developing countries, political asylum seekers or students from developing countries studying in the donor country, to the salaries of donor country consultants and research on developing countries in the donor country (OECD 2008a, 2008b). In addition, a certain percentage of the aid received will never reach its intended destination due to capital flight. Ruling elites often possess offshore financial assets and real estate. However, a large portion of development aid remains in the recipient countries and can be spent on own products and donor exports. Bad use of aid due to corruption and bad governance can reduce the effectiveness of aid in recipient development, but will not necessarily impede import demand in recipient countries associated with aid flows. Instead it can change the structure of import demand (e. g. more luxury goods instead of capital goods) (Graf Lambsdorff 2002; Kasper 2006; Kaufmann 2009; Easterly/Williamson 2010).

In short, as long as the aid money allows for an increase in effective spending in the recipient countries, development aid can lead to an increase in donor exports through the income channel (income as well as available foreign exchange in the recipient country rises). However, there are a few other channels through which aid could lead to increased imports from donor countries: Firstly, there might be an export effect triggered by the fact that a considerable share of donor aid has been tied to imports from the donor country. Secondly, there may be habit-formation effects in the sense that donor-funded exports for aid-related projects might increase the propensity of recipient countries to buy goods from the donor. Lastly, the aid relationship promotes a trade relationship in the sense that it creates

3 The aid spent in Germany will not generate aid-induced exports, but does of course generate direct economic benefits through the employment of staff in the donor country.

"goodwill" towards donor exporters. Given that donor countries might often combine aid missions and aid negotiations with trade missions, the aid relationship might "open the door" for donor exporters and lead to trade agreements (see also Martínez-Zarzoso et al. 2009, 2014; Nowak-Lehmann et al. 2009, 2013).

To model the impact of aid on recipient country imports and donor country exports, international trade literature (Bergstrand 1985, 1989) proposes the gravity model of trade as a suitable theoretical basis. This allows the determinants of trade in a *bilateral* donor-recipient framework to be evaluated.

2.2 Empirical literature on aid and trade

Whereas the effects of developmental assistance on the economic performance of the recipient countries have been extensively investigated in the last two decades (e. g. Morrissey 2006; Nowak-Lehmann et al. 2012), less attention has been devoted to quantifying the impact of aid on donor exports, perhaps because it is not the main motivation for giving aid. Nevertheless, it is worthwhile examining the issue given that previous research indicates that foreign aid also boosts donor exports. This outcome would be an important input in discussions, which regularly take place in donor countries, about the benefits of aid.

Early studies that examine the impact of aid on a donor country's exports are summarized in Martínez-Zarzoso et al. (2009). Our focus is on recent literature concerning the effect of aid on donor exports that takes the gravity model of trade as its main modelling framework, which is in turn augmented with development aid. Using this approach, Wagner (2003) researched the effect of aid on trade for 20 donor countries to 109 recipient countries for the period 1970–1990. The estimated trade elasticities with respect to aid ranged from 0.062 for fixed-effects (FE) to 0.195 for pooled OLS specifications. These elasticities translate into average returns on donor aid of around $2.29 (OLS) and $0.73 (FE) of exports per dollar of aid. Pettersson and Johansson (2013), on the other hand, find that aid increases bilateral trade flows in both directions. The authors analyze the effects from various foreign development assistance variables on both recipient and donor country exports and find a particularly strong relation between aid in the form of technical assistance and exports in both directions, supporting their interpretation that market knowledge through interpersonal relations is an important driver for exports. However, given that unobservable heterogeneity related to each bilateral relationship was not controlled for, this may bias the estimates, as pointed out by Nowak-Lehmann et al. (2013).

The most recent studies by Albrecht et al. (2007), Martínez-Zarzoso et al. (2009) and Nowak-Lehmann et al. (2009) on German aid also relied on a gravity

model and found that German aid always had a positive and significant impact on German exports. More specifically, an average return of between US$ 1.04–$1.50 for each US dollar of aid spent by Germany was calculated based on data from 1960 to 2005 and using fixed-effects, panel-data techniques.

This paper also follows a gravity model framework and expands on current literature by studying the effect of aid on a sectoral level, using sectoral export data and more advanced econometric techniques. In particular, we follow Shepherd (2008) in using a sectoral gravity-type model which is well suited to studying the sectoral impact of aid on trade. This model allows controlling for the impact of other influences on trade such as income (which affects production capacity and preferences for variety) and distance, in a world where trade agreements, colonial ties, common borders, and aid can also influence trade. We augment the model with exchange rates and two types of aid: German bilateral aid and the bilateral aid from DAC donors other than Germany, to assess possible displacement effects of other donors' aid on German exports.

We deviate from earlier studies, not only by estimating sectoral gravity equations that are much more demanding in terms of data and scaling down[4] requirements, but also by computing the gross output and gross employment effects of aid via their impact on sectoral exports. With this aim in mind, we use sector-specific labour coefficients and input-output analysis techniques in a partial equilibrium framework to derive the multiplier and to calculate the gross employment effect of aid associated with exports in different sectors.

3 Model specification and estimation

3.1 The gravity model

The gravity model of trade is nowadays the most commonly accepted framework with which to model bilateral trade flows. Although empirical applications preceded theory (Tinbergen 1962), a sound theoretical basis has been given to the model (e. g. Anderson 1979; Bergstrand 1985, 1989; Anderson/Van Wincoop 2003). In particular, it is currently widely acknowledged that controlling for relative trade costs is important for a theoretically-founded gravity model (Anderson/Van Wincoop 2003; Feenstra 2004). According to the underlying theory, trade between two countries is explained by nominal incomes, by the distance between the economic centres of the exporter and importer as a proxy

4 The sectoral export effects have to be scaled down as only a fraction of computed exports can actually be assigned to a specific sector.

for transport cost, and by a number of other factors aiding or preventing trade between them (e. g. trade agreements, common language, or a common border are generally modelled as dummy variables to proxy for these factors). Moreover, it allows us to simulate recipient country imports (German exports) with and without bilateral aid received by Germany.

The gravity model has been widely used to investigate the role played by specific policy or geographical variables in explaining bilateral trade flows. Consistent with this approach and in order to investigate the effect of development aid on German exports, we add bilateral aid from Germany as a "trade facilitator" factor and aid from other DAC countries as a "trade-deterrent" factor. We also add bilateral exchange rates.[5] In our specific empirical application, we focus exclusively on exports from Germany over time to all of its trading partners. We will therefore specify a one-sided gravity model where recipients are indexed by j, sectors by k and years by t. This model is estimated for each sector (15 sectors in total).

In this case the model reads as follows:

$$LX_{jkt} = (\chi_{kt}) + \alpha_j + \beta_1 LYR_{jt} + \beta_2 LYGER_t + \beta_3 LBAID_{jt} + \beta_4 LBAIDREST_{jt} + \beta_5 LEXRN_{jt} + \beta_6 FTA_{jt} + \varepsilon_{jkt} \quad [1]$$

where L denotes variables in natural logs; X_{jkt}, are the exports of sector k from Germany to country j in period t in current US$; YR_{jt}, indicates the recipient country's GDP in period t at current US$; $YGER_t$, stands for Germany's GDP in period t in current US$; $BAID_{jt}$ is bilateral net official development aid (net ODA disbursement) from Germany to country j in current US$; $BAIDREST_{jt}$ represents other DAC donors' net official development aid disbursed (except Germany) to country j in current US$; $EXRN_{jt}$ is the nominal bilateral exchange rate in monetary units of the recipient currency per Euro[6]; FTA_{jt} takes the value of 1 when Germany has a free trade agreement in force with the destination country, j, in period t.

χ_{kt}, are time fixed effects that control for omitted variables common to all trade flows but which vary over time (they are sector-specific in the estimation for all sectors). Sector-specific time-fixed effects are used as a proxy for the so-called "multilateral resistance" factors modelled by Anderson and Van Wincoop (2003). They are only included if autocorrelation is not controlled for and they therefore appear in brackets. ε_{jkt} denotes the error term that is assumed to be well behaved.

5 When the gravity model is estimated using panel data (with a time dimension), exchange rates are generally included as important determinants of bilateral trade flows over time.

6 The LCU/USD bilateral exchange rate would have been preferable but the use of time-fixed effects and/or control for autocorrelation reconciles the effect of using the LCU/EUR bilateral exchange rate.

α_j are recipient-specific fixed effects that proxy for time-invariant, recipient country characteristics or a time-invariant bonding between Germany and the recipient country (colonial ties). When these effects are included, the influence of the dummies that vary only with the "*j*" dimension, such as distance, colonial ties or common language, cannot be directly estimated. Consequently, these variables are not included in the regression equation.

As in principle all right-hand-side variables, but in particular our variable of interest, bilateral aid, might be endogenous (an increase in exports might increase the donor's willingness to give more aid) and feed-back on each other, the endogeneity issue has to be tackled. To control for endogeneity in a panel setting, this study uses the leads and lags approach, also known as the Panel Dynamic Ordinary Least Squares procedure (PDOLS). PDOLS was proposed by Kao and Chiang (2000) and Mark and Sul (2003) as a means of estimating long-run relationships between cointegrating variables.

3.2 Estimation issues

The estimation techniques used in this study are based on the concept of cointegration. In order to work within a cointegration framework, the time series and cointegration properties of the variables need to be checked. In our case, we find that all variables in the regression are non-stationary [I(1)],[7] while the error term, which contains all (redundant) omitted variables, is stationary [I(0)], implying that our variables are cointegrated (see the results for all sectors summarized in two tables in the Appendix (Tables A.1 and A.2)). As indicated above, the findings of cointegration are important for two reasons: Firstly, the existence of a stationary error term implies that the relationship is not spurious. Secondly, as the cointegration property is invariant to extensions of the information set, estimates will not be significantly affected by the presence of additional variables.

As our data consist of a maximum of 34 years and a cross-section of 75 countries,[8] we also test for the presence of autocorrelation and heteroskedasticity. The results of the Wooldridge test for autocorrelation in panel data and the LR test for heteroskedasticity indicate that the data suffer from both problems. Given the strong rejection of the null in both tests, the model is estimated by FGLS controlling for autocorrelation and by applying heteroskedasticity-corrected standard errors.

7 We used the Augmented Dickey Fuller unit-root test which assumes individual unit roots and operated with 3 lags.

8 Due to missing values, the regressions are run with 67 countries (cross-sections).

We proceed in three steps. Firstly, the long-term model is estimated using Panel Dynamic Ordinary Least Squares (PDOLS). The DOLS procedure (used throughout the paper) dates back to Saikkonen (1991) and Stock and Watson (1993) and involves augmenting the cointegrating regression with leads, lags and contemporaneous values of the first differences of the regressors to control for the endogenous feedback effects of all regressors (Wooldridge 2009: 642). Thus, an important feature of the PDOLS procedure is that it generates unbiased estimates for variables that co-integrate, even with endogenous regressors. The panel PDOLS regression, which is run for each sector k is given by (see, for example, Kao/Chiang 2000; Mark/Sul 2003):

$$\begin{aligned} LX_{jt} = (\chi_t) &+ \alpha_j + \beta_1 LYR_{jt} + \beta_2 LYGER_t + \beta_3 LBAID_{jt} + \beta_4 LBAIDREST_{jt} \\ &+ \beta_5 LEXNR_{jt} + \beta_6 FTA_{jt} \\ &+ \sum_{p=-1}^{p=+1} \theta_{1p} \Delta LYR_{jt-p} + \ldots + \sum_{p=-1}^{p=+1} \theta_{lp} \Delta LEXNR_{jt-p} + \eta_{jkt} \end{aligned} \quad [2]$$

where $\theta_{1p} \ldots \theta_{lp}$ are the coefficients of the lead and lag differences that account for endogeneity. j is recipient, p stands for the number of lags or leads, and t is time. Δ stands for the change that happened between period t and $t–1$ (first difference of the variables analyzed). The Schwarz and the Hannan-Quinn criteria were used to select the number of lags and leads.

α_j stands for the autonomous rise or fall in exports from donor countries through time-invariant factors that characterize the recipient country involved.

Secondly, as the PDOLS two-way, fixed-effect estimation with country-fixed and time-fixed effects does not remove the autocorrelation of the disturbances, we control for autocorrelation in the errors by integrating a FGLS procedure into the PDOLS procedure and estimate the model using a Panel Dynamic Feasible Generalized Least Squares (PDFGLS) procedure. This procedure involves two more steps: Once the model has been estimated via PDOLS (first step), the residuals are saved and the autocorrelation coefficient ρ of the residuals is estimated using $\eta^{*}_{jt} = \eta_{jt} - \hat{\rho}\eta_{jt-1}$. The estimated $\hat{\rho}$ is then used to transform all right- and left-hand-side variables into soft or quasi first differences (e. g. $LX^{*}_{jt} = LX_{jt} - \hat{\rho}LX_{jt-1}$; $LYR^{*}_{jt} = LYR_{jt} - \hat{\rho}LYR_{jt-1}$;... $LBAID^{*}_{jt} = LBAID_{jt} - \hat{\rho}LBAID_{jt-1}$(second step). In a third step, eq. [2] is re-estimated by replacing the original variables with the soft differences.

As a robustness check, we also use PPML and PGML. However, we are only able to apply panel-data methods instead of DOLS, and hence we are not fully controlling for the endogeneity of aid. Moreover, what we obtain are within-effects, which could be interpreted as short-run instead of long-run effects, as with DOLS.

3.3 Data sources and variables

Official Development Aid data are from the OECD Development Database on Aid from DAC Members.[9] We consider net ODA disbursements in current US$ instead of aid commitments because we are interested in the funds actually released to the recipient countries in a given year. Disbursements record the actual international transfer of financial resources, or the transfer of goods or services valued at the cost to the donor. Bilateral exports by sector are obtained from the UN COMTRADE database. Data on income variables are drawn from the World Bank (World Development Indicators Database 2011). Bilateral exchange rates are from IMF statistics. Distances between capitals have been computed as great-circle distances using data from CEPII. The FTA variable has been constructed using data from the World Trade Organization and programs provided by De Sousa (2012). A table with summary statistics for the main variables is included in the Appendix (Table A.3).

4 Main results

4.1 The average return of aid with respect to total exports

The model is estimated by means of the Dynamic Feasible Generalized Least Squares (DFGLS) technique for data on German exports and development aid (ODA) to 75 recipient countries from 1978 to 2011. The results from estimating the model for total exports (last row of Table 1) show that the elasticity of trade with respect to aid is 0.062, which implies that the average return on aid for German exports is approximately a 0.83 US dollar increase in exports for every dollar spent on aid.

This average return on aid for German exports can been calculated as,

$$\beta_{LBAIDG} = \frac{\partial X}{\partial BAIDG} * \frac{AVBAIDG}{AVX}$$

$$\Rightarrow \frac{\partial X}{\partial BAIDG} = \beta_{BAIDG} * \frac{AVX}{AVBAIDG} = 0.062 * \frac{485}{36.4} = 0.83$$

where the export figures refer to Germany's total bilateral exports, and the aid figures refer to Germany's bilateral net ODA disbursements. The mean values for all 75 countries over the period 1978–2011 are calculated.

9 www.oecd.org/dac/stats/idsonline.

Table 1: The impact of aid on German exports. Sectoral results.

Sector	Aid coeff.	*t*-value	R sq. adj.	D.W. stat.
Food, beverages, tobacco	**0.24*** **	**(3.17)**	**0.92**	**2.16**
Non-metallic minerals (glass, products of glass etc.)	**0.12*** **	**(3.06)**	**0.96**	**2.22**
Basic metals	**0.11*** **	**(2.45)**	**0.96**	**2.07**
Non-electrical machinery	**0.13*** **	**(3.72)**	**0.96**	**2.05**
Electrical equipment	**0.10*** **	**(2.74)**	**0.98**	**2.16**
Transport equipment	**0.14*** **	**(2.52)**	**0.95**	**2.13**
Coke, refined petroleum	**0.18*** **	**(2.46)**	**0.95**	**2.09**
Agriculture, hunting, forestry and fishing	0.07	(0.90)	0.85	2.18
Textiles	−0.05	(−1.00)	0.97	2.09
Leather	−0.05	(−0.89)	0.93	2.02
Wood, wood products	0.09	(1.13)	0.92	2.07
Pulp, paper	−0.14***	(−3.37)	0.96	2.17
Chemicals	0.03	(1.00)	0.98	2.3
Rubber, plastics	−0.02	(−0.44)	0.96	2.24
Manufacturing, NEC.	−0.02	(−0.44)	0.95	2.12
All Sectors	0.062**	(2.06)	0.95	2.04

Note: T-values are in brackets.***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All regressions contain controls for recipient GDP, donor GDP, bilateral aid given by non-German DAC countries, bilateral nominal exchange rates, and a trade agreement dummy. Data are annual and run from 1978 to 2011. Dynamic Feasible Generalized Least- Squares (DFGLS) estimation techniques were used. FE (recipient-country dummies) are always used as controls. The Durbin-Watson statistic (D.W. stat) indicates that this technique tackles the autocorrelation issue. Endogeneity of all regressors is always controlled for by means of the leads and lags approach, also known as DOLS estimation. By imposing FGLS on the panel DOLS estimation, the latter is transformed into a PDFGLS estimation which removes serial correlation of the disturbances. The PDFGLS procedure controls for cross-section heteroskedasticity. Figures in bold indicate the selected aid-coefficients used to calculate employment effects.

The effect is similar to that calculated by Martínez-Zarzoso et al. (2009) and Nowak-Lehmann D. et al. (2013) using total exports. Figure 1 shows the evolution over time of the aid coefficients in the gravity model by interacting them with specific time dummies. The point estimates (bold line) and the corresponding confidence intervals at the 95 % confidence level are shown. The coefficients on the control variables appear in Table A.4. The income effects show the expected positive sign and are statistically significant, the values are considerably lower than unity, as the theory predicted, but this is generally the case when using sectoral data. The effect of aid from other donors on German exports is not statistically significant, indicating that aid from other donors does not act as a trade-deterrent factor for German aid. The exchange rate variable is also not

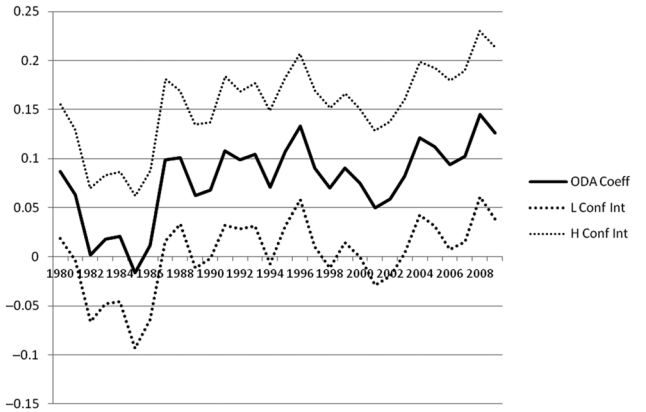

Figure 1: Time-specific aid coefficients and confidence bands.

statistically significant[10] and the FTA dummy variable shows a positive and significant coefficient, as expected.

As a robustness check, we consider the use of alternative estimators in Appendix (Table A.4). Using Poisson Maximum Likelihood or Gamma Maximum Likelihood estimators, we find that the coefficient of German bilateral aid remains substantial and highly significant, although slightly smaller. It is not surprising that the aid coefficients are slightly lower than the DOLS estimates. They are in fact very close to the estimates obtained using a log-log panel data fixed-effect estimation technique, which indicates that in our empirical application, the zero-trade and heteroskedasticity issues do not substantially affect the main results.

4.2 Sectoral exports and employment effects

Having obtained a robust positive and significant impact of bilateral German aid on German total exports, one might wonder how this positive effect is distributed among sectors, i. e. which sectors profit most and which sectors least or not at all, and finally how these sectoral export effects translate into employment effects.

In order to ascertain this, we collect sectoral export data (at the 2-digit level) from the UN-COMTRADE database using the Standard International Trade Classification (SITC Rev. 2). The 99-SITC sectors are then merged into 16 sectors

10 The use of time fixed effects usually removes the statistically significance of this variable.

Table 2: Concordance between SITC and ISIC classification.

SITC Rev. 2 (2-digit)	Input-Output Table for 2009, ISIC Rev. 3.1		
00 + 03 + 04 + 05 + 08 + 22 + 29	AtB	Agriculture, Hunting, Forestry and Fishing	1
extraction is not exported	C	Mining and Quarrying	2
01 + 02 + 06 + 07 + 09 + 11 + 12 + 41 + 42 + 43	15t16	Food, Beverages and Tobacco	3
26 + 65 + 84	17t18	Textiles and Textile Products	4
21 + 61 + 85	19	Leather, Leather and Footwear	5
24 + 63	20	Wood and Wood Products and Cork	6
25 + 64	21t22	Pulp, Paper, Paper, Printing and Publishing	7
32 + 33 + 34 + 35	23	Coke, Refined Petroleum and Nuclear Fuel	8
27 + 51 + 52 + 53 + 54 + 55 + 56 + 59	24	Chemicals and Chemical Products	9
23 + 57 + 58	25	Rubber and Plastics	10
66	26	Other Non-Metallic Minerals	11
28 + 67 + 68 + 69	27t28	Basic Metals and Manufactured Metal	12
71 + 72 + 73 + 74 + 75 + 76	29	Machinery, Nec	13
77 + 87 + 88	30t33	Electrical and Optical Equipment	14
78 + 79	34t35	Transport Equipment	15
81 + 82 + 89 + 93	36t37	Manufacturing, NEC; Recycling	16

according to the International Standard Industrial Classification (ISIC)[11] used in the German input-output tables. They contain export as well as employment data (see concordances in Table 2). The ISIC-specific employment (labour) coefficients are calculated using 2009 figures, the most recent input-output data available.

We then run sectoral regressions for 15 sectors, controlling for endogeneity and autocorrelation based on the Panel Dynamic Feasible Generalized Least Squares (PDFGLS) technique.[12] Focusing on the results generated for each sector using this technique, we find that German bilateral aid had a positive and significant impact on German exports to the recipient countries in seven (in bold) out of fifteen sectors (Table 1).

The sectors benefiting from bilateral aid comprise: food, beverages and tobacco, non-metallic minerals, basic metals, non-electrical machinery, electrical equipment, transport equipment, and coke and refined petroleum.

11 Since there are no exports in the mining and quarrying sector, only computations for 15 sectors are shown.

12 The Durbin-Watson statistic reveals that the technique that controls for autocorrelation (PDFGLS) is clearly superior to the PDOLS technique with time-fixed effects (results available upon request). The latter technique is not able to control for serial correlation of the disturbances, thus violating the assumptions of the Ordinary Least Squares (OLS) technique.

Most of the sectors that do not benefit from aid (reflected in insignificant aid coefficients), namely: agriculture; hunting; forestry and fishing; textiles; leather; wood and wood products; pulp and paper; rubber and plastics; and other non-classified manufacturing are sectors in which Germany does not enjoy a competitive advantage (in terms of price competitiveness) when exporting to developing countries. One might perhaps have expected a positive and significant increase of chemical exports due to an increase in bilateral aid but here emerging economies (such as Brazil) might be more (price) competitive in developing-country markets and outperform suppliers such as Germany. However, this does not imply that Germany necessarily enjoys a price-advantage in sectors such as food, non-metallic minerals, basic metals and coke where the aid coefficient is significantly positive. In these sectors other factors that were not considered in our analysis may play a role, such as a preference for variety, protection or quality. The role of quality in German exports has been highlighted by Lewney et al. (2012) who point to mostly low export price elasticities of German exports signalling their high quality (see table 4.2 in Lewney et al. 2012).

These estimations allow us to obtain estimates for the sectoral export effects with and without development aid. The sectoral export effects due to German bilateral aid can be either simulated,[13] based on PDFGLS regression coefficients, or simply calculated by multiplying the sectoral aid coefficient (only significant coefficients are used) with either average exports for the period 2000–2011 to produce conservative estimates, or with the 2009 exports, which is the last available year in the input-output tables. The 2009 results are more up-to-date but are influenced by the financial crisis that also affected the German economy. We show the export results for both periods, but then focus on the employment effects using the 2009 results.

When the elasticities of exports with respect to aid (aid elasticities = beta coefficients) were insignificant, no export and employment effects were calculated and the corresponding values were set to zero. Additional exports due to aid amounted to US$ 23.7 billion using 1973–2011 averages or US$ 27.4 billion relying on 2009 data (see Table 3). The average return on aid in different sectors (not calculated here) can vary greatly from year to year as the business cycle influences both exports and aid disbursements. It is therefore more appropriate to calculate the average return of aid on sectoral exports over the entire panel (see Section 4.1).

13 The value of exports is simulated with and without German bilateral development aid.

Table 3: Sectoral exports and employment effects generated by German bilateral aid.

Sector	Aid Coeff. (1)	Average Annual Exports* (2)	Exports 2009 (3)	Export effect * (4)	Export Effect 2009 ** (5)	Labour input coeff. 2009 (6)	Employment effect 2009 ** (7)
Food, beverages, tobacco	0.24	5.50E+09	8.00E+09	1.32E+09	1.92E+09	4.76	10,184
Non-metallic minerals (glass, products thereof)	0.12	3.00E+09	3.43E+09	3.60E+08	4.12E+08	5.00	2,887
Basic metals	0.11	2.26E+10	2.64E+10	2.49E+09	2.90E+09	4.15	23,331
Non-electrical machinery	0.13	7.25E+10	8.25E+10	9.43E+09	1.07E+10	4.26	52,180
Electrical equipment	0.1	3.62E+10	4.27E+10	3.62E+09	4.27E+09	4.59	23,821
Transport equipment	0.14	4.25E+10	4.61E+10	5.95E+09	6.45E+09	2.49	19,784
Coke, refined petroleum	0.18	2.76E+09	3.77E+09	4.90E+08	6.79E+08	0.25	226
Agriculture, hunting, forestry, fishing	n.s.	3.34E+09	4.98E+09	–	–	6.71	2,121
Textiles	n.s.	8.16E+09	8.91E+09	–	–	5.79	43
Leather	n.s.	1.25E+09	1.49E+09	–	–	6.92	4
Wood, wood products	n.s.	1.09E+09	1.21E+09	–	–	5.07	354
Pulp, paper	—	5.28E+09	6.37E+09	–	–	5.04	885
Chemicals	n.s.	2.27E+10	3.08E+10	–	–	2.52	288
Rubber, plastics	n.s.	8.96E+09	1.02E+10	–	–	5.41	2,050
Manufacturing, NEC	n.s.	2.26E+10	3.53E+10	–	–	5.02	413
Mining (no exports)	–	–	–	–	–		220
Total_goods							**138,789**
Total services (not reported)							**77,662**
Total	–	**258E+09**	**312E+09**	**23.7E+09**	**27.4E+09**	–	**216,451**

Note: Sectors are classified according to the International Standard Industrial Classification (ISIC) revision 3.1. Figures are calculated based on the input-output table for Germany in 2009 (WIOD (2014), available at: www.wiod.org). * based on the 2000–2011 average. ** based on the year 2009.Δexports denotes exports in US$ generated by German bilateral aid.Δemployment denotes number of jobs generated by German bilateral aid. Δexports** and Δemployment** have been calculated based on 2009 data. The labour input coefficient indicates the number of employees (in thousands) required to produce an output value of US$ 1 billion. Total output and total employment (in 2009) required to compute the labour input coefficients are from the German input-output Tables (WIOD 2014). Total exports are in current US$ and total employment in number of employees.

To calculate the employment effects, ideally one would use a well-specified general equilibrium model that could effectively capture the direct and indirect effects of increased sectoral exports and could be used to explore alternative uses of the aid funds (Vogler-Ludwig et al. 1999; Albrecht et al. 2007).[14] This would, however, reach far beyond the scope of the present paper. We therefore apply a much simpler technique to get a sense of the gross employment associated with the sectoral exports induced by aid (see also Schumacher 1981). In particular, we rely on input-output (I-O-A) techniques.[15] Additional sectoral exports due to aid ($\Delta \exp ort$) are transformed into additional sectoral gross output given that an increase in final demand requires production of intermediates whose production in turn also requires intermediates (and so forth). The required production of intermediates leads to the multiplier effect of production for final demand (i. e. to produce 1 unit of exports, the economy in question has to produce more than 1 unit of gross output to accommodate the production of intermediates). The multiplier is in the form of $(I\text{-}A)^{-1}$, where I denotes the identity (unit) matrix and A contains the input coefficients that result from the input-output tables.

$$\Delta output = (I - A)^{-1} \Delta\ export \tag{3}$$

After having calculated the change in sectoral gross output triggered by a change in exports, the gross sectoral employment effects of aid can be calculated:

$$\Delta jobs = job\_multi * \Delta output \tag{4}$$

where job_multi denotes the job multiplier or labour coefficient.

The input-output-analysis rests on several assumptions:

(i) Each sector in the economy produces only one product
(ii) There is no substitution between intermediate inputs
(iii) The production function is linear; we have constant returns to scale; if we double intermediate inputs, we double intermediate output
(iv) Final demand is exogenous
(v) Primary inputs are abundant; i. e. labour is abundant and available with the adequate mix of skills (i. e. no displacement effects of labour from other sectors)
(vi) No stocks; if final demand rises, there are no stocks to be depleted

14 The simulations based on general equilibrium models were performed by Bernd Meyer (University of Osanbrück, Germany).

15 We would like to thank Bart Los for his assistance in producing these results.

These assumptions are simplistic but may be effective in getting a sense of short-term effects, which is our objective. Most of the assumptions imply constant technology over shorter periods of time, which is a plausible assumption,[16] as well as a swift increase in production[17] with respect to increases in demand in recipient countries. Demand is considered exogenous, which again might be a realistic short-run assumption.

At the same time, it is clear that these are gross effects that are likely to overestimate the net employment creation of aid-induced exports for two reasons. Firstly, there are likely to be some general equilibrium effects operating via prices and wages that ensure that increased aid-induced exports partially crowd out other activities. Secondly, this approach does not consider alternative uses of the aid funds (e. g. lower taxes or other spending) with associated employment effects.

Turning to the results, we find pronounced employment effects associated with aid-induced sectoral exports in non-electrical machinery, transport equipment, electrical equipment, basic metals, as well as food and business-related services (i. e. services related to both food and business as renting of machinery and equipment; retail trade and repair of household goods; wholesale trade). About 52,000 jobs are associated with increased exports in non-electrical machinery, 20,000 in transport equipment, 24,000 in electrical equipment and basic metals, and another 10,000 jobs are created in food, beverages and tobacco, with about an additional 78,000 in business-related services that are induced by the exports of goods associated with aid. The increase in services results from services being an intermediate input in the production of export goods.[18] In total, between US$ 24 and 27 billion of additional sectoral exports are generated, with a total gross employment effect of about 216,000 jobs (based on 2009 figures).

16 Producers choose the most cost-efficient production technique. Thus, in the short run substitution between inputs and non-linear production functions can be assumed away.

17 Stocks are costly and therefore kept to a minimum. The possibility of labour and capital inflows allows producers to react promptly.

18 As to our dependent variable, one must bear in mind that we use UN COMTRADE data on the exports of goods only (excluding services). However, in the I-O-A both the goods and services sectors are included whereby an increase in the export of goods would also require an increase in the production of services (intermediate production). So this is an indirect effect of exports generated in the goods sector.

5 Conclusions

This paper examines the relationship between sectoral German exports and foreign German aid, and calculates the employment effects stemming from the growth in exports due to development aid. The main results indicate that German aid has a substantial, positive effect on German sectoral exports and that for a number of sectors, the employment effects associated with aid are economically important. Although the aid effect is not as large as predicted in earlier studies, it is still relevant. It is important to note that the estimated effects only account for first-round partial equilibrium effects and do not consider alternative uses of funds.

Our findings indicate that the average return for exports of German aid is an increase of about 0.83 US dollar in exports for every Euro of aid sent to the 75 development partners of the BMZ. Secondly, this effect differs by sector. Substantive export effects are generated in non-electrical machinery, transport equipment, electrical equipment, basic metals and food and business-related services; in many of these sectors, German exporters are internationally very competitive and aid appears to provide a further advantage, particularly in those sectors. Thirdly, by using input-output techniques, the gain in exports is reflected in the corresponding gross output and employment effects, which are most pronounced in non-electrical machinery, transport equipment, electrical equipment, and basic metals. According to conservative estimates, a total of about 216,000 jobs are generated through German bilateral aid.

This research and the related literature suggest that the impact of aid on trade depends on the type of products traded and the export strength in the respective sectors. The changing impact of aid over time is also discernible although there is no evidence of a decline of aid elasticities after 2002, when most German aid had been untied.

The relationship between sectoral trade and aid could be more closely analyzed by using more donor countries, or focusing on country case studies for other donors. This would give us additional insights into the extent to which a gain in donor exports is driven by the export structure of particular donors, or is determined by the specific choices of recipient countries.

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Appendix

Table A.1: Tests on non-stationarity.

	ADF-Fisher-Chi-square statistics	*p*-value
lx	1,979.35	1.00
lyr	206.71	1.00
lyGER	962.03	1.00
lbaid	1,469.38	1.00
lbaidrest	1,861.05	0.59
lexrn	1,728.02	1.00

Note: Null hypothesis: Unit root (individual unit root process); Unit-root test = Augmented Dickey-Fuller (ADF) test.

Table A.2: Test on cointegration (Kao Residual Cointegration Test).

Series	ADF *t*-statistic	*p*-value
lx, lyr, lyGER, lbaid, lbaidrest, lexrn	−39.58	0.00

Note: Null hypothesis: No cointegration; trend assumption: no deterministic trend.

Table A.3: Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	38,250	2.89E + 07	1.51E + 08	0	5.96E + 09
Ln Exports	34,347	14.448	2.670	2.079	22.508
Ln recipient income	32,550	22.990	1.684	18.522	28.538
Ln donor income	37,870	26.931	5.052	4.164	28.918
Ln ODA	30,768	16.114	2.483	7.092	21.260
Ln other donors' ODA	31,300	17.442	5.071	0	22.933
Ln bilateral exchange rate	32,759	3.974	5.507	−25.601	22.933
Ln distance	34,590	8.108	2.152	0	9.326
Colonial relationship dummy	34,635	0.036	0.186	0	1
Free trade agreement dummy	35,265	0.065	0.246	0	1

Table A.4: Alternative estimators.

All Sectors Variables	(1) FGLS-DOLS	(2) PPML	(3) PGML
Ln donor income	0.185***	0.110***	–0.0203
	[0.052]	[0.0163]	[0.0266]
Ln recipient income	0.674***	0.769***	0.592***
	[0.0428]	[0.0510]	[0.0281]
Ln ODA	0.0639**	0.0431***	0.0477**
	[0.0217]	[0.00860]	[0.0244]
Ln other donors' ODA	–0.0158	–0.0292**	0.0450
	[0.0204]	[0.0125]	[0.0319]
Ln bilateral exchange rate	0.00323	0.0232***	–0.00597
	[0.0067]	[0.00526]	[0.00604]
Free Trade Agreement dummy	0.115**	0.121	0.120
	[0.026]	[0.0749]	[0.0765]
Observations	21,542	27,424	27,424
R-squared (P-R-sq.)	0.979	(0.317)	–

Notes: Robust standard errors in brackets. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
PPML and PGML denote respectively Pseudo Poisson Maximum Likelihood, and Pseudo Gamma Maximum Likelihood.

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