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AID DISPERSION: MEASUREMENT IN PRINCIPLE AND PRATICE

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Aid Dispersion: Measurement in Principle and Practice[1]

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Abstract

Excessive dispersion of development assistance has been high on the Paris Agenda on aid effectiveness. However, there is no agreement in the existing literature on how aid dispersion should be measured and few studies of the extent of the problem. We argue for using the Theil Index for both recipients and donors. This relative inequality measure has a major advantage: it allows for a perfect decomposition into variation between and within entities. Exploiting this property, we can rank official donors and recipients not only in terms of the total spread, but also assess the contributions of geographic and sectoral dispersion. We provide a detailed picture of developments along various dimensions (globally as well as for countries, income groups, and regions, over 1998-2013). We further distinguish between bilateral and multilateral donors. Consistent with other studies using more limited samples, we find little effect of the Paris Agenda overall. Aid is more fragmented in Sub-Saharan Africa and in the poorest countries. Globally as well as for most donor and recipient countries, between variation is the main driver of the spread, lending support to the geographic concentration policies many donor countries have adopted. Bilateral aid has been somewhat more dispersed than multilateral aid and in both cases the large number of donors controlling similar shares of total funds is a major driver of the total spread. The latter suggests that concentration could also be achieved through a reduction of the number of actors on the donor side of the aid industry, a perspective that previous studies using other measures have been unable to capture.

Keywords: Foreign aid, aid dispersion, transaction costs, Paris Agenda, Theil Index

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1. INTRODUCTION

The dispersion of development assistance has been high on the so-called Paris Agenda on aid effectiveness.[4] In short, the argument has been that there are too many actors funding too many activities in too many countries. It is widely believed that this leads to excessive transaction costs, i.e., to spending on planning, monitoring, reporting, and evaluation being disproportionate relative to spending on activities actually generating valued goods and services.[5] It is also argued that the current situation creates incentive problems on both sides of the aid relationship. For example, recipients might suffer from the tragedy of the commons if aid agencies compete for resources such as host government personnel or funds.[6] However, while the usefulness of transaction costs of aid as an analytical concept is reflected in its widespread use in the literature it is not clear that they are measurable.[7] This implies that we cannot directly assess how changes in the structure of aid delivery affect these costs, neither in the aggregate nor for any single actor. Moreover, it is obvious that the optimal level is not zero.[8] A project that is better prepared has a higher chance of being a success. Monitoring progress may reveal that it is lacking, allowing adjustments that put projects back on track to be made or misconceived programmes to be terminated before they consume even more resources. Evaluations can provide valuable lessons learned, improving aid effectiveness in the future. One should also bear in mind that the issue of aid effectiveness goes beyond

[4] The term "Paris Agenda" is commonly used to describe a series of "high level" meetings as well as the preparations and follow-up activities connected with them. The first meeting was in Rome (2003). The two producing the clearest statements of the intentions of the participants (donors as well as recipients) were Paris (2005) and Accra (2008). The documents can be found at http://www.oecd.org/dac/effectiveness/34428351.pdf .

[5] Morss (1984) was probably the first to link such costs to increases in the number of donors and aid activities: "The expansion of project lending and the proliferation of donors have imposed heavy burdens on developing nations." (p. 466)

[6] See Knack and Rahman (2007) and Arimoto and Kono (2009), respectively. Similarly, Knack and Smets (2013) find that donors tie a smaller share of their aid when they have larger shares of the "market," i.e., they behave more narrowly self-interested when competition is fierce.

[7] As Acharya et al. (2006, p. 6) put it: "What are these transactions costs? No one has ever measured them. It is not clear that they are measurable." Anderson (2012) and Bigsten and Tengstam (2015) make laudable efforts, but it is not obvious that the statistical category of administrative costs equals transaction costs for donors. Moreover, they do not even try to do something similar for recipients.

[8] An indication of this is provided by Han and Koenig-Archibugi (2015), who find that both countries with few and those with many donors of health aid do worse in terms of child survival.

transaction costs and that fragmentation could in principle have positive effects in other dimensions.[9]

Still, we have indications that aid is currently spread too thinly, imposing excessive costs on recipients on average. Annen and Kosempel (2009), Djankov et al. (2009), and Kimura et al. (2012) all draw the conclusion that aid dispersion is associated with lower economic growth in recipient countries.[10] Furthermore, in addition to the commitments made as part of the Paris Agenda, several donors have adopted their own policies of concentration. An interesting question in its own right is then whether these declarations have resulted in lower spreads. Somewhat surprisingly given the attention the topic has received at the policy level, there are rather few academic studies of it. We know of just three that have this as the main focus, as opposed to looking at the consequences of dispersion.[11] Acharya et al. (2006) has a fairly broad coverage of donors (22 bilateral ones) and recipients (179), but only for three years (1999-2001). Aldasoro et al. (2010) have a longer time frame (1995-2006), but only data for 10 members of the OECD's Development Assistance Committee (DAC). They conclude that despite the Paris agenda, donors have made little progress in concentrating their aid. This conclusion is echoed by Nunnenkamp et al. (2013). They have 19 DAC-donors in their sample, which covers the period 1998-2009. This makes the "before-after" comparison more credible. Yet, as they split the sample at the halfway point and it ends in 2009, they might not have picked up longer-run effects of a process that arguably gathered speed until 2008 at least.

Another limitation of the extant literature is that there is little discussion of and no agreement on how dispersion should be measured.[12] For example, Acharya et al. (2006) use different measures to gauge dispersion for recipients and donors, with no convincing argument as to why this is the correct approach. We will apply their terminology and call the former *fragmentation* and the latter *proliferation*. However, we will use the same measure for both. Fragmentation is the major cause of concern in both policy circles and the academic

[9] For example, having several donors might reduce overall aid volatility as a reduction in transfers from one donor could be counteracted by others and vice versa. Nevertheless, the empirical evidence is inconclusive on this point, c.f. Canavire-Bacarezza et al. (2015) and Gutting and Steinwand (2015).

[10] In contrast, Gehring et al. (2016) find only limited evidence for such an effect.

[11] O'Connell and Soludo (2001) investigate "aid intensity" in Africa more broadly. Dispersion is also a very minor part of the studies of aid agency performance by Easterly (2007), Easterly and Pfutze (2008), and Easterly and Williamson (2013). More references to analyses of the effects on recipients will be given below.

[12] An important exception is Dreher and Michaelowa (2010), which we discuss in the next section. Also see Gehring et al. (2016).

literature. Still, what donors control is proliferation and the link to fragmentation is not straightforward; focussing on a single recipient could worsen fragmentation there and even a donor taking care to avoid this could see the effort nullified by the actions of other donors. Hence, it is important to check whether reduced proliferation is detectable on the other side of the relationship. In addition, the spread of donor funds is important in its own right as transaction cost savings could result in larger transfers to recipients for given overall aid budgets. Given that we do not know the transaction cost functions of donors and recipients, it is arguably more consistent to apply the same measure to both types of aid dispersion. To our knowledge, this is the first time this has been done.

Our second contribution is to fully exploit the properties of our preferred index, the Theil. This is a relative inequality measure informing us how far the actual distribution of aid is from the extremes of maximum spread and complete concentration and we argue that there is no reason why this is an inferior alternative to the more commonly used Herfindahl-Hirschman Index (HHI). Moreover, the Theil has a major advantage: it belongs to the only class of inequality measures that allow for a perfect decomposition into variation between and within entities (Shorrocks 1980). Using this property, we can rank donors and recipients not only in terms of the total spread, but also pinpoint whether the lion's share of it is due to having many partners (between) or to thinly dispersed aid at the sector level (within). In contrast, the standard approach of looking at the HHI calculated at the country level cannot account for the latter and hence could miss an important part of the total variation. And this information has obvious policy relevance as donor countries like the Netherlands, Norway, and Sweden have in recent years adopted policies aimed at reducing the number of partner countries.

Thirdly, the flip-side of perfect decomposability is perfect aggregation. While previous studies have focussed on individual donor and recipient countries, we can group these consistently in various ways. On the recipient side, we look at differences in fragmentation across regions and income levels, as well as aggregating all the way up to show the global picture. This enables us to provide new perspectives, including whether fragmentation globally is driven mainly by a relatively equal distribution across recipients or by high dispersion within them. On the donor side, we are able to study bilaterals and multilaterals separately. While proliferation is limited for most multilaterals by mandates that are restrictive in terms of geography or sector, their aggregate contribution is of interest, particularly in light of the increasing number of such actors (c.f. Figure 2 below). We believe our study is the first to analyse the consequences of this trend for aid dispersion.

Our final contribution is to look at these issues in a longer time-frame (1998-2013) than previous studies. Consistent with these, we find little effect of the Paris Agenda on either fragmentation or proliferation. In fact, dispersion has increased globally. There are also both more donors and more recipients recording higher spreads in the latter half of our time frame than those seeing reductions. Apparently, the various international declarations and individual aid policies have not had much bite in practice. Fragmentation is more severe in Sub-Saharan Africa and in the poorest countries. Both globally and for most donor and recipient countries, between variation is the main driver of the spread, lending support to the geographic concentration policies mentioned above. Bilateral aid has been somewhat more dispersed than multilateral aid. Proliferation by both donor types are in the aggregate mainly caused by there being many actors with quite similar shares of total bilateral and multilateral aid, respectively. This finding points to a neglected part of the picture, viz. that other things being equal concentration could also be achieved through a fall in the number of donors. Since it is likely that there will be even more bilateral donors in the future as emerging economies initiate their own aid programmes, this can probably only be achieved through a reduction in the number of multilaterals.

The rest of this paper is organised as follows. In the next section, we discuss principles for measuring aid dispersion and state formulas for different variants of the Theil. Our data are described in section 3. Section 4 contains the aggregate results, while the topic of section 5 is developments in individual donor and recipient countries. As a robustness check, the correlation of the Theil and the HHI is briefly analysed in section 6. Finally, we summarise our findings in section 7.

2. MEASURING AID DISPERSION: PRINCIPLES

The extent of fragmentation (within a recipient country, across donors) or proliferation (by a donor, across recipients) concerns how a certain sum (total aid to a recipient country or total aid by a donor) is spread across entities, which could be projects, thematic sectors, or recipient countries. There are many different measures of dispersion that could be used, but little discussion and no consensus in the literature on which of these are preferable. Some of those actually applied are fairly ad-hoc and/or only capture part of the phenomenon. This can be said of expressing fragmentation in terms of the number of donors, for example. In this section, we dispute the view that concentration measures like the HHI are better than inequality measures like the Theil in terms of capturing the effects of dispersion and contend that the best we can do currently is to assess dispersion itself. In our opinion, the Theil Index

does this as well as the alternatives. Moreover, its perfect (dis)aggregation property opens new and policy-relevant perspectives on the topic at hand.

Dreher and Michaelowa (2010, p. 11) argue that

To be appropriate for the assessment of in-country aid fragmentation [an] index should ideally fulfil all of the following requirements. It should (1) reflect fragmentation in a *theoretically correct* way, (2) be *easily understandable and computable*, and (3) use a functional form appropriate to reflect the *problems* involved with in-country aid fragmentation. (Emphasis in original)

These principles are sensible. However, on further reflection they are not easily applicable. The main problems concern requirements (1) and (3). What we ideally would like to have is a measure that relates fragmentation to transaction costs. However, we have neither a theoretical model nor empirical estimates of this relationship. Country- or sector-specific factors might imply that a certain level of fragmentation is more or less harmful, but there is currently no way of picking up these in an applied analysis. Moreover, we lack the data to take fully into account whether donors use aid modalities such as sector-wide approaches or multi-donor trust funds that are often argued to entail lower transaction costs.[13] Finally, although Dreher and Michaelowa (2010) claim that due to (1) concentration measures are preferable to inequality measures, their argument is not completely consistent.

The HHI is probably the most frequently used basis for quantifying the effects of fragmentation in the academic literature.[14] Dreher and Michaelowa (2010) find that it is overly sensitive to an increase in the number of donors at low levels. For this reason, they prefer measures that capture the cumulative shares of the 3-5 largest donors. However, these are ad-hoc and there is no way of knowing which is the "correct" one. Moreover, both these and the HHI are based on shares, like the Theil, and are not necessarily monotonically

[13] See e.g. the discussion in Nunnenkamp et al. (2013). Yet, it should be noted that coordination is costly too and sometimes these new forms of aid seem to merely add to the complexity of donor-recipient relationships, c.f. Leiderer (2015) on Zambia. Moreover, changes occurring within donor agencies, such as the proliferation of trust funds inside multilaterals documented by Reinsberg et al. (2015), are not reflected in standard data sets.

[14] It is used by Annen and Kosempel (2009), Djankov et al. (2009), Gehring et al. (2016), Kimura et al. (2012), and Knack and Rahman (2007). Kilby (2011) computes various indices of both proliferation and fragmentation to study their impact on project size. The most common approach is to subtract HHIs from 1 to get a fragmentation measure.

declining in the number of donors.[15] Hence, while there might be fixed transaction costs per donor, in the end their argument that concentration measures are superior on theoretical grounds is not so convincing. We will argue that given our current knowledge, we need to accept that we cannot quantify transaction costs and thus that there is no perfect measure of aid dispersion. However, we can still assess the latter. As we will elaborate on shortly, the perfect decomposability of the Theil Index is a very useful but hitherto unexploited property that provides new perspectives on this issue.

The standard formula for the Theil, using notation adapted to the purpose of quantifying fragmentation for a recipient with *D* donors, is

$$(1)\ T_{rt} = lnD - \sum_{d=1}^{D} \rho_{drt} ln\left(\frac{1}{\rho_{drt}}\right),$$

where $\rho_{drt} = A_{drt}/A_{rt}$ is the share of donor *d* in total aid to recipient *r* at time *t*.

The Theil is often used to quantify income inequality, with higher values implying greater inequality. In the current context, T_{rt} is a measure of how *concentrated* aid to recipient *r* at time *t* is, not of fragmentation. To see this, it is useful to rewrite the formula slightly (using $\Sigma_d \rho_{drt} = 1$):

$$(2)\ T_{rt} = lnD + \sum_{d=1}^{D} \rho_{drt} ln\rho_{drt} = \sum_{d=1}^{D} \rho_{drt} lnD\rho_{drt} = \sum_{d=1}^{D} \rho_{drt} ln\left(\frac{\rho_{drt}}{1/D}\right)$$

Intuitively, aid is maximally fragmented when all donors have the same share, i.e., when $\rho_{drt} = 1/D$. We then have $T_{rt} = 0$. The last formula highlights the fact that the Theil can be interpreted as a measure of the extent to which aid shares (the ρ_{drt}s) differ from the "population" shares ($1/D$, since all donors count the same). When aid shares equal population shares ($\rho_{drt} = 1/D$ for all *d*) there is no inequality, and hence T_{rt} is zero.

The Theil stays constant as long as the distribution of shares does not change. Dreher and Michaelowa (2010, p.11) use this as an argument against applying it because "fragmentation is driven by both the number of donors and their relative size." However, T_{rt}

[15] The following example illustrates this. Starting from a situation where there are two donors, both with aid shares 0.5, a new donor enters providing twice the original amount of total aid. The HHI then *stays constant* at 0.5. If the newcomer provides thrice the original total, the HHI *goes up* to 0.59.

will change with D as long as the distribution does not always stay the same and the probability that this is the case no matter how many partners a recipient country has is obviously zero in the real world. Taking into account the sectoral distribution, as we do below, this too would have to remain invariant to changes in D to keep T_{rt} constant. It is inconceivable that donors will adjust in this way whenever their numbers go up or down. Hence, for practical purposes this is not a concern.

A potentially more worrisome problem with using the Theil to capture fragmentation is that it will also be zero if D is the actual number of donors and $D = 1$. In our data set, a couple of very small recipients actually have only one donor (giving to only one sector), so this is not only a theoretical possibility. Without correction, their Theil Index would then show the same value as for maximum dispersion even though these are cases where aid is maximally concentrated. The reason is that inequality is obviously a meaningless concept for a "group" consisting of one entity only. In contrast, it is certainly meaningful to say that fragmentation in r is minimised if it has a single partner. However, there is a simple and intuitive way around this "double zero" problem.

As noted without discussion by Acharya et al. (2006) with respect to proliferation, D should be the number of *potential* donors. This is in fact how the Theil is used to assess income inequality in a given population, allowing the index to capture distributions where some individuals have nothing without excluding them from the group. In the current context, making this adjustment implies that unless all *possible* partners have aid shares of $1/D$ each, $T_{rt} > 0$. In other words, the "double zero problem" vanishes. If recipient r has only a single donor out of $D>1$ possible ones, (2) shows that $T_{rt} = \ln D$.[16] A value of zero is assigned to r if and only if it receives allocations from all possible donors and all of them give the same share of the total (and thus identical amounts as well). Ranking countries in inverse order, the Theil is a good measure of fragmentation. Alternatively, one can see it is a measure of concentration, which is what we will do.

A really useful property of the Theil is that it is *additively decomposable*. That is, the overall index can be divided into inequality across and inequality within groups.[17] For present

[16] In our analysis, D will be operationalised as the total number of donors giving aid in year t. As this could be a time-varying number, we will henceforth denote it by D_t.

[17] As mentioned above, it belongs to the only class of inequality measures that allows perfect decomposability in this sense. Decomposing the Gini, for example, generates a residual. This residual reflects the degree to which the distributions overlap, which is not interesting information in the aid context. For further discussion, see Sen (1997, pp. 152-154).

purposes, this means that we can distinguish between the contributions to recipient *r*'s overall level of fragmentation from its donors' shares in the total provided and their allocation of resources to different sectors within *r*. This is highly relevant information as it would indicate whether a perceived excessive degree of fragmentation is due to having too many donors or to aid being delivered in excessively small batches. Moreover, ignoring the sector spread means that we underestimate total dispersion as we are then implicitly assuming that every sector in every country gets the same share of the total aid received by that recipient.[18] This is the case for most previous studies, where fragmentation has been measured using donor shares at the country level to calculate the HHI.

In the current context, the decomposition is performed by dividing the overall Theil index for *r* into *the between component*, which is displayed in equations (1) and (2), and *the within component*, which captures the sectoral dispersion in this recipient. The latter term is in essence a weighted average of Theil indices for each sector, the weights being their shares in total aid to *r*. Consider the case where aid can be allocated across a maximum of *S* sectors in each recipient. We then have

$$(3)\ T_{rt} = T_{rt}^{Between} + T_{rt}^{Within} = \sum_{d=1}^{D_t} \rho_{drt} ln\left(\frac{\rho_{drt}}{1/D_t}\right) + \sum_{d=1}^{D_t} \rho_{drt}\left[\sum_{s=1}^{S} \sigma_{drst} ln\left(\frac{\sigma_{drst}}{1/S}\right)\right]$$

$$= lnD_tS + \sum_{d=1}^{D_t}\sum_{s=1}^{S} \rho_{drst} ln\rho_{drst}$$

As above, ρ_{drt} is the share of donor *d*'s aid in the total recipient *r* receives at time *t*, whereas $\rho_{drst} = A_{drst}/A_{rt}$ is the corresponding share of aid to sector *s* in recipient *r* and $\sigma_{drst} = \rho_{drst}/\rho_{drt} = A_{drst}/A_{drt}$ the share of sector *s* in the aid *r* receives from *d* at this point in time.[19]

As is the case for *D*, it is intuitive that *S* should be the *potential* number of sectors to which aid could be allocated, not the actual number. Which sectors are funded by aid is a result of choices. Thus, if the education sector receives assistance in Rwanda but not in Tanzania, this should not change the value assigned to the maximum spread, which it would if one were utilising recipient-specific (and most likely, time-varying) numbers S_{Rwanda} and $S_{Tanzania}$. Instead, the Theil should be allowed to register the impact this difference between the

[18] The same type of mismeasurement is of course made when judging global inequality solely on the basis of differences in mean incomes across countries, i.e., ignoring inequality within countries.

[19] To get from the first line to the second, it is useful to note that $\Sigma_r\rho_{drt} = \Sigma_s\sigma_{drst} = 1$.

two countries has on their respective levels of fragmentation. We will use the sector classification in DAC statistics, so *S* will also be the same across all years.

In the following, we work with a normalised version of (3). Dividing through by *ln* D_t**S* gives a number between 0 and 1, with higher values signifying greater concentration.[20] The interpretation of this index is that it shows how far the distribution of aid to *r* is from the theoretical maximum and minimum dispersion of 0 and 1, respectively, at any point in time. Thus, using the potential number of donors and sectors preserves the basic intuition of relative inequality measures.

Donors and recipients probably have separate transaction cost functions, but when these are unknown it is arguably more consistent to use the same measure to assess dispersion for both types of actors. We therefore calculate a normalised Theil for donor *d* at time *t*.[21] The basic formula is

$$(4)\ T_{dt} = T_{dt}^{Between} + T_{dt}^{Within} = \sum_{r=1}^{R_t} \alpha_{drt} ln\left(\frac{\alpha_{drt}}{1/R_t}\right) + \sum_{r=1}^{R_t} \alpha_{drt}\left[\sum_{s=1}^{S} \delta_{drst} ln\left(\frac{\delta_{drst}}{1/S}\right)\right]$$

$$= lnR_tS + \sum_{r=1}^{R_t}\sum_{s=1}^{S} \alpha_{drst} ln\alpha_{drst}$$

Here $\alpha_{drt} = A_{drt}/A_{dt}$ is the share of recipient *r* in donor *d*'s portfolio at time *t* and $\alpha_{drst} = A_{drst}/A_{dt}$ the share of aid to sector *s* in recipient *r* in that total. $\delta_{drst} = \alpha_{drst}/\alpha_{drt} = A_{drst}/A_{drt}$ is the share of its aid to this recipient that donor *d* allocates to sector *s*. R_t is the number of eligible recipients – below, all countries on the DAC-list - and, as above, *S* the number of sectors. Dividing through by *ln* R_t**S* results in a measure of how concentrated *d*'s aid is that runs on a scale from 0 (lowest) to 1 (highest).[22]

Note that since a donor's total spread is a function of both geographic and sectoral dispersion, concentration in one of these dimensions need not produce lower proliferation

[20] To have a direct measure of fragmentation, one could subtract T_{rt} from 1. However, it is not straightforward to decompose the result into between and within variation. We therefore think that it is better to define fragmentation as minus the Theil if one wishes to present dispersion from that angle.

[21] As far as we are aware, only Acharya et al. (2006) have applied the Theil proper to gauge proliferation.

[22] A measure of proliferation can then be obtained by subtracting the normalised index from one. However, it has the same disadvantage with respect to decomposition as the fragmentation measure discussed in footnote 17.

overall.[23] It is also worth bearing in mind that the relationship between a donor's proliferation and fragmentation in its recipients is not necessarily monotonic. For example, if a major donor pulls completely out of one recipient to concentrate all of its aid in another, the Theils of the two could easily move in opposite directions.[24] Studying developments in the indices for both proliferation and fragmentation over time provides a check of whether progress has been made on both sides and the decomposition makes it possible to locate more precisely the sources of both positive and negative changes.

A further check on developments comes from calculating global Theils for proliferation and fragmentation in every sample year, respectively:

$$(5a)\ T_t^B = \sum_{b=1}^{B_t} \beta_{bt} ln\left(\frac{\beta_{bt}}{1/B_t}\right) + \sum_{b=1}^{B_t} \beta_{bt} T_{bt} = lnB_t R_t S + \sum_{b=1}^{B_t}\sum_{r=1}^{R_t}\sum_{s=1}^{S} \beta_{brst} ln\beta_{brst}$$

$$(5b)\ T_t^M = \sum_{m=1}^{M_t} \mu_{mt} ln\left(\frac{\mu_{mt}}{1/M_t}\right) + \sum_{m=1}^{M_t} \mu_{mt} T_{mt} = lnM_t R_t S + \sum_{m=1}^{M_t}\sum_{r=1}^{R_t}\sum_{s=1}^{S} \mu_{mrst} ln\mu_{mrst}$$

$$(5c)\ T_t^R = \sum_{r=1}^{R_t} \pi_{rt} ln\left(\frac{\pi_{rt}}{1/R_t}\right) + \sum_{r=1}^{R_t} \pi_{rt} T_{rt} = lnD_t R_t S + \sum_{d=1}^{D_t}\sum_{r=1}^{R_t}\sum_{s=1}^{S} \pi_{drst} ln\pi_{drst}$$

In (5a) $\beta_{bt} = A_{bt}/A_t^B$ is the share of bilateral donor b in total bilateral aid at time t, A_t^B. β_{brst} is the share of this total received by recipient r from b as funding for sector s. In (5b), μ_{mt} and μ_{mrst} are defined in an analogous manner. B_t is the number of potential bilateral donors at time t and M_t the corresponding number of multilateral institutions, with $D_t = B_t + M_t$. In the formula for global fragmentation (5c), π_{rt} is the share of global aid at time t received by recipient r and π_{drst} is the share of this total received by that recipient from donor d for spending in sector s. Below, the three indices will all be normalised to the zero-one interval.

The between components of bilateral and multilateral aid dispersion – the first sums appearing after the first equality signs in (5a) and (5b) – provide a perspective that has hitherto been neglected. These expressions gauge the spread of total bilateral and multilateral aid respectively across such actors. Hence, we can see the degree to which these "sectors" are concentrated and judge the shares of the total dispersion that stem from there being a plethora

[23] This is formally demonstrated in the analytical appendix.

[24] See appendix B of Hagen (2015) for numerical examples of the effects of changes in a donor's allocation across two recipients on its own Theil and theirs.

of actors controlling the funds and from individual donors proliferating a lot (within variation, the second sums in the equations). In contrast, previous studies of proliferation like Aldasoro et al. (2010) and Nunnenkamp et al. (2013) have only considered the latter question.

It is important to note that the global Theil for proliferation is not simply the sum of (5a) and (5b). It is in fact the same as that for fragmentation, as these indices both cover the universe of donor-recipient-sector allocations. For this reason, the exact formula for the former is relegated to the analytical appendix.[25] Below, we will state and/or graph concentration indices for individual donor countries. However, multilateral institutions are more constrained by their mandates when it comes to where or for what purposes their funds can be allocated. Hence, we do not present individual Theils for these aid agencies. Still, they should be included in the Theils of recipients to get a complete picture of fragmentation. In addition, the total multilateral contribution to global aid dispersion is clearly an interesting statistic. We thus show how T_t^M develops over our sample period.

It is well-known that aid intensity varies between regions. It is hence conceivable that the dispersion of development assistance varies across them. This could also be useful information for policy purposes. For this reason we calculate regional dispersion indices for recipients as well.[26] Finally, we do the same for income groups.

3. DATA

In the aid allocation literature it is common to use *commitments* as they are assumed to reflect better donors' intentions.[27] *Disbursements* – actual payments - can vary for a number of reasons, including factors beyond their control, e.g. delays due to pipeline problems on the recipient side. However, as one of our robustness checks we look at the dispersion of disbursements, as there are reasons why this too is of interest.

To fully exploit the comparative advantage of the Theil in the study of proliferation and fragmentation, we want to go beyond cross-country allocations and look at the spread within recipients. The best database for this purpose is the Creditor Reporting System (CRS)

[25] This is clear from (3) and (4), as $\sigma_{drst} = \delta_{drst}$. Hence, the basic building blocks of the global index are the same whether you start from the recipient or donor side.

[26] The formula is in the analytical appendix.

[27] A commitment is "[a] firm obligation, expressed in writing and backed by the necessary funds, undertaken by an official donor to provide specified assistance to a recipient country or a multilateral organisation." http://www.oecd.org/dac/dac-glossary.htm#Commitment

database of the DAC, available from its website.[28] This source provides a wealth of information at the level of "transactions." Since these entries differ widely in their characteristics, making an analysis at the lowest level less meaningful, we aggregate to the two-digit sector level of the DAC classification, c.f. Table 1. An interesting extension for future work could be to assess which of these sectors see the largest degree of aid dispersion by splitting them into subsectors using the CRS codes. Given that we both discuss principles for measurement and provide the first results of utilising the perfect (dis)aggregation property of the Theil, we find it necessary to limit the level of detail somewhat. On the other hand, aggregating even more would in our opinion disguise too much information on the sectoral spread of aid.

We also make some other minor adjustments. Humanitarian assistance is excluded because it must almost by definition go where emergencies appear, as are donor administrative costs, expenditures on refugees in donor countries, and unallocated/unspecified aid, for obvious reasons. Table 1 shows the sectors included with the number of observations. As may be seen, education and government and civil society are by far the two most important ones.

[Table 1 about here]

Years prior to 1998 are dropped because Aldasoro et al. (2010) and Nunnenkamp et al. (2013) suggest underreporting is a significant problem then. According to Birchler and Michaelowa (2016), reporting on disbursements of education aid in the CRS database was below 60% before 2002. This is a second argument for using commitments instead of disbursements in the main analysis as there is no reason to believe that the problem is specific to education, the second largest sector in our sample. 2013 is the most recent year for which data was available when we started working on this project.

The CRS covers official donors only. NGOs are clearly numerous in the aid industry, but we are not aware of any database on private aid that would allow us to calculate their contribution to overall dispersion. However, official aid agencies are dominant in terms of

[28] The major alternative is aiddata, available at aiddata.org (see Tierney et al. 2011). Their main source is the CRS database, but they seek to improve it by geocoding the data and increasing precision in the sector coding as well as to extend it by including other donors such as China through e.g. webscraping. However, when we started this project the CRS was described as well suited for our purposes by Michael Tierney (personal communication). As it is the original source of detailed aid data, we prefer to make use of it in this paper.

volume. Moreover, as a robustness check we check whether the spread of official aid channelled through NGOs differ from that of regular bilateral and multilateral funds.

We thus focus on entries where a country is specified as the recipient and DAC-members as well as multilaterals reporting to DAC are the donors. As is well-known, consistent data for new donors are not easily available. However, it is likely that their share of global aid is still quite limited. Focusing on the "traditional" donors (mainly agencies from Western countries plus multilateral institutions) should be sufficient to capture the big picture. Moreover, these are the actors that have made the strongest commitments to do something about the perceived problem of dispersion. Table 2 shows that there are 28 DAC donors in our main sample, though not all of them are present in every year.[29] We have data for 31 multilaterals.[30] All 169 recipients that remain in the data after the adjustments mentioned have been made are retained.[31]

[Table 2 about here]

4. AGGREGATE RESULTS

We start by describing developments in the number of donors, recipients, and sectors. Figure 1 displays the number of recipients for major donors like the US, the UK, and Japan, as well as the DAC average. It gives little impression that the Paris Agenda has mattered. This statistic is up after 2005 (the year of the Paris Declaration) for these three donors. For the UK the increase is large and Japan and the US are now close to the maximum. The average is on the rise for the whole of the sample period and with the potential number of recipients moving in the other direction as countries exit the DAC-list, it would be surprising to find a decrease in the geographic proliferation of aid.

[Figure 1 about here]

Turning to the other side of the equation, we see almost a mirror image in Figure 2. The average total number of donors has approximately doubled over 1998-2013 and there is

[29] The only bilateral donors dropped from our sample are the United Arab Emirates and Estonia, which, besides not being DAC-members, are negligible (0.01% and 0.18% of the observations, respectively).

[30] There are 32 multilateral organisations in the database, but no information on commitments for the WFP, which therefore drops out. See Table A2 in the data appendix for the list of included institutions.

[31] They are listed in Table A1 of the data appendix.

little sign that the trend has abated in the wake of the Paris Declaration.[32] Much of the increase is due to there being more multilaterals on average. As shown in Figure 1, the average DAC donor had more than 100 recipients at the start of the sample period and while there is an increase in the number of bilateral donors in our data set over time, the newcomers tend to be small and thus concentrated (c.f. Table 6 below). This is probably the reason why the gap between the potential and average actual number of donors widens over time and why the increase in the latter has come mainly from multilaterals. One could perhaps have expected that donor countries would manage to use these institutions of cooperation to reduce geographic fragmentation. However, they seem to lack either the will or the ability to have multilaterals spearhead the international agenda on aid effectiveness on this point.

[Figure 2 about here]

There has been no change in the sectoral structure of DAC statistics. Hence, we see no temporal variation in the maximum number of sectors to which aid can be given or received (Figure 3). However, for donors the actual number is down on average, suggesting some thematic concentration, albeit from a very high level. The trend is the reverse for recipients and their average is now even closer to the potential. Donor involvement is clearly broad in most partner countries, implying that we should expect to find continuing high levels of sectoral aid dispersion there.

[Figure 3 about here]

We now plot different Theil indices. Figure 4, which is based on equation (5a), shows that prior to the Paris Declaration bilateral aid actually got slightly more concentrated, though there was quite some variation around the trend. On the other hand, after 2005 proliferation increased at first. The minor rise in the Theil in recent years has not sufficed to bring the level of concentration back to the 2005-value. It is noteworthy that these developments are more or less wholly due to variations in the within component, demonstrating that most of the action is due to changes in the distribution of aid across recipients (and sectors within them). In contrast, the between component, showing how much of the total index value that is due to

[32] An increasing number of actors on the donor side is actually a red thread running through the history of foreign aid, c.f. Klein and Harford (2005).

variations in aid shares across donor countries, is fairly stable. Still, it clearly contributes the most to bilateral proliferation. This suggests that there are too many similarly sized bilateral actors in the aid industry and that dispersion from this source could be reduced by concentration among donors. This point has been missing from the debate, which has focussed on the perceived excessive proliferation by each donor country. Moreover, previous studies have been unable to capture this phenomenon, partly because they have been concerned with the country level and partly because they have not used measures that can be perfectly aggregated and decomposed, as we do. Note that we too are actually underestimating the bilateral spread by aggregating from the agency level to the country level. Most donor countries have several entities involved in executing their aid policies. Kilby (2011) finds that aid projects decrease in size as proliferation amongst their agencies increases. This strengthens the case for concentration amongst bilaterals.

[Figure 4 about here]

The Theil for multilateral donors shows more concentration than its bilateral counterpart, c.f. Figure 5, which plots equation (5b) over time. Of course, some caution is needed in interpreting this contrast as multilaterals generally have less leeway when it comes to distributing their funds. In any case, it is interesting to see that over the sample period multilateral aid has become more dispersed, even though the downward trend is less pronounced after 2005. Here too, it is mainly the within component that causes changes in the overall index and the between part that is the major driver of the level of proliferation. Hence, dispersion of multilateral aid could also be significantly reduced by concentrating funds in fewer, larger actors. This is probably a more potent policy conclusion than in the bilateral case, as it seems more likely that donor countries could be persuaded to cut down on the number of multilateral agencies they support than to discontinue their own bilateral programmes. Furthermore, the proliferation of trust funds inside multilaterals highlighted by Reinsberg et al. (2015) is not reflected in our data, but probably raises the transaction costs of aid for both multilaterals and recipients. This is a trend that could easily be reversed if donor countries are seriously concerned about these costs.

[Figure 5 about here]

As mentioned in section 2, the global Theil for aid dispersion is the same whether calculated from the donor or the recipient side. Starting from the former angle we can assess the bilateral and multilateral contributions to the total. Recall that equation (5c) – global fragmentation/proliferation - is not simply the sum of (5a) and (5b), so these are not the same as the Theils shown in figures 4 and 5.[33] The conclusion we draw based on our more comprehensive dataset and consistent measurement is the same as that of previous studies: the Paris agenda on aid effectiveness have not been able to make much difference, c.f. Figure 6. In fact, the trend is clearly in the direction of greater dispersion, albeit at a slow pace. For most of the sample period the bilateral part of the aid industry is the one dragging the Theil down, the exception being the years around 2005. This could be a sign that proliferation will continue to be high in the future as emerging economies change status from recipients to donors, thus increasing the number of bilaterals. Also note the interesting fact that the inputs from bilateral and multilateral proliferation tend to move in opposite directions. In the first half of the sample period, the former was going up, making global aid more concentrated, while the latter decreased to an extent that the global Theil went down. After 2005, the roles were reversed, but the contribution to concentration that multilaterals made was more than outweighed by bilaterals, keeping the global trend negative. This pattern is somewhat puzzling as the DAC-donors control many multilateral institutions and thus could be worth looking further into in the future.

[Figure 6 about here]

Equation (5c), displayed in Figure 7, again demonstrates that global aid is more fragmented in 2013 than it was in both 1998 and 2005. More importantly, when looking at it from the recipient side we see that the main reason is that the allocation across countries (the between component) has become less concentrated. This holds for both subperiods. Furthermore, this has continually been the main source of fragmentation. The finding could be interpreted as support for the geographic concentration policies that many individual donor countries have adopted in recent years. However, at the same time Figure 7 definitely casts some doubts about the sincerity or effectiveness of those policies, or both, though of course the multilateral role in the overall picture should not be forgotten, as Figure 5 illustrated.

[33] The bilateral part is the sum of the first and third terms in equation (A3) in the technical appendix, while the multilateral one is the sum of the second and fourth terms there.

[Figure 7 about here]

Figure 8 provides another angle by showing regional Theil indices. No region has seen continuous increases or decreases in fragmentation over the whole period. The most noteworthy aspect of this graph is that it singles out one region that rather consistently has had the highest level of concentration (Middle East and North Africa) and one that as consistently has had the lowest (Sub-Saharan Africa). The latter is no surprise, of course, but serves to confirm the conclusions already drawn as dispersion has actually increased in recent years in the most aid dependent region of all.

[Figure 8 about here]

There is obviously an income gradient in the concerns about excessive aid dispersion. Poorer countries are usually more dependent on aid and have lower capacities for dealing with extensive and diverse donor requirements. In this light, Figure 9 paints a worrisome picture. Aid fragmentation is monotonically decreasing in income, with low income countries consistently having the highest spread.

[Figure 9 about here]

We make various changes to the dataset to perform a series of robustness tests of the results derived with the main sample. First of all, we follow Acharya et al. (2006) in distinguishing between small (below USD 500,000) and large aid transactions. They argue that "a substantial proportion of all aid events take the form of small grants, notably for travel and education scholarships, or for in-country events financed directly from the donor's embassy. It seems likely that these kinds of activities typically do not generate the kinds of transactions costs with which we are concerned." (pp. 8-9). It might be added that whether the distributions of large and small commitments differ is of independent interest. We also leave out transfers channelled through NGOs to see if these allocations follow a pattern different from "regular" bilateral and multilateral aid.

In our third robustness check, we calculate Theils using disbursements. Recall that the presumption in the literature is that donors have more control over commitments. While this is certainly plausible, it could be argued that at least some transaction costs are associated with

reporting on and auditing of disbursements. Evaluations will also often be based on funds actually transferred. Moreover, discrepancies between commitments and disbursements could be a sign of recipient influence over allocations. The dispersion of disbursements is therefore of independent interest. To minimise the risk of underreporting we set the start of this sample to 2004. This is also the first year in which we can separate out aid through NGOs, whereas the division into large and small transactions is of course available for the whole sample period.

[Table 3 about here]

We present the results of the robustness tests in tables 3-5. Table 3 shows the mean differences between the Theils from equations (5a-c) based on our main sample and the corresponding Theils from the alternative samples as well as the p-value for whether these are significant.[34] Tables 4 and 5 contain the same information at the level of regions and income groups, respectively. Three observations stand out. Firstly, disbursements are more dispersed than commitments. The difference in these Theils is always positive and is significant at conventional levels most of the time. It is not immediately clear why standard culprits for explaining deviations between the two aid concepts such as project delays and failing to meet donor conditionalities should imply a greater spread of disbursements.[35] In the latter case, it could be that donors move funds elsewhere to make sure that the money is spent within their fiscal frames, but this might as well lead to greater concentration as it is presumably easier to redirect transfers to recipients in which they are already firmly engaged. Investigating discrepancies between disbursements from commitments from this angle could thus provide new insights. Interestingly, the two aid series do not show significantly different spreads on average in low income countries and in Sub-Saharan Africa, where large deviations could be expected to be especially harmful. Indicator 7 for monitoring progress in the implementation of the Paris Declaration is "Aid is more predictable," which is to be measured as "Percent of aid disbursements released according to agreed schedules in annual or multi-year frameworks." Hence, this could be a micro-level indication that donors have actually made an effort where it matters the most.

[34] Figures A1-A3 in the data appendix displays the Theils calculated from these different datasets.

[35] Discrepancies between commitments and disbursements have been studied in the literature on aid volatility and predictability, c.f. Bulíř and Hamann (2003) and Celasun and Walliser (2008), where the focus is mainly on the problems these create for macroeconomic management in recipient countries.

[Table 4 about here]

The second main finding from the robustness tests is that large transactions tend to be significantly more concentrated than the average. There are some exceptions to this general pattern at the regional level and it does not hold for multilaterals, though the sign always points in the same direction: small transactions are more thinly spread than large ones. This might be considered a somewhat "mechanical" effect emanating from the size difference itself. And if Acharya et al. (2006) are correct in their presumption about the relative transaction costs of large and small aid events, it might not matter much. However, it could be an indication that bilateral donors miss out on a simple way of achieving concentration.[36] If there are fixed costs involved in planning and implementing projects, increasing the size of transactions would create cost savings for them.

[Table 5 about here]

The final results from comparing these different samples concern the use of NGOs as conduits for official aid. Aid channelled through NGOs does not seem to differ much from regular bilateral funds when it comes to dispersion. This is in line with other studies, which suggest that NGOs tend to follow the official agencies of their home countries when it comes to the geographic allocation of resources.[37] In contrast, transfers through NGOs by multilaterals are significantly more dispersed than their "in-house" aid. For recipients, there is no difference in the average spread across regular official aid and funds arriving through the NGO channel.

5. COUNTRY-LEVEL RESULTS

A natural question to ask is whether there are donor countries that have managed to concentrate their aid. The answer is yes, although they are in a clear minority. As Table 6 shows, among the major donors (more than 1% of the observations) Canada, Denmark, France, the Netherlands, Norway and Sweden have higher Theil values after the Paris

[36] We are of course not suggesting that they lump projects together to create a statistical impression of lower dispersion. As we aggregate to the sector level, our results are quite robust to such illusionary changes in spread.

[37] See Koch et al. (2009), as well as the more detailed studies of Germany (Nunnenkamp and Öhler 2011), Sweden (Dreher et al. 2010), and Switzerland (Nunnenkamp et al. 2009).

Declaration was issued than they had before. However, the improvement is only significant for the Netherlands and Norway (c.f. data appendix table A3). The stellar performer is the Netherlands, which adopted its own geographical concentration policy during this period. Tables A4 and A5 in the data appendix confirm that about two-thirds of the increase in the Dutch Theil for 2006-2013 compared to 1998-2005 is due to the between component. Yet, the Netherlands started out with one of the highest levels of dispersion and is still well behind the major donor country that has consistently proliferated the least, Austria. Moreover, the geographical spread remains the main problem in the sense that the between variation is less than the within variation, a fact that the Netherlands share with most other donors in both subperiods as well as for the whole of 1998-2013.

[Table 6 about here]

Two large donors, Germany and the US, are in the bottom three in both subperiods and thus also overall. The latter plus Japan and Switzerland are the major bilaterals that have actually seen a significant increase in proliferation from the first to the second half of the sample. As Austria as well as other high-Theil countries like Denmark, Italy, and Korea are fairly small in terms of overall aid volume, there seems to be a negative correlation between size in this sense and the degree of dispersion. Indeed, the truly minor donors (less than 1% of the observations) also tend to be concentrated. A final feature of Table 6 is that the distribution of Theil values has shifted "left," with both the highest and the lowest value being smaller in 2006-2013 than in 1998-2005. This is yet another indication that the international commitments donors have made have not significantly affected their actual aid allocations.

With the number of recipient countries being far too large to fit in a table similar to the one just shown for donors, we have chosen to present the top and bottom 10 recipients in terms of Theil values (Table 7). As was the case for donors, we discuss the overall index in the main text and provide similar information on the between and within components in the data appendix (Tables A6 and A7). The first finding is that size seems to matter here too: tiny island states in the Caribbean and the Pacific make out most of the top 10 in both sub-periods. Moreover, in these countries fragmentation is not an important aspect of aid performance, as the very high Theil values show.[38] This is due to most of them having a dominant donor,

[38] We even have a couple of cases where the maximum value of 1 is attained.

generally the former colonial power or the current regional one, but occasionally a multilateral institution like the EU.

[Table 7 about here]

Secondly, countries in Sub-Saharan Africa dominate the bottom of the distribution. Mali, Mozambique, and Tanzania are among the 10 recipients with the most fragmented aid in both subperiods. They are joined on the list for the whole period by Burkina Faso, Kenya, and Uganda. As these are also highly aid dependent countries this suggests that higher levels of development assistance tend to imply more dispersion on the recipient side too.

Thirdly, the recipient data provides what is perhaps the clearest indication that donor promises of concentration have been anything but commitments in the literal sense. More than 30 per cent of the countries for which this calculation is possible have seen little or no change in their level of fragmentation in the wake of the Paris Declaration. Figure 10 illustrates this disappointing fact. Only 12 out of 151 countries have experienced a reduction that is significant at the 5% level and these are outnumbered by those where fragmentation has significantly increased (20 in total).

[Figure 10 about here]

The last point that we want to emphasise is that for a majority of the recipients as well, between variation is a more important source of dispersion than within variation. This is most clearly the case when the sample is confined to bilateral donors, thus demonstrating that there seems to be a link in the data between bilateral proliferation and fragmentation in recipient countries.

6. CORRELATION OF THE THEIL AND HERFINDAHL-HIRSCHMAN INDICES

In section 2, we argued that the Theil is as well suited for assessing aid dispersion as the alternatives. The main purpose of our applied analysis has thus been to use this index and its perfect (dis)aggregation property to elucidate developments in fragmentation and proliferation at various levels over 1998-2013. Still, it is interesting to contrast our results with those generated by other measures. As a final "robustness check," we therefore compare

the Theil and the most commonly used alternative, the HHI.[39] This is not a straightforward exercise given the differences in decomposability. We have chosen to do the comparison at the level at which the HHI is most commonly calculated, i.e., at the country level for both donors and recipients, which should be neutral ground. This implies that the HHIs are most similar to the between component of the corresponding Theils. Figures 11 and 12 show the resulting simple averages for donors and recipients, respectively.

[Figure 11 about here]

While the levels of the two indices are not directly comparable given the different functional forms, the impression the graphs give is of a quite high correlation between them. This is indeed the case. The correlation for bilateral donors is 0.89 and for recipients as high as 0.96. Confining the comparison for recipients to bilateral donors does not change the picture as this correlation is 0.97.[40] The conclusion is thus that the Theil and the HHI tend to move closely together at the most commonly used level of measurement for the latter. This strengthens our conviction that the Theil is a very useful addition to the toolbox when it comes to gauging aid dispersion.

[Figure 12 about here]

7. CONCLUSIONS

Our paper is motivated by the gap between strong emphasis on the costs of dispersed aid for recipient countries at the policy level as well as the academic literature and the dearth of empirical studies measuring spreads systematically over an extended period of time for a comprehensive set of donors and recipients. We argue for using the Theil to assess both proliferation and fragmentation and, exploiting its unique property of perfect decomposability, are able to provide a detailed picture of developments in the era of the Paris Agenda, globally, for bilateral and multilateral donors, for recipients sorted by region and income level, and for individual donors and recipients. Consistent with other studies using more limited samples, we find the opposite of the concentration that so many actors claim is

[39] The HHI is the sum of squared aid shares and is thus a number between zero and one, like our normalized Theil.

[40] The graph for recipients using only data for bilaterals can be found in the data appendix (Figure A4).

desirable. There are both more donors and more recipients recording higher spreads in the latter half of our time frame than those experiencing a change in the opposite direction.

Aggregating up, globally as well as for bilaterals and multilaterals separately, confirms that aid is becoming more dispersed. Fragmentation is higher in Sub-Saharan Africa and in the poorest countries. Globally and for most donor and recipient countries, between variation is the main driver of the spread, lending some support to the geographic concentration policies many bilateral donors have adopted. However, both types of proliferation are in the aggregate mainly caused by there being many actors with quite similar shares of total bilateral and multilateral aid, respectively. Hence, the policy conclusion is not only that individual donor countries should be more focussed geographically, they should also be more selective about the distribution of the multilateral part of their aid. Hopefully, these novel perspectives will stimulate both more research on the consequences of aid dispersion and renewed discussion of the determinants of aid effectiveness. Even if the Paris Agenda was not successful in every respect, it was arguably not because the issues on it are trivial.

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Tables and Figures in the Main Text

Table 1: Sectors in the sample

DAC5 code	Sector	Number of observations

110	Education	128,293
120	Health	59,920
130	Population policies/programmes and reproductive health	28,622
140	Water and sanitation	29,905
150	Government and civil society	145,768
160	Other social infrastructure and services	64,085
210	Transport and storage	11,929
220	Communications	14,949
230	Energy generation and supply	13,218
240	Banking and financial services	9,472
250	Business and other services	12,009
310	Agriculture, forestry, fishing	64,632
320	Industry, mineral resources and mining, construction	23,302
330	Trade policy and regulations and trade-related adjustment, tourism	11,727
410	General environmental protection	31,025
430	Other multisector	77,124
510	General budget support	1,739
520	Developmental food aid/Food security assistance	20,235
530	Other commodity assistance	436
600	Action relating to debt	4,566
Total		752,956

Table 2: Donor countries in the dataset

Donor	No of obs.	Percent
Australia	60,566	4.50
Austria	19,379	1.44
Belgium	39,711	2.95
Canada	74,846	5.56
Czech Republic	1,531	0.11
Denmark	18,590	1.38
Finland	17,164	1.27

France	85,452	6.35
Germany	143,936	10.69
Greece	6,522	0.48
Iceland	114	0.01
Ireland	24,109	1.79
Italy	35,449	2.63
Japan	130,343	9.68
Korea	41,758	3.10
Luxembourg	7,132	0.53
Netherlands	35,973	2.67
New Zealand	8,554	0.64
Norway	56,905	4.23
Poland	543	0.04
Portugal	9,482	0.70
Slovak Republic	329	0.02
Slovenia	733	0.05
Spain	98,909	7.34
Sweden	52,234	3.88
Switzerland	36,880	2.74
United Kingdom	50,286	3.73
United States	289,330	21.48
Total	1,346,760	100.00

Table 3: Mean comparison tests, bilateral and multilateral proliferation and global fragmentation

	Comb. obs	Mean difference	Pr(|T| > |t|)
Bilateral donors			
Disbursements	20	.0297471	0.0301
Excluding NGOs	20	-.0100524	0.2645

Excluding small transactions	32	-.022565	0.0135
Multilateral donors			
Disbursements	20	.0385029	0.0066
Excluding NGOs	20	.0116596	0.0869
Excluding small transactions	32	-.0046628	0.5740
Recipients			
Disbursements	20	.0325876	0.0049
Excluding NGOs	20	.0011572	0.8319
Excluding small transactions	32	-.0131761	0.0585

Table 4: Mean comparison tests, Theil by region

	Combined obs.	Mean difference	Pr(|T| > |t|)
East Asia & Pacific			
Disbursements	20	.0363351	0.0001
Excluding NGOs	20	-.006731	0.3132
Excluding small transactions	32	-.0123719	0.0749
Europe & Central Asia			
Disbursements	20	.0431979	0.0000
Excluding NGOs	20	-.0018699	0.7755
Excluding small transactions	32	-.0119602	0.0571
Latin America & Carribean			
Disbursements	20	.0497116	0.0008
Excluding NGOs	20	.002489	0.7382
Excluding small transactions	32	-.0144981	0.1019
Middle East & North Africa			
Disbursements	20	.0291998	0.1951
Excluding NGOs	20	-.0081234	0.6610
Excluding small transactions	32	-.0091435	0.5443
South Asia			
Disbursements	20	.0600809	0.0000
Excluding NGOs	20	.0070668	0.4250

Excluding small transactions	32	-.0073732	0.4495
Sub-Saharan Africa			
Disbursements	20	.017163	0.3204
Excluding NGOs	20	-.0171702	0.0547
Excluding small transactions	32	-.0179914	0.0270

Table 5: Mean comparison tests, Theil by income group

	Combined obs.	Mean difference	Pr(|T| > |t|)
Lower Income			
Disbursements	20	.0159982	0.2910
Excluding NGOs	20	-.0122968	0.0095
Excluding small transactions	32	-.0174107	0.0011
Lower Middle Income			
Disbursements	20	.025228	0.1006
Excluding NGOs	20	-.007587	0.3391
Excluding small transactions	32	-.0115494	0.0874
Upper Middle Income			
Disbursements	20	.0355362	0.0000
Excluding NGOs	20	-.0064083	0.0693
Excluding small transactions	32	-.0128038	0.0232

Table 6: Ranking donors according to the Theil index

Donor	1998-2005	Donor	2006-2013	Donor	1998-2013
Portugal	0.6917	Iceland	0.6698	Iceland	0.6698
Greece	0.6093	Portugal	0.6238	Portugal	0.6577
Austria	0.6006	Poland	0.6117	Poland	0.6117
Luxembourg	0.5633	Slovenia	0.5960	Slovenia	0.5960
Italy	0.5504	Austria	0.5838	Austria	0.5922
Denmark	0.5164	Greece	0.5795	Greece	0.5894
Australia	0.5120	Korea	0.5665	Korea	0.5665
Japan	0.5089	Slovak Republic	0.5560	Slovak Republic	0.5560
Finland	0.4896	Denmark	0.5216	Italy	0.5322

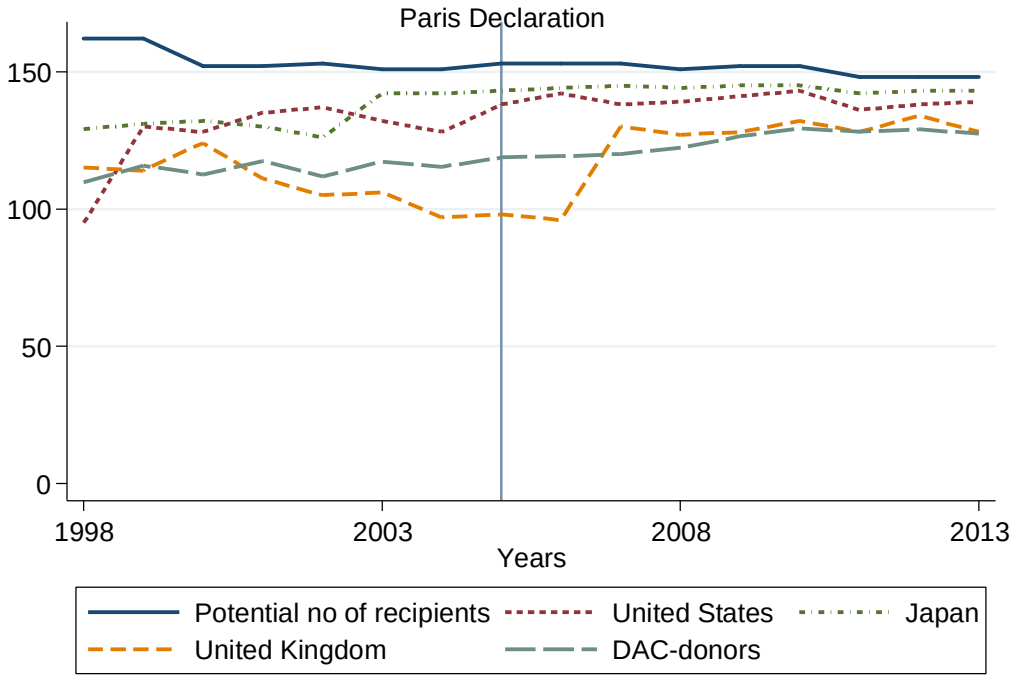
New Zealand	0.4812	Italy	0.5141	Denmark	0.5190
Belgium	0.4732	New Zealand	0.5087	New Zealand	0.4995
United Kingdom	0.4669	Netherlands	0.4790	Australia	0.4923
Sweden	0.4480	Czech Republic	0.4754	Japan	0.4810
Ireland	0.4462	Australia	0.4726	Finland	0.4789
Switzerland	0.4404	Finland	0.4682	Czech Republic	0.4754
France	0.4280	Sweden	0.4654	Luxembourg	0.4752
Spain	0.4263	Japan	0.4530	Belgium	0.4589
Netherlands	0.4197	United Kingdom	0.4477	United Kingdom	0.4573
Canada	0.4062	Belgium	0.4446	Sweden	0.4567
United States	0.4054	France	0.4350	Netherlands	0.4493
Norway	0.3905	Canada	0.4347	Ireland	0.4391
Germany	0.3803	Ireland	0.4337	France	0.4315
		Luxembourg	0.4201	Switzerland	0.4241
		Norway	0.4192	Canada	0.4204
		Switzerland	0.4078	Spain	0.4077
		Spain	0.3892	Norway	0.4049
		Germany	0.3806	Germany	0.3804
		United States	0.3546	United States	0.3800

Table 7: Ranking recipients according to the Theil index (all donors)

Recipient	1998-2005	Recipient	2006-2013	Recipient	1998-2013
Top 10					
Northern Marianas	1.0000	Turks&Caicos Isl.	0.9826	Northern Marianas	1.0000
Gibraltar	1.0000	Anguilla	0.9137	Gibraltar	1.0000
Aruba	0.9985	St. Kitts-Nevis	0.8890	Aruba	0.9985
Korea	0.9851	Tokelau	0.8587	Korea	0.9851
Netherlands Ant.	0.9447	Wallis & Fortuna	0.8557	Netherlands Ant.	0.9447
Wallis & Fortuna	0.9264	Montserrat	0.8439	Macao	0.9011
Nauru	0.9160	Mayotte	0.8408	Wallis & Fortuna	0.8911
Macao	0.9011	St. Helena	0.8301	St. Kitts-Nevis	0.8821

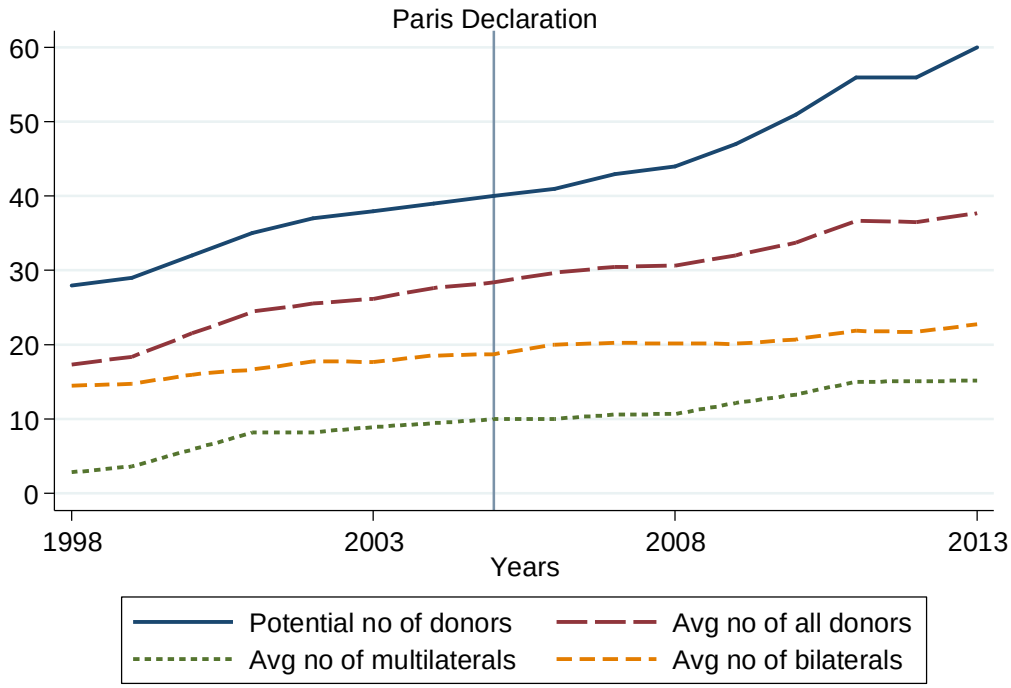
Antigua & Barbuda	0.8817	Trinidad&Tobago	0.8253	Virgin Isl. (UK)	0.8613
St. Kitts-Nevis	0.8752	Marshall Islands	0.8128	Anguilla	0.8592
		Bottom 10			
Burkina Faso	0.4688	Burundi	0.4589	Kenya	0.4681
Ethiopia	0.4665	Niger	0.4576	Bolivia	0.4669
Mali	0.4662	Tanzania	0.4573	Burkina Faso	0.4665
Cambodia	0.4650	Senegal	0.4530	Uganda	0.4585
Uganda	0.4574	Bolivia	0.4488	Laos	0.4545
West Bank & Gaza	0.4569	Mali	0.4399	Mali	0.4531
Kenya	0.4429	Laos	0.4315	Nicaragua	0.4499
South Africa	0.4390	Nicaragua	0.4306	Cambodia	0.4463
Tanzania	0.4346	Cambodia	0.4275	Tanzania	0.4460
Mozambique	0.4142	Mozambique	0.4183	Mozambique	0.4163

Figure 1: Number of recipients for donors



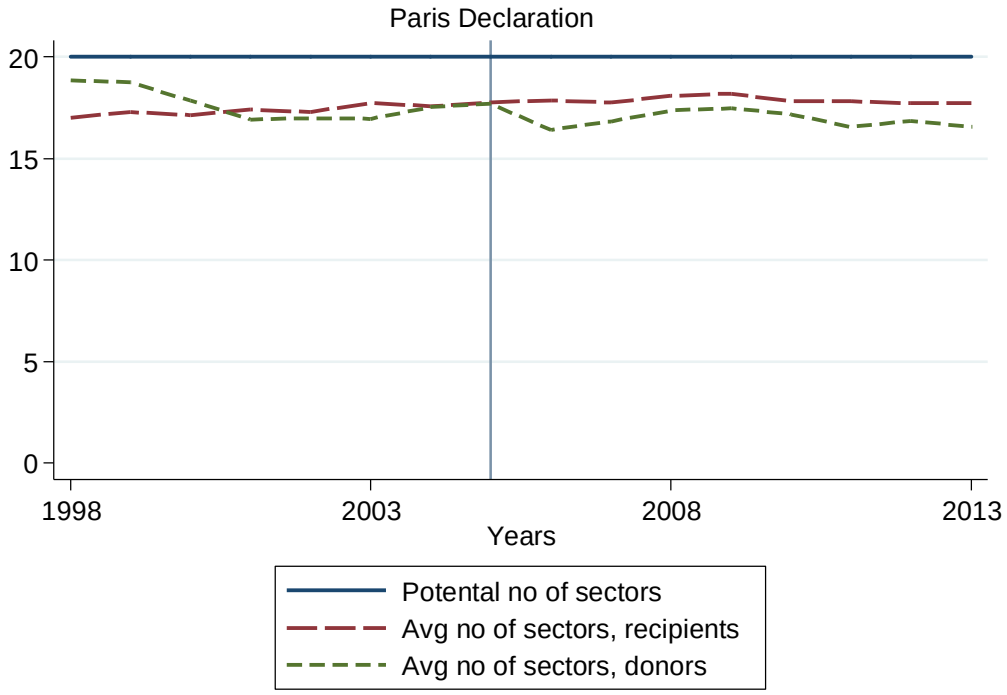
Source: Authors' calculations

Figure 2: Average and potential number of donors



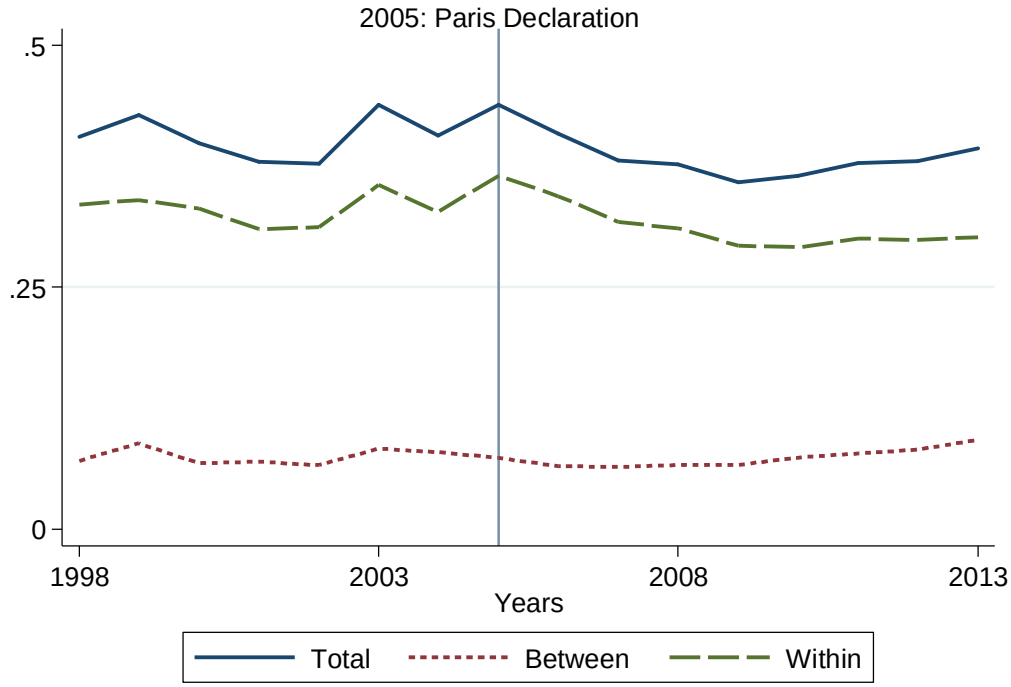
Source: Authors' calculations

Figure 3: Average and potential number of sectors, donors and recipients



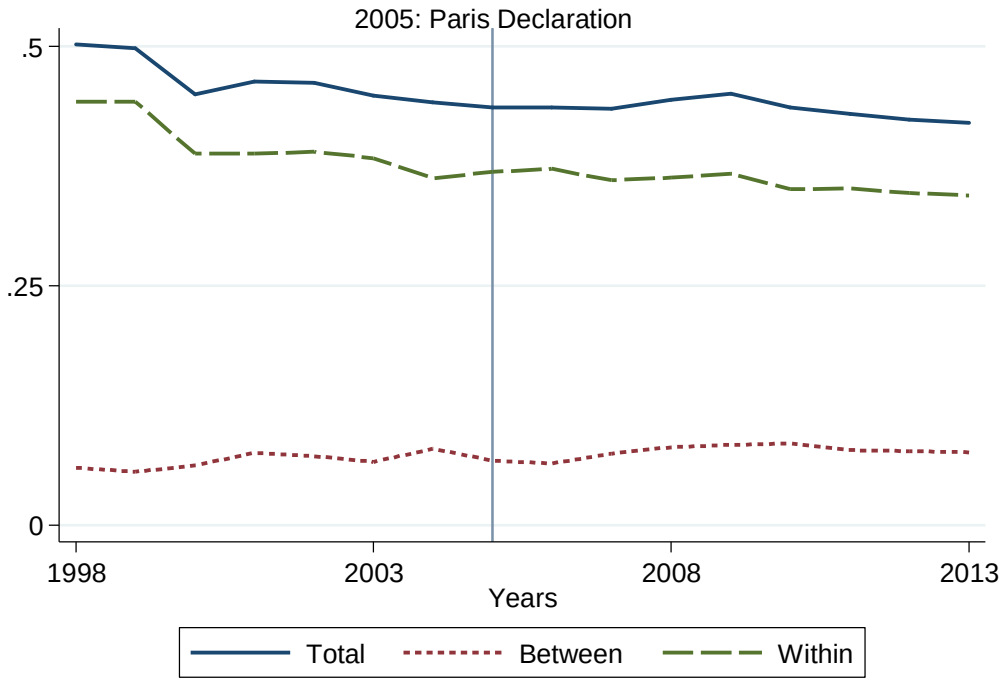
Source: Authors' calculations

Figure 4: Theil for bilateral donors



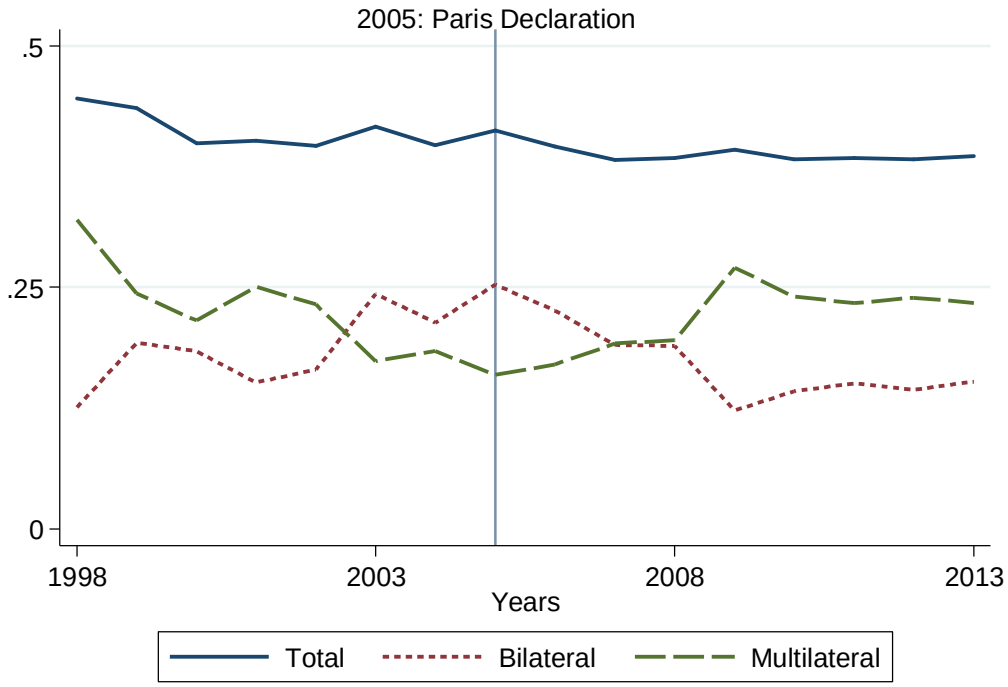
Source: Author's calculations

Figure 5: Theil for multilateral donors



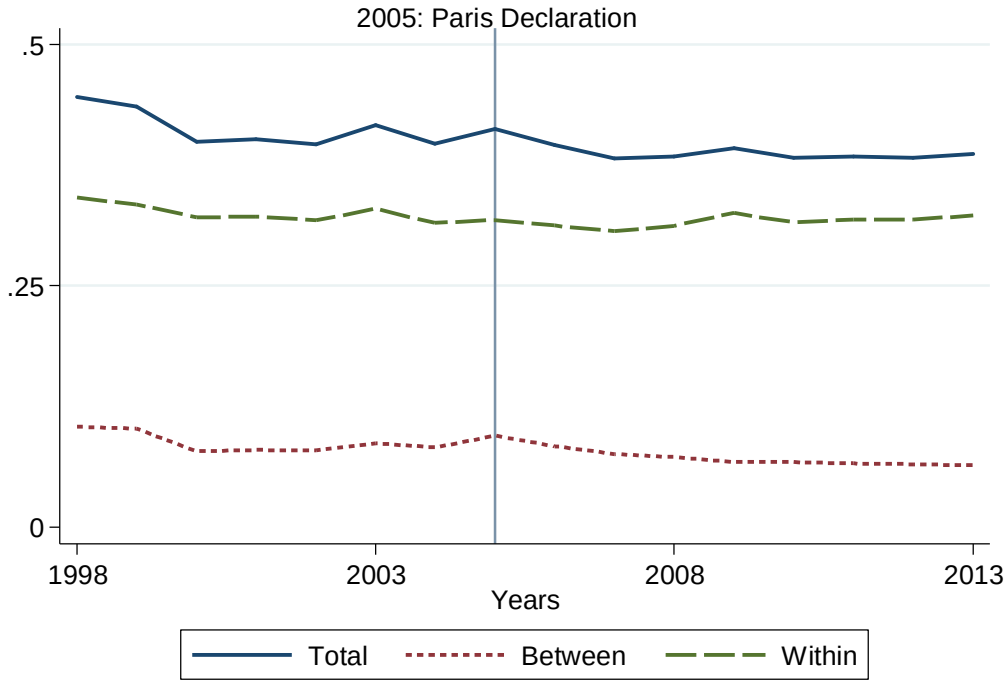
Source: Author's calculations

Figure 6: Bilateral and multilateral contributions to global Theil



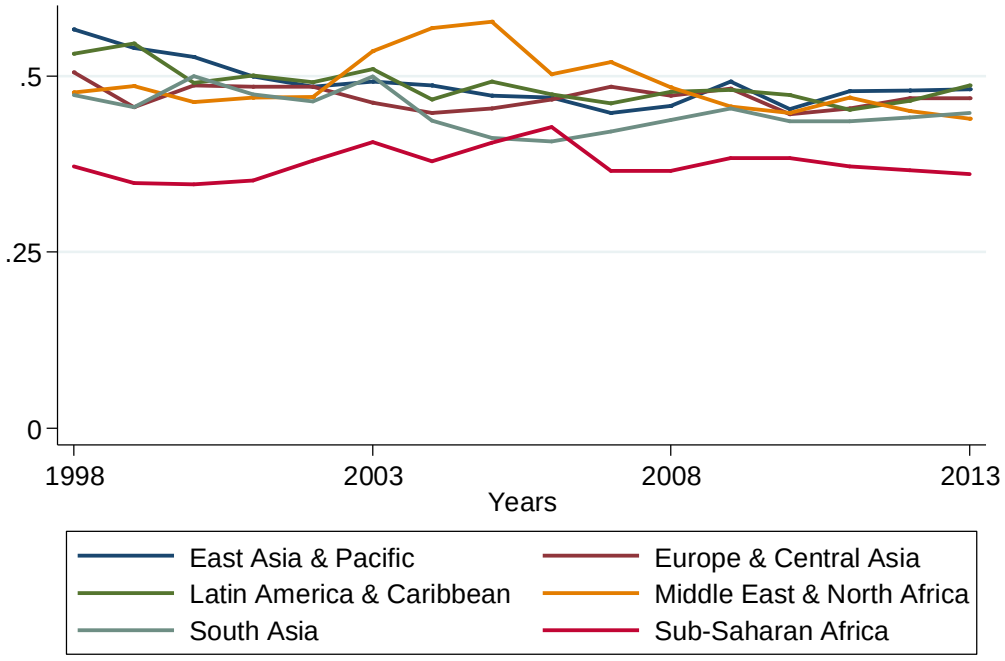
Source: Authors' calculations

Figure 7: Theil for recipients (global Theil, all donors)



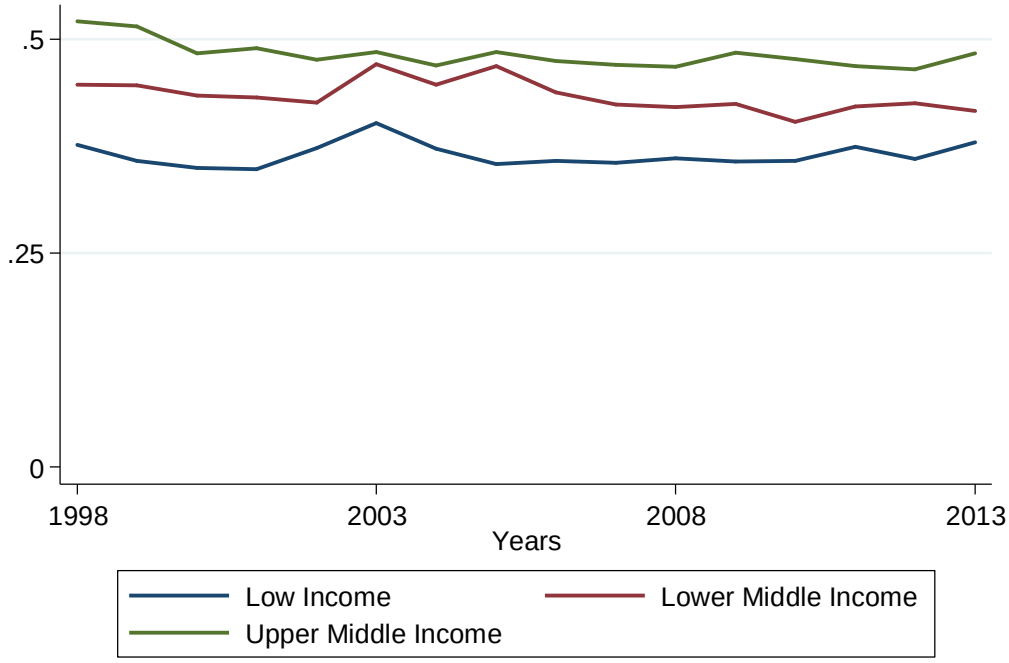
Source: Author's calculations

Figure 8: Regional Theil indices for recipients



Source: Authors' calculations

Figure 9: Theil indices for recipients by income group



Source: Authors' calculations

Figure 10: Mean difference of the Theil index for recipients, before-after 2005

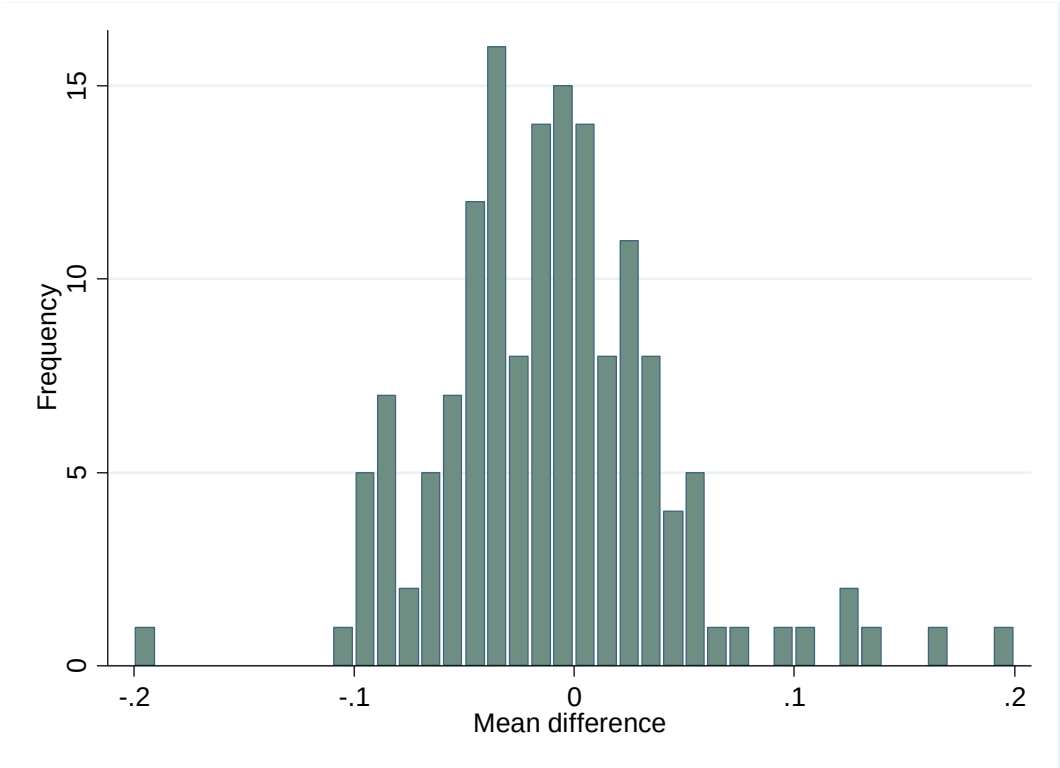
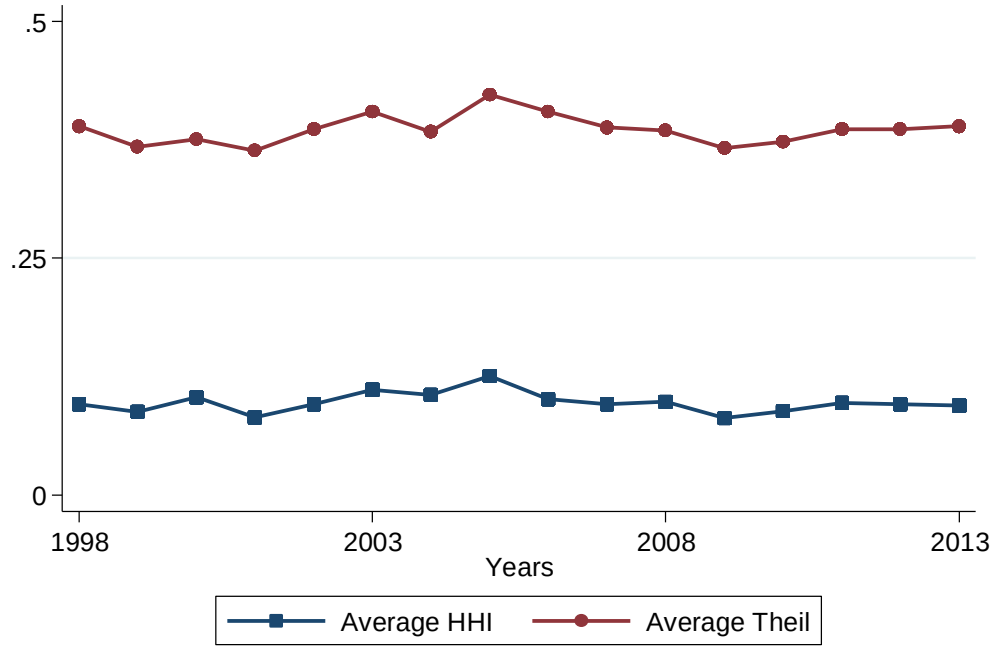
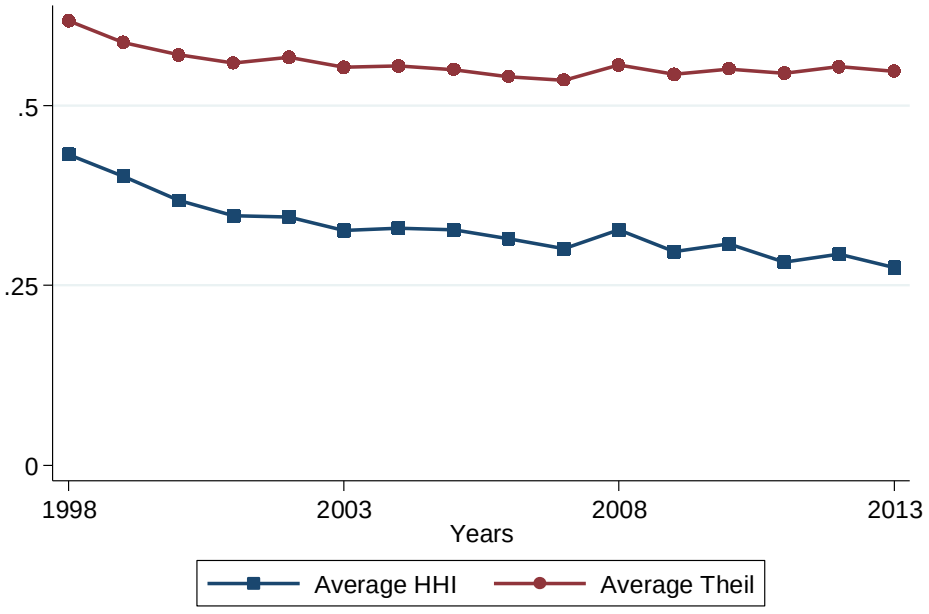


Figure 11: Average Theil and Herfindahl-Hirschman indices for bilateral donors



Source: Authors' calculations

Figure 12: Average Theil and Herfindahl-Hirschman indices for recipients



Source: Authors' calculations

DATA APPENDIX

Table A1: List of recipients in the sample

Afghanistan	Ecuador	Malaysia	Slovenia
Albania	Egypt	Maldives	Solomon Islands
Algeria	El Salvador	Mali	Somalia
Angola	Equatorial Guinea	Malta	South Africa
Anguilla	Eritrea	Marshall Islands	South Sudan
Antigua and Barbuda	Ethiopia	Mauritania	Sri Lanka
Argentina	Fiji	Mauritius	St. Helena
Armenia	Former Yugoslav Rep. of Macedonia	Mayotte	St. Kitts-Nevis
Aruba	French Polynesia	Mexico	St. Lucia
Azerbaijan	Gabon	Micronesia	St. Vincent and the Grenadines
Bahrain	Gambia	Moldova	Sudan
Bangladesh	Georgia	Mongolia	Suriname
Barbados	Ghana	Montenegro	Swaziland
Belarus	Gibraltar	Montserrat	Syria
Belize	Grenada	Morocco	São Tomé and Principe
Benin	Guatemala	Mozambique	Tajikistan
Bhutan	Guinea	Myanmar	Tanzania
Bolivia	Guinea-Bissau	Namibia	Thailand
Bosnia and Herzegovina	Guyana	Nauru	Timor-Leste
Botswana	Haiti	Nepal	Togo
Brazil	Honduras	Netherlands Antilles	Tokelau
Burkina Faso	India	New Caledonia	Tonga
Burundi	Indonesia	Nicaragua	Trinidad and Tobago
Cambodia	Iran	Niger	Tunisia
Cameroon	Iraq	Nigeria	Turkey
Cape Verde	Jamaica	Niue	Turkmenistan
Central African Rep.	Jordan	Northern Marianas	Turks and Caicos Isl.

Chad	Kazakhstan	Oman	Tuvalu
Chile	Kenya	Pakistan	Uganda
China,P.R.: Mainland	Kiribati	Palau	Ukraine
Colombia	Korea	Panama	Uruguay
Comoros	Korea, Dem. Rep.	Papua New Guinea	Uzbekistan
Congo, Dem. Rep. of	Kosovo	Paraguay	Vanuatu
Congo, Republic of	Kyrgyz Republic	Peru	Venezuela
Cook Islands	Lao People's Dem. Rep.	Philippines	Vietnam
Costa Rica	Lebanon	Rwanda	Virgin Islands (UK)
Cote d'Ivoire	Lesotho	Samoa	Wallis and Fortuna
Croatia	Liberia	Saudi Arabia	West Bank and Gaza
Cuba	Libya	Senegal	Yemen
Djibouti	Macao	Serbia	Zambia
Dominica	Madagascar	Seychelles	Zimbabwe
Dominican Republic	Malawi	Sierra Leone	

Table A2: List of multilateral donors in the sample

AfDB	IDB Sp. Fund
AfDF	IFAD
Arab Fund (AFESD)	IMF (Concessional Trust Funds)
AsDB	Kuwait (KFAED)
AsDB Special Funds	Nordic Dev. Fund
BADEA	OFID
GAVI	OSCE
GEF	UNAIDS
GGGI	UNDP
Global Fund	UNECE
IBRD	UNFPA
IDA	UNICEF
IDB	UNPBF
GAVI	UNRWA
GEF	WHO

Isl. Dev Bank

Table A3: Mean comparison tests for bilateral donors, before-after 2005

	Combined obs.	Mean difference	Pr(|T| > |t|)
Austria	16	-.016813	0.7643
Australia	16	-.039348	0.1915
Belgium	16	-.0286023	0.4840
Denmark	16	.0052019	0.7863
France	16	.0069616	0.7752
Germany	16	.0003643	0.9900
Greece	12	-.0298021	0.6235
Italy	16	-.0362933	0.4846
Luxembourg	13	-.1431538	0.0125
Japan	16	-.0558994	0.0031
Netherlands	16	.0593535	0.0023
New Zealand	12	.0275511	0.1542
Norway	16	.0286538	0.0360
Portugal	16	-.067938	0.1150
Sweden	16	.0173764	0.2074
Switzerland	16	-.0325957	0.0813
Finland	16	-.0213417	0.1943
Ireland	14	-.0124702	0.3630
Spain	16	-.0370812	0.2278
Canada	16	.028534	0.1898
United States	16	-.0507942	0.0421
United Kingdom	16	-.0191414	0.5592

Notes: Czech Republic, Iceland, Korea, Poland, Slovak Republic, and Slovenia only have observations after 2005.

Table A4: Ranking donors according to the between component of the Theil index

Donor	1998-2005	Donor	2006-2013	Donor	1998-2013
Portugal	0.4403	Iceland	0.4007	Portugal	0.4129
Greece	0.3494	Portugal	0.3855	Iceland	0.4007

Australia	0.3032	Poland	0.3498	Poland	0.3498
Luxembourg	0.3009	Slovenia	0.3405	Slovenia	0.3405
Austria	0.2949	Greece	0.2965	Greece	0.3141
Ireland	0.2775	Korea	0.2954	Korea	0.2954
Denmark	0.2651	Austria	0.2782	Australia	0.2906
Japan	0.2622	Australia	0.2780	Austria	0.2865
Italy	0.2608	Slovak Republic	0.2774	Slovak Republic	0.2774
New Zealand	0.2440	New Zealand	0.2709	Czech Republic	0.2685
Finland	0.2423	Czech Republic	0.2685	Ireland	0.2621
United Kingdom	0.2349	Ireland	0.2506	New Zealand	0.2619
Belgium	0.2334	Denmark	0.2503	Denmark	0.2577
Sweden	0.2108	Italy	0.2460	Luxembourg	0.2555
Spain	0.2076	Belgium	0.2361	Italy	0.2534
United States	0.2075	Japan	0.2329	Japan	0.2475
Switzerland	0.1964	Netherlands	0.2303	Belgium	0.2348
Netherlands	0.1926	Luxembourg	0.2271	Finland	0.2341
France	0.1911	Finland	0.2260	United Kingdom	0.2297
Norway	0.1895	United Kingdom	0.2245	Netherlands	0.2114
Canada	0.1700	Canada	0.2152	Sweden	0.2047
Germany	0.1577	Sweden	0.1985	Spain	0.1962
		Norway	0.1908	Canada	0.1926
		France	0.1855	Norway	0.1901
		Spain	0.1849	France	0.1883
		United States	0.1684	United States	0.1880
		Switzerland	0.1675	Switzerland	0.1819
		Germany	0.1665	Germany	0.1621

Table A5: Ranking donors according to the within component of the Theil index

Donor	1998-2005	Donor	2006-2013	Donor	1998-2013
Austria	0.3058	Austria	0.3056	Austria	0.3057
Italy	0.2895	Greece	0.2830	Italy	0.2788
Luxembourg	0.2624	Slovak Republic	0.2786	Slovak Republic	0.2786
Greece	0.2599	Denmark	0.2713	Greece	0.2753

Portugal	0.2514	Korea	0.2711	Korea	0.2711
Denmark	0.2513	Iceland	0.2691	Iceland	0.2691
Finland	0.2472	Italy	0.2680	Poland	0.2619
Japan	0.2467	Sweden	0.2668	Denmark	0.2613
Switzerland	0.2440	Poland	0.2619	Slovenia	0.2556
Belgium	0.2398	Slovenia	0.2556	Sweden	0.2520
Sweden	0.2372	France	0.2495	Portugal	0.2449
New Zealand	0.2372	Netherlands	0.2487	Finland	0.2448
France	0.2369	Finland	0.2423	France	0.2432
Canada	0.2362	Switzerland	0.2403	Switzerland	0.2422
United Kingdom	0.2320	Portugal	0.2383	Netherlands	0.2379
Netherlands	0.2271	New Zealand	0.2379	New Zealand	0.2376
Germany	0.2226	Norway	0.2284	Japan	0.2334
Spain	0.2187	United Kingdom	0.2232	Canada	0.2279
Australia	0.2087	Japan	0.2201	United Kingdom	0.2276
Norway	0.2010	Canada	0.2195	Belgium	0.2241
United States	0.1979	Germany	0.2141	Luxembourg	0.2197
Ireland	0.1688	Belgium	0.2084	Germany	0.2183
		Czech Republic	0.2070	Norway	0.2147
		Spain	0.2042	Spain	0.2115
		Australia	0.1947	Czech Republic	0.2070
		Luxembourg	0.1930	Australia	0.2017
		United States	0.1863	United States	0.1921
		Ireland	0.1831	Ireland	0.1770

Table A6: Ranking recipients according to the between component of the Theil index (all donors)

Recipient	1998-2005	Recipient	2006-2013	Recipient	1998-2013
Top 10					
Montenegro	0.5492	Wallis & Fortuna	0.5462	Mayotte	0.5399
Mayotte	0.5410	Mayotte	0.5381	Wallis & Fortuna	0.5395
St. Helena	0.5386	Turks & Caicos	0.5377	St. Helena	0.5377

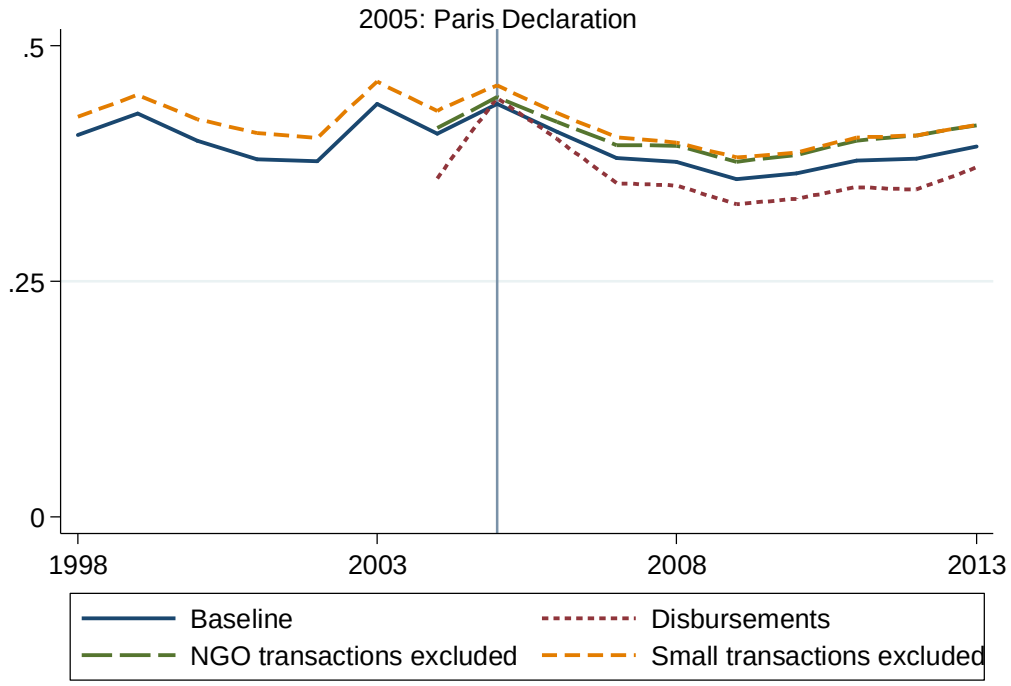
		Isl.			
				Northern	
Wallis & Fortuna	0.5329	St. Helena	0.5368	Marianas	0.5292
Northern					
Marianas	0.5292	Tokelau	0.5264	Aruba	0.5279
Aruba	0.5279	Montserrat	0.5261	Gibraltar	0.5279
Gibraltar	0.5279	Anguilla	0.5240	Netherlands Ant.	0.5274
Netherlands Ant.	0.5274	St. Kitts-Nevis	0.4940	Montserrat	0.5243
Anguilla	0.5245	Micronesia	0.4891	Anguilla	0.5242
Montserrat	0.5225	Niue	0.4801	Korea	0.5187
			Bottom 10		
Bosnia-Herzegov.	0.1928	Kyrgyz Republic	0.2040	Uganda	0.2036
Rwanda	0.1928	Burkina Faso	0.2037	Kenya	0.2012
Burkina Faso	0.1918	Tanzania	0.2013	Mali	0.2012
Zambia	0.1905	Sierra Leone	0.2005	Zambia	0.2001
South Africa	0.1846	Uganda	0.1996	Rwanda	0.1998
Cambodia	0.1830	Mali	0.1973	Burkina Faso	0.1977
Kenya	0.1823	Cambodia	0.1909	Cambodia	0.1870
Nicaragua	0.1819	Nicaragua	0.1881	Nicaragua	0.1850
Tanzania	0.1619	Burundi	0.1873	Tanzania	0.1816
Mozambique	0.1369	Mozambique	0.1669	Mozambique	0.1519

Table A7: Ranking recipients according to the within component of the Theil index (all donors)

Recipient	1998-2005	Recipient	2006-2013	Recipient	1998-2013
			Top 10		
Gibraltar	0.4721	Turks & Caicos Isl.	0.4449	Gibraltar	0.4721
				Northern	
Macao	0.4708	Trinidad & Tobago	0.4074	Marianas	0.4708
Northern					
Marianas	0.4708	St. Kitts-Nevis	0.3950	Macao	0.4708
Aruba	0.4707	Barbados	0.3917	Aruba	0.4707

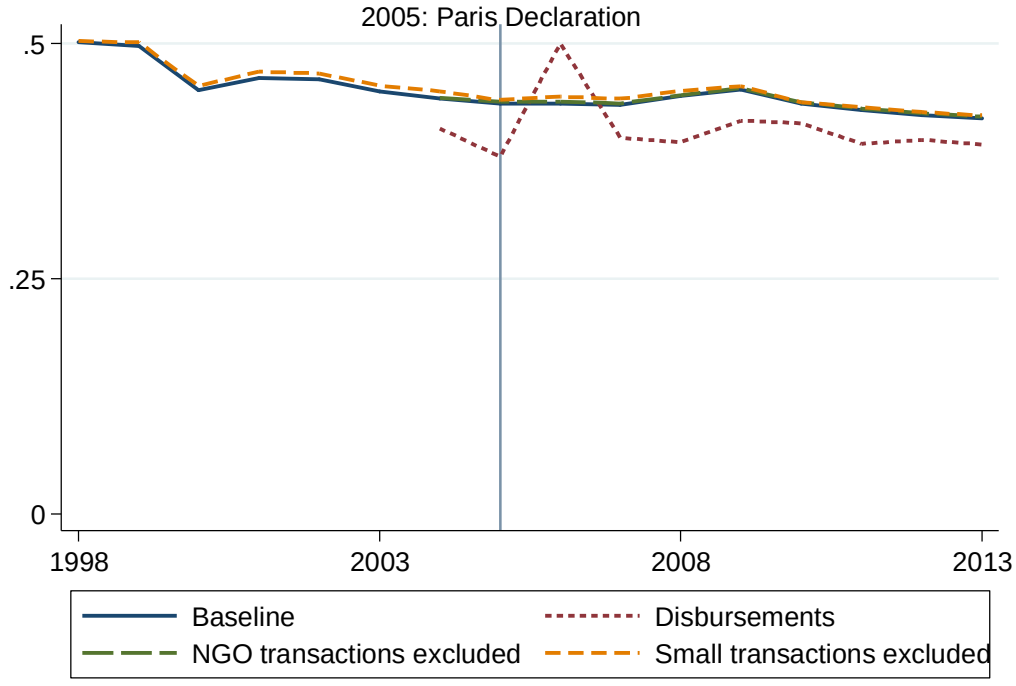
Korea	0.4664	Anguilla	0.3896	Korea	0.4664
Antigua & Barb.	0.4254	Botswana	0.3895	Netherl. Antilles	0.4173
Libya	0.4222	St. Vincent & the Gr.	0.3870	St. Kitts-Nevis	0.4082
St. Kitts-Nevis	0.4213	Antigua & Barbuda	0.3854	Trinidad & Tobago	0.4072
Netherl. Antilles	0.4173	Oman	0.3805	Antigua & Barbuda	0.4054
Korea. Dem. Rep.	0.4165	Grenada	0.3789	Barbados	0.4047
Bottom 10					
Ethiopia	0.2588	South Sudan	0.2353	Uganda	0.2548
Ukraine	0.2558	Vietnam	0.2351	Mali	0.2518
Malawi	0.2553	Peru	0.2337	Peru	0.2493
South Africa	0.2544	Argentina	0.2327	Afghanistan	0.2477
Vietnam	0.2504	Turkey	0.2310	Laos	0.2432
Uganda	0.2498	Haiti	0.2310	Vietnam	0.2427
Haiti	0.2494	Brazil	0.2294	Haiti	0.2402
New Caledonia	0.2380	Indonesia	0.2273	New Caledonia	0.2380
Brazil	0.2362	Laos	0.2236	South Sudan	0.2353
Montserrat	0.2217	Afghanistan	0.2100	Brazil	0.2328

Figure A1: Bilateral Theil based on different samples (equation 5a)



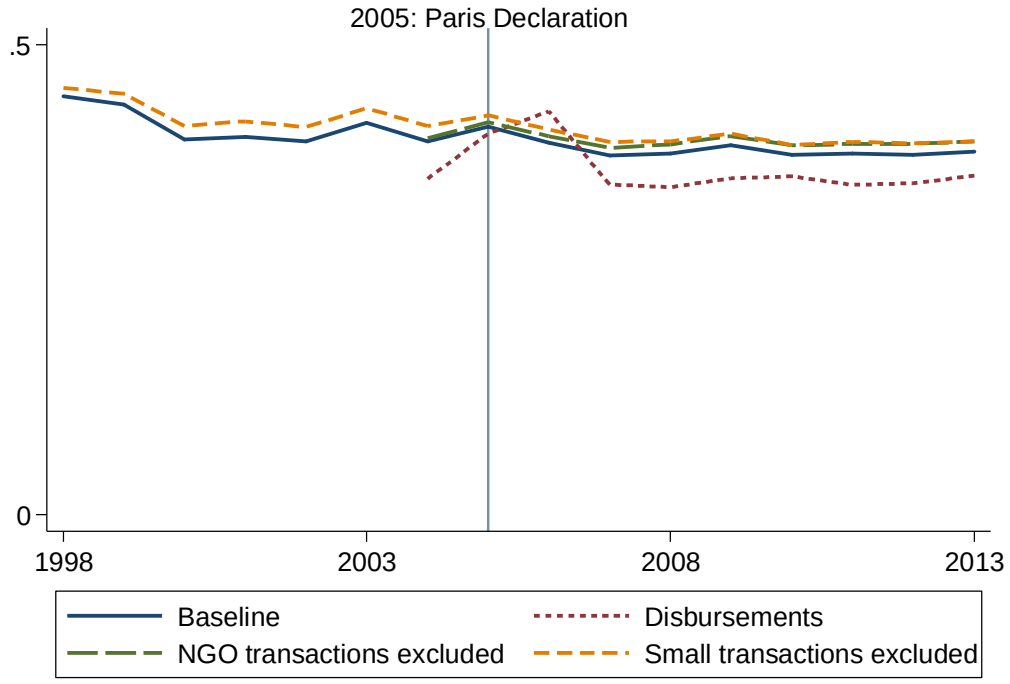
Source: Authors' calculations

Figure A2: Multilateral Theil based on different samples (equation 5b)



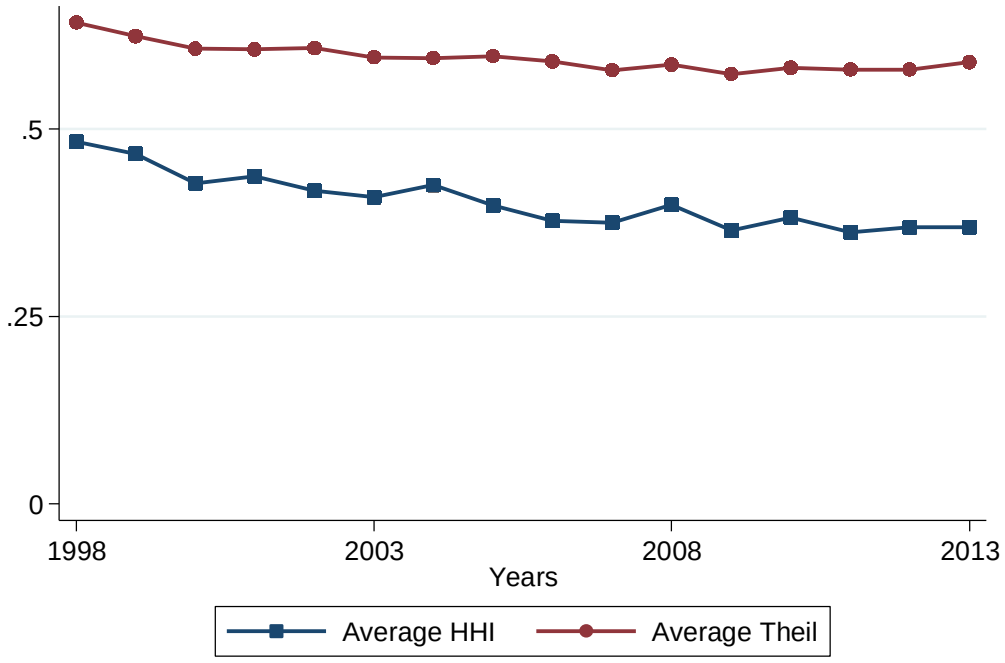
Source: Authors' calculations

Figure A3: Global Theil based on different samples (equation 5c)



Source: Authors' calculations

Figure A4: Average Theil and Herfindahl-Hirschman indices for recipients, bilateral donors only



Source: Authors' calculations

ANALYTICAL APPENDIX

In this appendix, we demonstrate how changes in various aid shares affect proliferation by a donor. The comparative statics for fragmentation in recipients are entirely symmetric.

We start from the variant of the Theil given in (4) of the main text, restated here as (A1):

$$(A1)\ T_{dt} = \sum_{r=1}^{R_t} \alpha_{drt} ln\left(\frac{\alpha_{drt}}{1/R_t}\right) + \sum_{r=1}^{R_t} \alpha_{drt}\left[\sum_{s=1}^{S} \delta_{drst} ln\left(\frac{\delta_{drst}}{1/S}\right)\right]$$

$$= lnR_tS + \sum_{r=1}^{R_t}\sum_{s=1}^{S} \alpha_{drst} ln\alpha_{drst} + \sum_{r=1}^{R_t}\sum_{s=1}^{S} \alpha_{drst} ln\alpha_{drst}$$

There are three different aid shares in this equation, two in the first expression and one in the final one. These all sum to one: $\Sigma_r\alpha_{drt} = \Sigma_s\beta_{drst} = \Sigma_r\Sigma_s\alpha_{drst} = 1$. To perform the comparative statics, define the last share as one minus the others, e.g. $\alpha_{dRt} = 1\text{-}\Sigma_r\alpha_{drt}$. Then

$$(A2a)\ \frac{\partial T_{dt}}{\partial \delta_{drst}} = \alpha_{drt} ln\left(\frac{\delta_{drst}}{\delta_{drSt}}\right)$$

$$(A2b)\ \frac{\partial T_{dt}}{\partial \alpha_{drt}} = ln\left(\frac{\alpha_{drt}}{\alpha_{dRt}}\right) + \sum_{s=1}^{S} \delta_{drst} ln\delta_{drst} - \sum_{s=1}^{S} \delta_{dRst} ln\delta_{dRst}$$

$$(A2c)\ \frac{\partial T_{dt}}{\partial \alpha_{drst}} = ln\left(\frac{\alpha_{drst}}{\alpha_{dRSt}}\right)$$

The Theil obeys the Pigou-Dalton-principle: a redistribution from rich (poor) to poor (rich) implies less (more) inequality. In the current context, the result is that donor *d*'s aid becomes more concentrated if aid to *r* is redistributed from sectors receiving relatively small shares at the outset to those receiving relatively high shares ($\delta_{drst} > \delta_{drSt}$), c.f. (A2a). Changes across countries are more complex. The first term in (A2b) is the Pigou-Dalton effect at the country-level, but there is an additional effect that depends on whether *d*'s aid to *r* is more or less concentrated than *d*'s aid to *R* (the two last terms). In principle, it is thus conceivable that *d*'s aid will be more concentrated according to the Theil even if resources are redirected from a major to a minor recipient. However, a redistribution from small to large allocations at the most basic level ("country-sectors") conforms to the Pigou-Dalton-principle, c.f. (A2c) for the case of $\alpha_{drst} > \alpha_{dRSt}$.

The formula for the global Theil for proliferation is

$$(A3)\ T_t^D = \gamma_t^B ln\left(\frac{\gamma_t^B}{B_t/D_t}\right) + \gamma_t^M ln\left(\frac{\gamma_t^M}{M_t/D_t}\right) + \gamma_t^B T_t^B + \gamma_t^M T_t^M$$

γ_t^B and γ_t^M are the shares of bilateral and multilateral aid in the global total, respectively. Making use of the fact that these shares sum to one and applying the formulas in (5a) and (5b), one arrives at the expression on the right hand side of (5c). The first two terms in (A3) constitute the between variation, while within variation is captured by the latter two. The bilateral part of the total is made up by the first and third terms, whereas the multilateral contribution comes from the second and the fourth. The result can be seen in Figure 6 of the main text.

The formula for the Theil of region j at time t is completely analogous to the global fragmentation index (5c):

$$(A4)T_{jt} = \sum_{r=1}^{R_{jt}} \theta_{rt} ln\left(\frac{\theta_{rt}}{1/R_{jt}}\right) + \sum_{r=1}^{R_{jt}} \theta_{rt} T_{rt} = lnD_{jt}R_{jt}S + \sum_{d=1}^{D_{jt}} \sum_{r=1}^{R_{jt}} \sum_{s=1}^{S} \theta_{drst} ln\theta_{drst}$$

$\theta_{rt} = A_{rt}/A_{jt}$ is the share of regional aid A_{jt} received by recipient r and θ_{drst} is the share of this total received by that country from donor d as funding for sector s. R_j is the number of eligible recipients in region j and D_j the potential number of donors. The former number is obviously region-specific. The latter includes all bilateral donors, which in principle have no limitations on where their aid goes, but as some multilaterals have mandates based on geography the total number of possible donors varies between regions. The results from applying equation (A4) can be seen in Figure 8 of the main text.

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