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Can fungibility of development aid lead to more effective achievement of the SDGs?

An analysis of the aggregate welfare effect of aid fungibility

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Abstract: In this paper, we explore the relationship between foreign aid fungibility and aggregate welfare. Using panel data from 35 low-income and lower-middle-income countries, we first check the presence of sectoral aid fungibility in our sample and find evidence for it. We then use econometric methods to empirically analyse the impact of this fungibility on aggregate welfare as measured through the Human Development Index. Our findings suggest that in some cases sectoral aid fungibility can lead to an improvement in aggregate welfare. We conclude that recipient governments and donors can consider aid fungibility as a policy tool in ensuring optimal allocation of limited resources to ensure progress towards the sustainable development goals (SDGs).

Key words: foreign aid, econometrics, aggregate welfare, aid fungibility, Sustainable Development Goals

JEL classification: F35, B23, H53

Note: This paper formed a chapter of Zunera Rana's PhD thesis.

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1 Introduction

Much has been researched and published about aid fungibility—the idea that in the presence of aid, recipient governments alter their planned expenditures in such a way that the incoming aid is not spent in the allocated sector/region but is diverted elsewhere (Pack and Pack 1990, 1993; Wagstaff 2011). The common conclusion observed in the literature is that aid, even when earmarked for a specific sector, can be fungible. This fungibility is viewed as having a negative impact on aid effectiveness, and researchers and policy makers have therefore proposed several measures over the years to reduce and curb this phenomenon.

Similarly, an overwhelming number of papers on the topic of aid fungibility focus on whether or not fungibility exists at the aggregate or sectoral level (Devarajan and Swaroop 1998; Lu et al. 2017; Pack and Pack 1990, 1993). However, only a few studies consider the impact of the fungibility thus found (Morrissey 2001 Pettersson 2007a; Wagstaff 2011). We believe that the limited literature on the impact of aid fungibility represents an incomplete picture of aid effectiveness. For this reason, we hope to add to this limited theme in the literature through our research.

In this paper, we look at the impact of sectoral aid fungibility on aggregate welfare by hypothesizing that the fungibility of development aid can be positive in nature and is needed when the yardstick is progress towards meeting the Sustainable Development Goals (SDGs). We use a microeconomic theoretical framework based on the work of McGillivray and Morrissey (2001) for this research and show that fungibility can be considered to be positive if it has a positive impact on aggregate welfare. Thus, fungibility, when positive, allows for a more efficient allocation of resources from a comparatively static point of view (Rana and Koch 2020a), which, we believe, allows for higher aggregate welfare in the respective country.

The main research question therefore is: does the sectoral fungibility of development aid have a negative impact on aggregate welfare? As we use the SDGs as the yardstick, the term 'welfare' is defined in this case through the variables that determine progress towards meeting the SDG indicators such as the Human Development Index (HDI). There are, of course, limitations associated with using such a broad definition of aggregate welfare. However, most aid is targeted at reducing poverty and/or improving economic growth, especially in low- and lower-middle-income countries. The recipient countries of this aid are also focused on achieving SDGs related to health, poverty, and education. An HDI measure in such a case can capture the impact of aid through the dimensions of income, education, and health as it is composed of these elements. We therefore believe that it can present a comprehensive picture of changes in aggregate welfare for low- and lower-middle-income countries.

This study adds to the current literature on fungibility in three ways. First, the current prominent literature on aid fungibility is at least ten years old, which makes this study the most up-to-date empirical research on the subject. Second, to our knowledge, this is the only study that tries to look at the impact of aid fungibility on progress towards meeting the SDGs through the lens of aggregate welfare. Third, through this study we try to give a new, positive connotation to the term 'aid fungibility', something that has not been discussed much in the literature so far.

Our hypothesis is tested through a two-part empirical model where we first establish that fungibility of development aid exists at sectoral levels in our data sample and then look at the impact of this fungibility on the aggregate welfare of the recipient countries by using the HDI as a proxy variable for aggregate welfare.

We divide our paper into the six sections. Following this introduction to the theme of aid fungibility, Section 2 analyses the existing literature in the field. Section 3 discusses the theoretical background that forms the basis of our analysis. Section 4 talks about the methodology and is further divided into two parts to discuss the empirical model and results in more detail. We then discuss our results in Section 5 and conclude the paper in Section 6.

2 Development aid and welfare: a review of the literature

Improvement in the effectiveness of aid has been a primary focus for development practitioners as well as academics. According to the Paris Declaration (2005), aid effectiveness is defined through the five principles of ownership by recipient countries, alignment of objectives between donors and recipients, harmonization of interests, focus on achievement of results, and having mutual accountability (OECD 2005). The Accra Agenda (2008) further highlights four areas that need to be focused on to improve aid effectiveness. These are inclusive partnerships, delivering results, increased ownership, and capacity building of the recipient countries (OECD 2008).

While the Paris Declaration and Accra Agenda concentrate on aid effectiveness from the angle of the relationship between the donors and the recipients of aid, the academic literature on aid effectiveness has mostly focused on the impact of aid on economic growth. Although improved economic growth is a good measure for determining aid effectiveness, development aid also has an indirect impact on poverty reduction and welfare, which, if ignored, will undermine the effectiveness of aid. For example, aid targeted to health projects will only show its impact on growth in the long run, but it has a direct impact on aggregate welfare in the short run (Morrissey 2001). Mosley et al. (2004) also emphasize the need for a greater focus on measures and policies that reduce poverty as the main goal instead of economic growth. Pro-poor expenditures can easily be manipulated by recipient governments and at the same time can be highly influenced by incoming aid (Mosley et al. 2004). Analysing these expenditures and the aid linked to them can give a better measure of aid effectiveness.

However, the biggest problem with poverty reduction measures is that they are monetary in nature (for example, income measure of poverty) and are not usually comparable across countries (Gomanee, Morrissey et al. 2005). For this reason, to test the effectiveness of development aid, the literature uses non-monetary measures of aggregate welfare, including changes in the HDI (Gomanee, Morrissey et al. 2005), infant mortality rates (Boone 1996; Gomanee, Morrissey et al. 2005; Kotsadam, et al. 2018), education, health, nutrition/water (De and Becker 2015; Martorano et al. 2020), and infrastructure (Agenor and Devri 2013).

Boone's (1996) paper is one of the most-cited works that uses non-monetary measures of welfare to test aid effectiveness. He observes no evidence of aid being associated with human development indicators, especially lower infant mortality rates. In contrast, Gomanee, Morrissey et al. (2005) discover that aid is positively associated with aggregate welfare (measured through the HDI and infant mortality rates) and that the impact is higher in low-income countries. They observe the effectiveness of aid both directly and through the effect of growth in a sample of 104 countries (Gomanee, Morrissey et al. 2005a).

In another paper, Gomanee, Girma et al. (2005) use quantile regressions and find a positive correlation between social sector spending and increased welfare in a sample of 38 countries. Similarly, Martorano et al. (2020) analyse the impact of Chinese aid on welfare by looking at changes in education, child health, and nutrition. They find evidence of a welfare increase in the education and health sectors in areas where there is Chinese aid compared to areas where there are no aid projects.

In general, the limited literature on aid and welfare shows that, in most cases, aid positively impacts aggregate welfare or its components. However, a number of these studies ignore the impact of aid on public expenditure[1] that is not official development assistance (ODA), as changes in public expenditure in the presence of aid may undermine its effectiveness. For example, aid can lead to a change in public expenditure directed at development sectors like education and health. This change in expenditure could lead to improvement in these sectors, thus resulting in aid indirectly affecting aggregate welfare—a consequence of aid that is not usually considered in the literature. Gomanee, Morrissey et al. (2005) show that such aid allocation rules do not consider the fact that aid affects welfare via public expenditure, and this effect is greater in countries with lower welfare levels.

Thus, an increase in government development expenditure in the presence of aid does not necessarily mean that it will impact growth. But it is also reasonable to assume that such expenditure will impact aggregate welfare even if the development expenditure finances a different sector to the aid project. The increase in social expenditure by the government when aid increases may lead to high levels of aggregate welfare even if this increased social expenditure does not directly reduce headcount poverty or increase economic growth. Therefore, if a government wants to improve its aggregate welfare, it should focus more on non-income dimensions of poverty which are directed at the poor population of the country (World Bank 2001).

Our brief overview of the literature on aid and aggregate welfare brings us to the conclusion that non-monetary measures of aggregate welfare tend to present a better picture of the impact of aid. In addition, the effectiveness of aid will be underestimated if its impact on public expenditure is not taken into consideration. Even if this impact is in another sector, it can nonetheless result in an increase in aggregate welfare. Now that we have analysed the literature related to development aid and aggregate welfare, we can move on to a brief discussion of welfare and aid fungibility.

2.1 Welfare in the presence of aid fungibility

As mentioned previously, the literature on aid fungibility focuses mostly on the question of whether or not aid is fungible by looking at sectoral aid (Alvarez et al. 2016; Dieleman et al. 2013; Farag et al. 2009; Lu et al. 2017; Van de Sijpe 2010) or governmental aid (Khilji and Zampelli 1991; Morrissey 2001; Pack and Pack 1990, 1993). Almost all studies find aid to be fungible, and they mostly recommend reducing fungibility and improving aid effectiveness.

McGillivray and Morrisey (2000), Pettersson (2007a), and Wagstaff (2011) are among the few researchers who consider that aid fungibility does not reduce aid effectiveness. In this regard, Wagstaff (2011) looks at the impact across provinces in Vietnam, while Pettersson (2007a) analyses the impact of aid fungibility on growth and poverty reduction. Pettersson (2007a) finds that non-fungible sectors do not have better performance than fungible sectors. However, his results also indicate that non-fungible sectors improve welfare (using infant mortality rates as a proxy).

In another study, Pettersson (2007b) finds evidence that the extent to which aid is considered fungible is uncorrelated with the amount of incoming aid, government expenditures, or the democracy levels of the recipient country. He concludes that 'fungibility in pro-poor sectors is at worst unimportant, at best desirable' (Pettersson 2007b: 690). Similarly, Dreher et al. (2008) look

[1] Public expenditure here refers to direct expenditure by the government and not the impact on the taxation system.

at aid fungibility indirectly by comparing the impact of education aid and government education spending on school enrolment rates in 100 countries. They conclude that education aid leads to an increase in enrolment rates but that government education spending does not, thus indicating that aid fungibility can positively impact school enrolment rates.

A few studies also look at the role of governance in aid fungibility and welfare. Burnside and Dollar (2000) conclude that aid effectiveness is higher in good policy environments, while Pettersson (2007a) finds no evidence of aid fungibility being associated with institutional inefficiencies or irrational fiscal policies by the recipient government. In a similar vein, Adedokun (2017) analyses foreign aid in sub-Saharan Africa and concludes that the amount of aid and the level of governance have an impact on the effectiveness of aid in the selected sample of countries. Odokonyero et al. (2018) use geo-coded data to consider the impact of health aid and observe that proximity to aid projects is associated with higher aid effectiveness, thus indicating that aid allocation is an important characteristic for better results. Kaufmann (2009) also pushes donors to consider governance and political corruption when selecting development partners.

Overall, we conclude that the literature on aid fungibility lacks detailed analysis of the impact of fungibility on aggregate welfare. There are some indirect discussions on aid effectiveness in the presence of fungibility and good governance, but, to the best of our knowledge, the papers by Pettersson (2007a, 2007b) are the only ones that analyse the impact of aggregate welfare and aid fungibility. In our paper, we want to extend the approach used by Pettersson (2007a, 2007b) by looking at sectoral data for health, education, and social protection and observing the effect on the HDI and infant mortality rates.

In the next section, we introduce our theoretical framework which we use later in explaining our methodology and results.

3 Theoretical framework

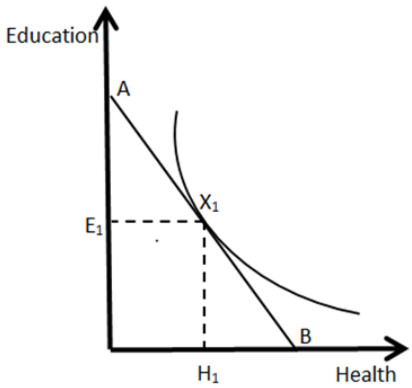
In this section, we discuss the theoretical underpinning of our analysis, which is based on the microeconomic framework developed by McGillivray and Morrissey (2001) and later discussed by Rana and Koch (2020a).[2]

3.1 A model for aggregate welfare

Let us assume that a budget constraint of a developing country is equal to AB and the country allocates its resources to only two sectors: health (H_1) and education (E_1) (Figure 1). The amount spent on health and education is determined by the tangency between the budget constraint and the indifference curve I_1. At point X_1, the government can maximize its utility, as at this point the marginal rate of substitution between education and health is equal to H_1 / E_1 (Rana and Koch 2020a).

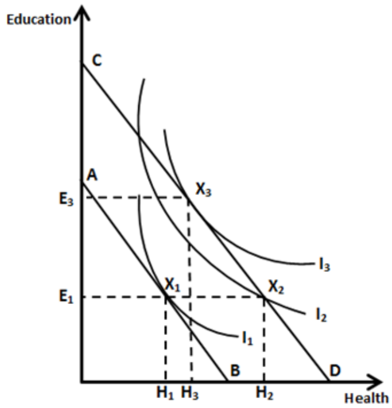
[2] Rana and Koch (2020a) discuss three frameworks for positive aid fungibility. We focus only on the first of these.

Figure 1: A two-sector economy



Source: authors' own illustration.

Figure 2: Partial fungibility



Source: authors' own illustration.

Now let us assume that the government receives some development assistance for health in the form of cash transfers. This moves the budget curve outwards to the new line CD (Figure 2). The government can in turn increase its budget for health by the same amount as that of the aid and move to point X_2 on CD on the new indifference curve I_2, increasing overall welfare. However, the government can also choose a different point on CD, which may increase spending in both the health and education sectors (for example point X_3 on I_3)—i.e. it may choose to divert funds that were originally planned for the health sector to the education sector, causing fungibility while also increasing aggregate welfare by a higher amount.

The fungibility in such a case is based on optimal allocation of resources and can therefore be considered positive (Rana and Koch 2020a). In addition to this, higher spending in education may lead to a higher increase in aggregate welfare in the long run, especially if the government deems it necessary for its citizens. Fungibility under such circumstances will lead to an increase in aggregate welfare by improving both the health and education sectors. This fungibility, coupled with effective government strategies, can help the recipient government to achieve a higher level of welfare. Therefore, we can conclude that fungibility may sometimes be the result of optimal allocation of resources and, in such a case, this fungibility can be considered positive if it positively affects aggregate welfare.

Using this framework of indifference curves and utility maximization, we intend to give a broader picture of aid fungibility and how it can impact aggregate welfare. However, for the methodology and analysis section, we use a more pragmatic approach for calculating change in aggregate welfare, as mentioned in Section 1. Our methodology is discussed in greater detail in the next section.

4 Methodology

Now that we have discussed the relevant literature and developed the theoretical framework, we move on to the methodology, which is divided into two steps: a discussion of the model for sectoral aid fungibility and an analysis of the impact of fungibility thus observed on aggregate welfare.

4.1 Step I: a model for sectoral aid fungibility

As a first step, we develop a model to determine the presence of fungibility in our sample of countries. Later, we use the fungibility calculated from this model to test its impact on aggregate welfare.

We start with our microeconomic framework of utility maximization. As discussed in Section 3, any recipient government of development aid faces a budget constraint under which it tries to maximize its utility. Let us assume that the budget constraint faced by the recipient government of a developing country looks like the following equation:

$$DEV + CURR + DS \; = R + ODA + DEF$$

Here, DEV = development expenditure, CURR = current expenditure, DS = debt servicing, R = total revenue, ODA = official development assistance, and DEF = budget deficit.

As aid can impact both development expenditure and current expenditure, we cannot use aggregate measures of expenditure to determine the presence of aid fungibility. Empirically, it is easier to observe the shifting of funds between sectors as an indication of aid fungibility rather than at an aggregate level. For this reason, while keeping in mind the same budget constraint mentioned above, for this analysis we focus on three development sectors, i.e. health, education, and social protection. The reason for focusing on these sectors is that they constitute progress towards meeting several SDGs.[3] Therefore, we develop the following equation for the econometric models to determine the presence of sectoral aid fungibility:

$$GovExp_{ss} = \beta_0 + \beta_1 ODA_{ss} + \beta_2 ODA_{nss} + \beta_3 DS + \beta_4 R + \beta_5 FDI + \epsilon \; ..... \qquad (1)$$

Where, $GovExp_{ss}$ = sector-specific government expenditure,[4] ODA_{ss} = sector-specific official development assistance, ODA_{nss} = aid to other non-sector-specific development sectors, and FDI = foreign direct investment. The descriptions and constructions of the variables are included in Table B2 in Appendix B. From the equations, we can derive that ODA in a particular sector will be fungible when:

$$\frac{\partial GovExp_{ss}}{\partial ODA_{ss}} < 1$$

that is, a change in sector-specific ODA is met by a less than equal change in sector-specific government expenditure.

Using the equation above, we run a panel regression analysis on a sample of 35 low- and lower-middle-income countries. However, the panel regression (see Table 3) shows problems of cross-sectional dependencies. The tests for cross-sectional dependencies are included in Table A1 in Appendix A.

To correct for cross-sectional dependencies, we opt for a seemingly unrelated regression (SUR) model by developing a system of equations as done by Pack and Pack (1993) and Pettersson

[3] SDGs 1, 3, and 4 directly, and SDGs 2, 8, 9 , 10, 16, and 17 indirectly.

[4] We consider four models with dependent variables as: health expenditure (H), education expenditure (Edu), health and education expenditure (HE), health, education, and social protection (HES)

(2007a). Therefore, the new regression models consist of equation (1), as mentioned above, as well as a second equation which takes other development expenditure[5] into consideration:

$$OTHExp_{nss} = \beta_0 + \beta_1 ODA_{ss} + \beta_2 ODA_{nss} + \beta_3 DS + \beta_4 R + \beta_5 FDI + \epsilon \ldots \qquad (2)$$

Using the two equations, we run the SUR model and discuss the results in detail in the next section.

4.2 Summary of data

We start with an unbalanced panel of 65 countries. However, because of limited data availability, only those countries that have at least eight or more observations in terms of the number of years are considered. Therefore, we end up with unbalanced panel data consisting of 35 low- and lower-middle-income countries. The data collected is from 2002 to 2019, as the Organisation for Economic Co-operation and Development (OECD) creditor's reporting system only has data for ODA disbursements from 2002 onwards. We use the DAC-5 table as the main source of ODA data; disbursements from all official donors are considered and the codes for each sectoral ODA are included in Table B2 in Appendix B.

We only consider sectoral ODA and not general budget support as it is difficult to determine the flow of general budget support to each development sector. Therefore, if a country has received a large amount of general budget support instead of sectoral aid, this can underestimate our fungibility results. We also understand that not all sectoral ODA flows through the governmental budget, but we assume that the government is aware of the sectoral aid projects going on in the country even if it does not flow through government departments and can take them into consideration while planning its own expenditure.

Summaries of the start and end dates for each country are included in Table B1 in Appendix B along with information on its region and income group.

In Table B2 in Appendix B, we also include information summarizing the sources from which the data is collected and the construction/composition of each of the variables used in the system of equations developed in the previous section. Table 1 provides the summary statistics of all the variables used in the SUR model.

[5] Construction of the variables is explained in Table B2 in Appendix B.

Table 1: Summary statistics of variables

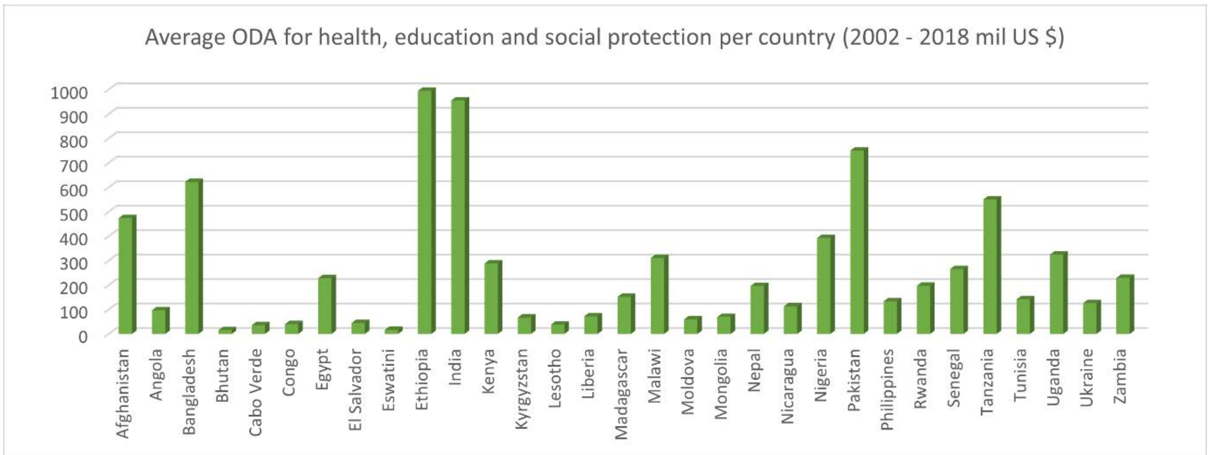
Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max	Median
Year	548	2,011.01	4.95	2,002	2,007	2,015	2,019	2011
ODA edu	548	115.07	135.15	1.25	29.19	144.24	770.29	69.19
ODA health	548	112.48	130.04	0.69	21.17	161.75	772.99	58.61
ODA SP	548	24.02	52.04	0.01	2.93	22.02	467.46	8.91
ODA oth	548	108.93	131.58	0.39	30.83	131.87	1,010.20	67.04
ODA HES	548	251.57	276.76	3.64	69.45	310.53	1,417.76	145.74
SP exp	548	1,361.31	3,558.65	0.00	21.90	480.86	25,877.95	116.54
Health exp	548	600.34	1,105.61	0.07	91.43	521.51	7,309.41	217.86
Edu exp	548	2,147.16	6,196.97	0.12	191.34	1,557.13	50,568.63	472.19
OTH exp	548	5,147.36	16,117.07	0.24	317.46	3,154.80	122,263.10	594.96
HES exp	548	4,108.81	9,848.59	0.19	334.36	2,707.86	70,317.51	895.00
R	548	15,434.95	40,758.27	0.0000	912.60	12,148.77	337,829.70	2,649.09
Urban pop	548	25.77	69.76	0.11	2.04	16.85	471.03	6.06
DS	548	3,103.68	8,628.98	0	82.9	1,910.8	92,816	444.66
FDI	548	2,008.30	5,971.47	-7,397	107.8	1,497.3	50,611	493.27
IM	548	41.38	21.47	7.20	23.28	55.45	114.20	38.6
Geff	548	-0.56	0.43	-1.57	-0.83	-0.34	0.78	-0.59
HDI	545	0.57	0.10	0.37	0.49	0.66	0.78	0.55

Note: unless stated otherwise, (where applicable) all values are in million USD. SP = social protection, IM = infant mortality rates, HES = heath + education + social protection, exp = expenditure, DS = debt servicing, FDI = foreign direct investment, Geff = government effectiveness, ODA oth = aid to sectors other than education, health and social protection.

Source: authors' own calculation.

As we can see from Table 1, our regression model consists of 548 observations. The data collected in local currency units is converted to US dollars using exchange rates from the International Monetary Fund. Some countries, for example Zimbabwe, were dropped from the sample because of missing exchange rates. In some cases, linear interpolation and/or extrapolation is used when there are a maximum of two missing observations for a specific country variable. Figure 3 presents the average ODA received per country for health, education, and social protection.

Figure 3: Average ODA per country for health, education, and social protection from 2002 to 2019



Source: authors' own calculation.

In the next section, we introduce and discuss the results from our SUR models at the aggregate level as well as based on income and regional groups.

4.3 Results: fungibility at the aggregate level

Table 2 presents the results of the SUR model for a group of 35 countries over a period of 17 years in the form of an unbalanced panel.[6] Both the SUR model and fixed-effect panel regressions are included in the table. However, as mentioned in Section 4.1., the results of the fixed-effect model are biased due to cross-sectional dependencies and are therefore not discussed here. In general, the table shows four different models. Model 1 considers health expenditure (H) as the dependent variable, model 2 considers education expenditure (Edu), while model 3 and model 4 consider aggregates of health and education expenditures (HE) and health, education, and social protection expenditure (HES) as dependent variables, respectively.

As we explained in Section 4.1, we divided ODA into two parts: sector-specific ODA (ODA_{ss}) and non-sector-specific ODA (ODA_{nss}). This means that, in model 1, ODA_{ss} represents ODA to health only, while the data for ODA to all other sectors including education and social protection is included in the variable ODA_{nss}. Similarly, if we consider model 4, ODA_{ss} consists of development aid for health, education, and social protection, while ODA to all other sectors is included in the variable ODA_{nss}. So, for each of the four models, the data for ODA_{ss} and ODA_{nss} varies based on the dependent variable in consideration.

The results from the SUR model indicate that as the amount of sector-specific ODA comes in, it negatively impacts the expenditure in that sector. For example, a US$1 million increase in ODA to education causes the education expenditure to fall by US$1.631 million, ceteris paribus, as model 2 (E) shows. A similar and significant trend can be seen in model 4 (HES), while, in model 1 (H) and model 3 (HE), the relationship stays negative, albeit insignificant. On the other hand, the impact of ODA on other development sectors seems to be negative but insignificant in models 1 (H), 2 (E), and 4 (HES). The only significant relationship between ODA and other development expenditure is visible in model 3 (HE), where an increase in ODA to health and education of US$1 million causes other government expenditure to increase by US$2.438 million, keeping everything else constant.

ODA_{ness} shows a positive and significant relationship in all the models in the SUR regression, indicating that as non-sector-specific ODA increases, government expenditure in health, education, and social protection increases, ceteris paribus. This shows clear evidence of aid fungibility in almost all four models, although the results need to be treated with caution in models 1 (H) and 3 (HE) as the coefficient of sector-specific ODA is not significant.

The results from other control variables including revenue and FDI (where significant) are uniform in all the models and are in line with our expectations. In the case of debt servicing, they indicate a positive relationship between expenditure and debt servicing, i.e. as debt servicing increases, expenditure in each of the sectors also increases. This relationship can be explained by the fact that a large portion of ODA to lower-middle-income countries is given in the form of soft loans which require repayment. Thus, increased debt servicing can also be an indication of the availability of larger amounts of money (in the form of soft loans) to increase development expenditure. Overall, the results from the aggregate SUR models show evidence of sectoral aid fungibility in our sample of countries, i.e. as ODA in a specific sector increases, the government expenditure in the sector starts to fall—that is, the government tends to divert its own spending to another sector/expenditure.

[6] We include the corelation coefficient matrix in Figure D1 in Appendix D.

Table 2: SUR model—all countries and income groups

	SUR models – aggregate								Fixed-effect panel regression			
	H		Edu		HEdu		HES		H	Edu	HEdu	HES
	HExp	OthExp	EduExp	OthExp	HEexp	OthExp	HESexp	OthExp				
	(1)		(2)		(3)		(4)		(5)	(6)	(7)	(8)
ODA_{ss}[7]	-0.318	-2.109	-1.631**	-2.523	-0.632	2.438*	-1.473***	-0.105	1.108***	-2.593**	-0.158	0.887
	(0.281)	(2.997)	(0.888)	(2.952)	(0.583)	(1.292)	(0.498)	(1.117)	(0.335)	(1.011)	(0.765)	(1.288)
ODA_{nss}[8]	0.335**	4.124**	1.582***	3.639**	3.791***	1.694	4.563***	6.333***	0.063	2.132***	3.020**	1.166
	(0.147)	(1.569)	(0.449)	(1.493)	(1.246)	(2.761)	(0.905)	(2.025)	(0.155)	(0.536)	(1.324)	(1.849)
R	0.021***	0.363***	0.086***	0.301***	0.107***	0.223***	0.108***	0.226***	0.017***	0.081***	0.097***	0.145***
	(0.002)	(0.017)	(0.005)	(0.015)	(0.005)	(0.012)	(0.005)	(0.012)	(0.001)	(0.004)	(0.005)	(0.009)
DS	-0.008	0.146**	0.047***	0.109**	0.036*	0.071	0.034**	0.069	0.001	0.120***	0.112***	0.138***
	(0.006)	(0.063)	(0.016)	(0.055)	(0.019)	(0.044)	(0.019)	(0.044)	(0.005)	(0.016)	(0.019)	(0.034)
FDI	0.019*	1.286***	0.364***	0.931***	0.379***	0.959***	0.376***	0.959***	0.033***	0.312***	0.339***	0.344***
	(0.009)	(0.103)	(0.027)	(0.089)	(0.032)	(0.072)	(0.032)	(0.072)	(0.008)	(0.024)	(0.030)	(0.053)
Obs	555	555	555	555	555	555	555	555	555	555	555	555
Est. SD	582.81	6213.09	1,621.8	5,389.7	1960.6	4,344.9	1947.3	4,358.9				
R2									0.487	0.815	0.794	0.680
Adj. R^2									0.447	0.800	0.778	0.655
F Stat									97.52***	452.35***	396.86***	218.68***

Note: *p<0.1; **p<0.05; ***p<0.01.

Source: authors' own calculation.

[7] ODA refers to ODA for the specific sector, i.e. ODA for model 1 is ODA for health only. Similarly, ODA in model 2 represents ODA for education only, and so on.

[8] ODA_ness represents ODA for all other development sectors. For example, in model 1, ODA_oth includes all the variables mentioned in the description of the variable in Table B2 plus ODA for education. Similarly, in model 2, ODA_oth includes all variables mentioned in description of the variable in table B2 plus ODA for health.

Having established the presence of aid fungibility in our model, we now want to see its impact on aggregate welfare in our sample of countries. However, to run a regression on aid fungibility against a proxy for aggregate welfare, we need to first calculate individual values of fungibility that can be used for the welfare regression model. In the next section, we discuss the methodology for calculating the values of aid fungibility based on the SUR model for individual countries.

4.4 Calculating aid fungibility

While the panel models gave a good idea of the presence of aid fungibility, they did not provide us with the exact estimates that are needed for testing the paper's second research question, i.e. what is the impact of aid fungibility on the aggregate welfare of developing countries? Therefore, as a next step, we calculate the SUR model for individual countries in our sample. As the individual country SUR is a time-series model, our maximum number of observations is limited to 17 per country. We use the same system of equations as in Section 4.1 for running individual country SUR models. However, instead of running the model for each sector separately, we run it on the aggregate model only, with HES as the dependent variable. We consider the log of our dependent variable to have estimates in the form of elasticities, somewhat similar to the approach of Pettersson (2007a). Thus, our system of equations is:

$$\ln HESexp = \beta_0 + \beta_{11} ODA_{HES} + \beta_{21} ODA_{oth} + \beta_{31} R + \beta_{41} DS + \epsilon$$

$$\ln OTHExp = \beta_0 + \beta_{12} ODA_{HES} + \beta_{22} ODA_{oth} + \beta_{32} R + \beta_{42} DS + \epsilon$$

We run the SUR model with the system of equations mentioned above and use the results to determine the value of fungibility along the same lines as introduced and modelled by Pack and Pack (1993) and Pettersson (2007a). To calculate fungibility, we first develop that:

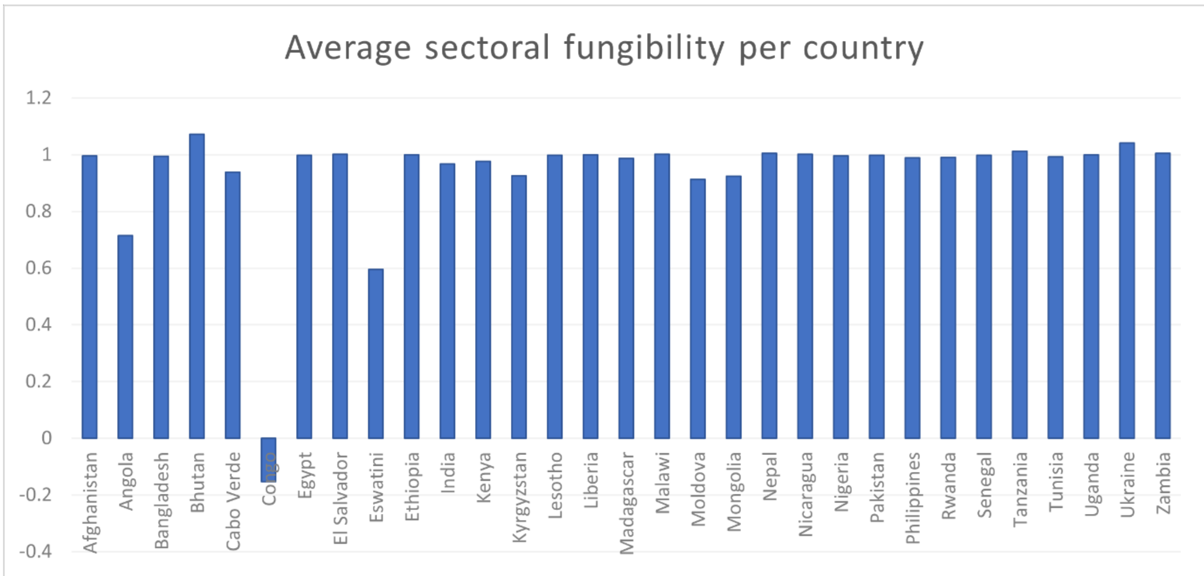
$$\partial \widehat{HES} = \beta_{11} \frac{HESexp}{ODA_{HES}} \partial HES + \beta_{21} \frac{HESexp}{ODA_{oth}} \partial OTH$$

$$\partial \widehat{OTH} = \beta_{12} \frac{OTHexp}{ODA_{HES}} \partial HES + \beta_{22} \frac{OTHexp}{ODA_{oth}} \partial OTH$$

Where $\partial HES = \overline{ODA_{HES}} / \overline{Total\ aid}$ and $\partial OTH = \overline{ODA_{OTH}} / \overline{Total\ aid}$. Total aid here is the sum of ODA_{HES} and ODA_{oth} and is equal to 1 (or 100 per cent). The equation above tells us that the change in net HES expenditure is dependent on the ratio of HES expenditure to ODA to HES and other development sectors. Similarly, the change in other sectoral development expenditure can be seen through the ratio of other expenditure to both ODA to HES and other development sectors. Therefore, a change in sector-specific expenditure (HES) that is less than a change in ODA to that sector will indicate diversion of funds away from the sector, leading to fungibility. Using the same logic as developed by Pack and Pack (1993) and Pettersson (2007a), we can observe that $\partial \widehat{HES} + \partial \widehat{OTH}$ gives us the total effect of net expenditure on an additional dollar of sectoral aid, i.e. it tells us if sectoral aid is used for sectoral expenditures.

As total ODA between HES and OTH is equal to 100 per cent or 1, the variable FUN (fungibility) can be defined as the difference from the total aid and allocated aid to expenditure effect, i.e. $FUN = 1 - \partial \widehat{HES} - \partial \widehat{OTH}$, where a value of 0 indicates no diversion of funds (or sectoral aid increaseds sectoral spending, i.e. no fungibility) and a value of 1 indicates full fungibility, i.e. sectoral aid is completely diverted away from the sectors it is intended for. A value of between 0 and 1 indicates partial fungibility, meaning that some of the ODA is used in the intended sector. A negative value of fungibility means additional expenditure by the recipient government.

Figure 4: Average sectoral fungibility per country



Source: authors' own calculation.

As including the individual regression results for each country would take up a lot of space, we include the estimates for β_{11}, β_{21}, β_{12}, and β_{22} (variables used to calculate the value of fungibility) in Table B1 in Appendix B. Even though the fungibility values thus calculated are for each year and each country, it would also take up too much space to include them in the paper. Therefore, we calculate the average value of fungibility for each country and include it in Table B1 in Appendix B to give an idea of what the estimates looked like. Figure 4 also gives a summary of the average values for all countries in our sample. In general, the values are all close to 1 except in the case of Congo where the amount of ODA reported is quite low especially for non-HES sectors.

The FUN variable tells us about total sectoral aid and its diversion away from the development sectors (we use both ODA_{HES} and ODA_{oth} for calculating FUN). Like Pettersson (2007a), we also want to go a step further and calculate whether sectoral ODA specifically intended for HES is used for these sectors or is diverted away to alternative sectors. We established earlier that $\partial HES = \overline{ODA_{HES}/Total\ aid}$ is the share of total aid that is *intended* for HES and that $\partial\widehat{HES}$ is the *allocated* share; thus we can calculate the fungibility of aid for HES alone using the difference between $\partial\widehat{HES}$ and ∂HES, i.e.:

$$FUN_{HES} = \frac{\partial HES - \partial\widehat{HES}}{\partial HES}$$

If $\partial\widehat{HES} \geq \partial HES$, then the amount of ODA targeted for HES is indeed used in these sectors and FUN_{HES} is 0. If, on the other hand, $\partial\widehat{HES} < 0$, this indicates that sectoral aid to HES would lead to a reduction in government expenditure of HES, resulting in full fungibility. This means that the value of FUN_{HES} would lie between 0 and 1. Therefore, we can calculate the amount of fungible and non-fungible ODA to HES as:

$$ODA\ HES_{NF} = ODA_{HES}(1 - FUN_{HES})$$

$$ODA\ HES_{F} = ODA_{HES}(FUN_{HES})$$

where ODA HES_{NF} represents the amount of non-fungible aid to HES and ODA HES_F represents the amount of fungible aid to HES. A summary statistic table of the values calculated in this section is included in Table C1 in Appendix C. After calculating the amount of fungible and non-fungible aid to HES, we can use these values to determine the impact on aggregate welfare. We discuss this in more detail in the next section.

4.5 Step II: a model for fungibility and aggregate welfare

In this section, we deal with the question of the impact on aggregate welfare in the presence of aid fungibility. We use the value of fungible and non-fungible ODA to HES calculated in the previous section in a model of aggregate welfare to answer our second research question. Ideally, we would have preferred to use data from all SDG indicators to determine aggregate welfare but, as the amount of data available for our sample of countries for various SDG indicators is quite limited, we opt for a more comprehensive indicator for measuring aggregate welfare.

As discussed in Section 2, Gomanee, Morrissey et al. (2005a) argue that non-monetary indicators of welfare like the HDI represent a more comprehensive picture of aggregate welfare than monetary indicators like the poverty headcount ratio. Keeping this argument as our background, we also use HDI as our measure for aggregate welfare. To check the robustness of our results for HDI, we also use infant mortality (IM) as an alternative welfare measure.

The HDI measures country-specific achievements in key dimensions of human development, including education, a long and healthy life, and a basic standard of living (UNDP 2020). The education dimension is measured by mean years of schooling among adults and expected years of schooling among children. Health and well-being are measured by life expectancy at birth, while standard of living is measured by per capita gross national income (UNDP 2020). In this way, the HDI presents a comprehensive picture of aggregate welfare in any country. We also include an additional variable for the government effectiveness and rule of law of the recipient country in our model as the literature suggests that an effective policy environment is needed to have a positive effect of ODA (Burnside and Dollar 2000). The information on our data source for the HDI, IM, and government effectiveness indicators are included in Table B2 in Appendix B.

Development aid is usually considered to be endogenous in nature, i.e. the amount of aid that a country receives may be influenced by the aid it received in previous years and by its economic growth or income levels (Reddy and Minoiu 2006). The endogenous nature of ODA, if not controlled for, could lead to biased econometric results. Apart from this, the distribution of welfare across countries tends to be skewed; therefore the effectiveness of aid on welfare may change depending on whether it is perceived from the highest or lowest level of welfare (Gomanee, Girma et al. 2005b). The marginal effect of fungible aid may be higher for areas that have lower HDI than countries where HDI is already higher. In such a case, using an ordinary least squares (OLS) regression has the disadvantage that it only considers the mean of the dependent variable in the presence of the independent variables.

There is also the problem that HDI in period t-1 could have an impact on time t, i.e., without considering the lagged timeframe of HDI, our results will be biased. Therefore, to control for dynamic misspecification and endogeneity; we use an autoregressive dynamic quantile instrumental (QRD-IV) regression model as proposed by Galvao (2011). Quantile regression has the advantage that it allows us to estimate the results centred around different quantiles. For example, we can calcuate the impact of fungible aid on aggregate welfare along the 4th quantile, which will give us estimates for the countries with low values of HDI, thereby allowing us to trace the distribution of welfare across different countries and reducing outliers. The QRD-IV model is different from the OLS or fixed-effect model in the sense that in OLS the econometric model satisfies the relationship:

$$y_i = \alpha + \beta_0 x_i + e_i$$

with strict condition of exogeneity. The condition of exogenity is already violated in our sample, as explained in the previous paragragh and therefore OLS results will be biased for our case. On the other hand, a classical dynamic panel data model with individual fixed effects will be:

$$y_{it} = \eta_i + \alpha y_{it-1} + \acute{x}_{it}\beta + u_{it}$$

where, I = 1,…N and t = 1,…..T, y_{it} is the dependent variable, y_{it-1} is the lag of the dependent variable, x_{it} is the exogenous variable, and η_i is the individual fixed effect. The fixed-effect model uses a time-demeaning approach by subtracting the averages over time (individual) to every variable (Croissant and Millo 2019). The QRD-IV model is much more comprehensive as it divides the data into different quantiles instead of testing them against a centred mean, resulting in a functional form as discussed by Galvao (2011):

$$Q_{yit}(\tau | y_{it-1}, x_{it}) = \eta_i + \alpha(\tau) y_{it-1} + \acute{x}_{it}\beta(\tau)$$

which represents the τth conditional quantile function on the *t*th observation on *i*th individual (Galvao 2011). η_i can be used to capture unobserved hetrogenity, while the covariates of (y_{it-1}, x_{it}) are the only ones allowed to depend on the specific quantile τ (Galvao 2011).

For our specific case, this means that we would be combining normal quantile regressions with lagged fungible ODA, i.e. ODA $HES_{F(n-1)}$ as an instrument to make our QRD-IV model, as Galvao (2011) did in his study. Lagged fungible ODA is expected to be highly correlated with current year ODA and so will make a good instrument. We check the strength of our instrument using the weak instrument test from OLS and include it in Table C5 in Appendix C. Our model is defined as follows:

$$\begin{aligned} HDI_{it}(\tau) = \gamma_0 + \alpha(\tau) HDI_{it-1} + \beta_1(\tau) HES_{Exp_{it}} + \beta_2(\tau) \widehat{ODA\, HES}_{F_{it}} \\ + \beta_3(\tau) R_{it} + \beta_4(\tau) NDE_{it} + \beta_5(\tau) Geff_{it} + \beta_6(\tau) UP_{it} \\ + \beta_7(\tau) FDI_{it} + \beta_8(\tau) RoL_{it} + \epsilon_{it} \end{aligned}$$

$$\begin{aligned} IM_{it}(\tau) = \gamma_0 + \alpha(\tau) IM_{it-1} + \beta_1(\tau) HES_{Exp_{it}} + \beta_2(\tau) \widehat{ODA\, HES}_{F_{it}} + \beta_3(\tau) R_{it} \\ + \beta_4(\tau) NDE_{it} + \beta_5(\tau) Geff_{it} + \beta_6(\tau) UP_{it} + \beta_7(\tau) FDI_{it} \\ + \beta_8(\tau) RoL_{it} + \epsilon_{it} \end{aligned}$$

where HDI_{t-1} / IM_{t-1} represents the autoregressive part of the model and $\widehat{ODA\, HES}_F$ represents the instrumented variable for aid targeted at HES sectors but used outside of these sectors (fungible ODA). Other control variables include Geff = government effectiveness, UP = urban population (in millions), and RoL = rule of law.

The τ represents the quantile level of the regression. We run the model for our unbalanced panel for every 10th quantile, i.e. from 0.1 to 0.9. We discuss the results obtained from the QRD-IV model in the next section.

4.6 Results: fungibility and aggregate welfare

In this section, we discuss the results from our aggregate welfare equation that we obtained using the QRD-IV method.

Table 3 gives the results of the regression models with all countries and income groups.[9] The first two columns give the results from the fixed-effect and the generalized methods of moments (GMM) estimations, while columns (3) to (11) give the results from the QRD-IV model. The results for the fixed-effect model showed cross-sectional dependencies and are therefore biased. For this reason, we do not discuss them in this section. As mentioned previously, the QRD-IV model is tested for every 10th quantile.

The GMM estimation and most quantiles (6 out of 9) show that fungible ODA has a positive and significant impact on HDI, but that the impact is quite small. If we take quantile 6 as an example, it shows that for every US$1 million increase in fungible ODA, HDI increases by ten units,[10] keeping everything else constant. On the other hand, quantile 8 shows a significant but negative relationship between fungible ODA and HDI which becomes insignificant for the seventh and ninth quantiles. This indicates that contrary to countries with low HDI, in countries with higher levels of HDI, aid fungibility either harms HDI or does not have a significant impact on it.

To test the robustness of the HDI results, we opt for an alternative welfare indicator, i.e. infant mortality rate (IM). The results for the IM model are included in Table C2 in Appendix C and indicate negative and significant values only for the GMM estimate and 1 out of 9 quantile regressions. Pettersson (2007b) also reached a similar conclusion in his research, indicating that fungibility within specific sectors did not explain the differences in mortality rates. From our results, we can deduce that the impact of fungible aid changes based on the kind of welfare indicator used. However, there is still some evidence of aid fungibility leading to an increase in aggregate welfare.

The results from our control variables, where significant, are mostly in line with our expectations, except for urban population in the HDI model, which indicated a decrease in aggregate welfare as urban population increased (the relationship is consistent in both the HDI and IM models). Tripathi (2019) notices a similar correlation between urban population and HDI and explains that the relationship between the two variables depends on the management of urbanization. If not managed properly, urbanization can lead to increased inequality and exclusion of parts of the population (Tripathi 2019). As our sample consists of low-income countries and lower-middle-income countries, which sometimes lack institutions for planned urbanization, the negative relationship seen in Table 3 is not surprising. Similarly, the RoL variable has inconsistent results along the quantiles, i.e., at higher quantiles and in the GMM estimation, RoL shows a negative and significant impact on HDI, while, at lower quantiles, the result turns positive and, in some cases, significant. For the IM model, RoL is mostly insignificant except for the 9th quantile, where the relationship between IM and RoL turns positive and significant. Thus, at lower levels of HDI (where aid fungibility also has a positive impact on welfare), RoL can also play a role in improving welfare, although this conclusion needs to be investigated further. On the other hand, government effectiveness, where significant, shows an improvement in welfare in both the HDI and IM models.

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[9] Figure C1 in Appendix C shows the scattered plot of HDI and fungible ODA.

[10] 0.00001 x 1 million (as all values are in million USD).

Table 3: Aggregate welfare regression—all countries and income groups

	HDI model (without interaction term)										
	Dependent variable: HDI										
	FE	GMM	QRD-IV								
			Ʈ = 0.1	Ʈ = 0.2	Ʈ = 0.3	Ʈ = 0.4	Ʈ = 0.5	Ʈ = 0.6	Ʈ = 0.7	Ʈ = 0.8	Ʈ = 0.9
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Intercept			0.954***	0.975***	0.991***	0.992***	1.005***	1.016***	1.018***	1.019***	1.026***
			(0.020)	(0.012)	(0.014)	(0.011)	(0.011)	(0.012)	(0.008)	(0.010)	(0.006)
HES_{Exp}	0.0000*	0.000***	0.000**	0.000***	0.000***	0.000***	0.000**	0.000***	0.000	0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ODA $HES_{F(t-1)}$	-0.0000	0.00001*	0.00008***	0.00006***	0.00004***	0.00003***	0.00002***	0.00001**	0.000	- 0.00001***	0.000
	(0.000)	(0.000)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.000)	(0.00001)
R	0.0000**	0.000***	0.000	0.000***	0.000***	0.000***	0.000***	0.000	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
NDE	-0.0000	0.000***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Geff	0.03***	0.088***	0.016	0.005	-0.005	-0.013	-0.011	-0.008	-0.001	0.014**	0.025***
	(0.01)	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.007)
UP	-0.0002**	0.00077**	-0.0007**	-0.00052***	-0.00042***	-0.00046***	-0.00046***	-0.00045***	-0.00045***	-0.00048***	-0.00058***
	(0.0001)	(0.0002)	(0.0003)	(0.00008)	(0.00009)	(0.00004)	(0.00003)	(0.00005)	(0.00007)	(0.00005)	(0.00006)
$HDI_{(t-1)}$	-0.003***	-0.025***	-0.003***	-0.0032***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***	-0.003***
	(0.0001)	(0.0032)	(0.00015)	(0.00009)	(0.00011)	(0.00009)	(0.00009)	(0.00009)	(0.00007)	(0.00008)	(0.00006)
FDI	-0.0000	-0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RoL	-0.02***	- 0.011***	0.009	0.019***	0.014	0.024***	0.025***	0.016***	0.007	-0.005	-0.012***
	(0.01)	(0.0007)	(0.010)	(0.009)	(0.009)	(0.007)	(0.008)	(0.008)	(0.007)	(0.006)	(0.006)
Obs.	544	544	544	544	544	544	544	544	544	544	544
Adj. R^2	0.84										

Note: *p<0.1; **p<0.05; ***p<0.01.

Source: authors' own calculation.

In addition to checking the individual impact of good governance and fungible ODA on aggregate welfare, we examine their combined effect by introducing an interaction term in our welfare model. The results indicate no significant effect of the interaction term on HDI and a negative impact on IM for higher quantiles (quantiles 7–9), which goes against our expectations. However, even in this case, the individual effect of fungible ODA on IM is insignificant. Therefore, the results from the interaction term need to be investigated further and should not be considered conclusive. As the results from the interaction model are mostly insignificant, we include them in Tables C3 and C4 in Appendix C only and do not discuss them in detail here.

Hence, we can conclude that, at the aggregate level, fungibility has a positive impact on lower levels of HDI while, at higher levels of HDI, fungibility may lead to a small decrease in aggregate welfare. The somewhat positive effect of aid fungibility on HDI can be explained through our theoretical framework discussed in Section 3, i.e. when recipient governments treat aid as fungible, they are able to allocate development funds much more efficiently across sectors and can therefore achieve a higher level of aggregate welfare. Our results also show that even when government policies are not significantly effective, the impact of fungibility on aggregate welfare stays positive and significant.

Therefore, to a certain extent, fungibility of development aid can be considered good for recipient countries, especially when looking at it through the lens of aggregate welfare. In the next section, we summarize our discussion of the fungibility and the aggregate welfare models considering our theoretical framework and research questions.

5 Discussion of results

Partial or full fungibility of development aid is found in all the countries in our sample and in both low- and lower-middle-income countries. At the aggregate level, sector-specific ODA tends to decrease expenditure in the intended sector, indicating that governments tend to reshuffle their expenditure plans as ODA comes in. The reshuffling of expenditure in the presence of aid is not an indication of public inefficiency or malicious intent by the government; it may simply be an indication that the government is trying to optimally allocate its resources in light of the new funds. This can be seen from the fact that, for countries with lower aggregate welfare, aid fungibility leads to an improvement in HDI in our second regression model.

In this sense, fungibility can be considered a policy tool for ensuring that the incoming aid and resulting access funds can be allocated in a manner that impacts multiple sectors positively. Fungibility, in such a case, will be the result of mutual agreement between the donors and the recipients in such a way that recipients will have more ownership of the incoming aid and its allocation, as they will have a better understanding of their development needs. This will then be in line with the aid effectiveness agenda agreed upon in the Paris Declaration (2005), which we discussed in Section 2.

As fungibility is usually considered to be the result of government inefficiencies or corruption, we also consider the impact of effective government policies on aggregate welfare. The results in this case show that effective government policies are not always necessary to have a significant impact on aggregate welfare. This does not mean that strong institutions and effective development policies do not improve aggregate welfare; instead, our finding suggests that having strong institutions should not be considered a pre-requisite for fungible aid to improve aggregate welfare. It is therefore important that the development process is led by the recipient governments themselves and that they are encouraged to come up with a development plan. The recipient governments can then guide the donors to where aid is needed and can also decide on using aid fungibility as a tool for progressing towards meeting the SDGs. We see such a case in Rwanda when the government took ownership of its development process, which led to fungibility that was positive in the sense that it led to decreased government inefficiencies through reduced administrative processes and to more sectors being positively affected by aid and government expenditure (Rana and Koch 2021b).

To ensure that 'no one is left behind'—the motto of the SDGs—it is important that the plan for achieving the SDGs comes from the recipient governments having the flexibility of planning and reallocating their expenditures whenever necessary, i.e. giving them room for aid fungibility. Evidence from the literature suggests that aid fungibility is not associated with irrational fiscal policies or low government effectiveness, nor does non-fungible aid have a higher impact than fungible aid (Pettersson 2007a). If countries are given ownership of their development process, the fungibility can lead to stronger and more positive outcomes in terms of increased welfare and achievement of the SDGs, which is the ultimate goal of development aid.

6 Conclusion

In this paper, we analysed the impact of fungibility on aggregate welfare, keeping progress towards the SDGs as our yardstick. We used a microeconomic framework of utility maximization as a theoretical background and built an SUR model to test the presence of fungibility in a sample of 35 low- and lower-middle-income countries. We found evidence of decreasing government expenditures in sectors where aid was targeted, indicating the presence of aid fungibility. We then used the results from our SUR model to check the impact of fungibility on aggregate welfare through an autoregressive dynamic quantile instrumental regression model. The regression models confirm that, at lower levels of welfare, fungibility can have a relatively positive effect.

We conclude that fungibility of development aid exists in low- and lower-middle-income countries. However, this fungibility can be considered positive in some cases as it helps to improve aggregate welfare for countries with lower levels of HDI, thereby answering our research question about the relationship between fungibility and aggregate welfare. The results indicate that, for some countries, aid fungibility can help recipient governments to reach a higher level of aggregate welfare. In the presence of aid fungibility, recipient governments can allocate their own resources in an optimal manner, as they have a better understanding of their own needs.

Our research has some important policy implications and can be used to draw conclusions about a larger framework of aid effectiveness. First, aid effectiveness does not always decrease in the presence of aid fungibility; indeed, aid fungibility can play an important role in improving the ownership and effectiveness of aid. Second, both the donors and recipient governments are allegedly working towards the same goal, i.e. achievement of the SDG indicators. In this case, policy makers can use aid fungibility as a tool to increase aid ownership to ensure the most optimal allocation of resources that can efficiently help them to achieve the targets. Thus, aid fungibility can be used to bring everyone onto the same page and to strengthen the relationship between the donors and recipients of development aid.

It is clear from our analysis that it is time to turn a new page in the fungibility debate. We urge both policy makers and researchers to use this research as a starting point to consider fungibility as a policy tool for further improving aid effectiveness and the relationships between the donors and the recipients of development aid.

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Appendix A

Table A1: Bruesch Pagan LM test for cross-sectional dependencies

Model	Chisq	p-value	Cross-sectional dependencies
H	1,328	< 2.2e-16	Yes
Edu	1,034.7	< 2.2e-16	Yes
HE	913.92	< 2.2e-16	Yes
HES	890.35	< 2.2e-16	Yes

Source: authors' own calculation.

Appendix B

Table B1: Summary of country-specific data

	Country	#Ob	St. year	E. year	Income	Region	β_{11}	β_{21}	β_{12}	β_{22}	FUN avg.
1	Afghanistan	18	2002	2019	LIC	Asia	1.78E-03	3.30E-05	1.54E-03	-2.61E-04	0.9962388
2	Angola	18	2002	2019	LMC	Africa	4.85E-03	-1.26E-03	7.25E-03	3.10E-03	0.1811959
3	Bangladesh	18	2002	2019	LMC	Asia	-2.04E-04	2.97E-03	-7.18E-04	4.13E-04	0.9852545
4	Bhutan	18	2002	2019	LMC	Asia	1.05E-02	-6.98E-03	7.09E-03	9.33E-03	0.7764785
5	Bolivia	12	2002	2013	LMC	Latin America	4.93E-04	-2.24E-04	2.76E-04	-6.35E-05	0.9972112
6	Cabo Verde	12	2008	2019	LMC	Africa	6.12E-03	4.91E-03	0.04481	0.01059	0.817257
7	Congo	12	2004	2015	LMC	Africa	2.86E-02	-1.02E-01	4.07E-02	-1.35E-01	-2.13E+00
8	Egypt	18	2002	2019	LMC	Africa	1.13E-03	-3.05E-04	-6.60E-05	-1.17E-04	0.960528
9	El Salvador	18	2002	2019	LMC	Latin America	3.15E-03	4.83E-03	-2.05E-03	4.20E-03	0.7985103
10	Eswatini	13	2007	2019	LMC	Africa	1.63E-02	-1.83E-02	-1.80E-03	-1.57E-02	8.92E-01
11	Ethiopia	9	2011	2019	LIC	Africa	4.74E-04	5.86E-03	-2.49E-04	4.31E-03	0.9833165
12	India	18	2002	2019	LMC	Asia	1.66E-04	-6.82E-05	-2.23E-04	2.73E-04	0.9942712
13	Kenya	18	2002	2019	LMC	Africa	1.85E-03	1.95E-03	1.07E-03	5.14E-03	0.9293146
14	Kyrgyzstan	18	2002	2019	LMC	Asia	6.10E-04	1.56E-02	8.47E-04	2.48E-02	0.8170846
15	Lesotho	18	2002	2019	LMC	Africa	2.34E-03	-3.22E-03	-0.010392	-0.03571	1.0463063
16	Liberia	12	2005	2016	LIC	Africa	-0.00171	-0.002403	0.003042	-0.00635	1.0000631
17	Madagascar	17	2003	2019	LIC	Africa	-3.37E-04	8.94E-03	0.003228	0.022968	0.9390015
18	Malawi	13	2007	2019	LIC	Africa	-9.98E-04	-2.58E-03	-0.000917	-0.006025	1.0069825
19	Moldova	18	2002	2019	LMC	Europe	6.60E-03	-2.06E-03	0.003161	0.004764	0.9500005
20	Mongolia	18	2002	2019	LMC	Asia	-5.66E-04	1.68E-02	1.29E-02	7.58E-03	0.8442901
21	Mozambique	14	2006	2019	LIC	Africa	9.85E-04	-2.21E-04	7.79E-03	6.74E-03	0.97748
22	Nepal	18	2002	2019	LIC	Asia	2.90E-03	1.93E-03	4.14E-03	5.73E-04	0.9641462
23	Nicaragua	18	2002	2019	LMC	Latin America	-7.85E-05	1.93E-04	4.79E-04	-6.80E-04	1.0004037
24	Nigeria	14	2003	2016	LMC	Africa	3.87E-05	2.92E-03	7.53E-05	5.33E-04	0.9715244
25	Pakistan	18	2002	2019	LMC	Asia	-1.01E-03	9.27E-03	-3.29E-04	3.13E-03	0.9633509
26	Philippines	18	2002	2019	LMC	Asia	3.00E-03	-2.70E-03	4.65E-03	-2.86E-03	0.9259172
27	Rwanda	18	2002	2019	LIC	Africa	2.84E-03	7.42E-03	3.57E-04	2.51E-03	0.9720312
28	Senegal	15	2005	2019	LMC	Africa	1.71E-03	4.53E-05	9.40E-04	7.74E-04	0.9931873

29	Solomon Islands	9	2011	2019	LMC	Asia	2.66E-03	5.70E-03	4.91E-03	3.55E-03	0.9348199
30	Tanzania	12	2008	2019	LIC	Africa	-4.16E-04	7.43E-04	7.79E-04	3.60E-03	0.9890872
31	Tunisia	18	2002	2019	LMC	Africa	3.09E-04	1.91E-04	7.46E-05	5.89E-04	0.9816488
32	Uganda	18	2002	2019	LIC	Africa	-1.38E-04	-2.42E-03	0.001331	-0.00574	1.0156613
33	Ukraine	15	2005	2019	LMC	Europe	-3.09E-04	-7.97E-04	-4.90E-04	-7.41E-04	1.1442298
34	Uzbekistan	9	2011	2019	LMC	Aisa	-5.47E-04	3.00E-04	1.67E-03	-4.85E-04	0.9921569
35	Zambia	18	2002	2019	LMC	Africa	0.001949	-3.04E-03	0.002140	-0.00634	1.0252193

Note: LIC stands for low-income countries and LMC stands for lowr-middle-income countries.

Source: authors’ own calculation.

Table B2: Data collection—sources and explanation

Variable	Abb.	Explanation	Source
Health expenditure	HExp	Government expenditure for health (code: GF07)	GFS, International monetary funds
Education expenditure	EduExp	Government expenditure for education (code: GF09)	GFS, International monetary funds
HE expenditure	HEexp	Government expenditure for health and education (code: GF07, GF09)	GFS, International monetary funds
HES expenditure	HESExp	Government expenditure for health, education, and social protection (code: GF07, GF09, GF10)	GFS, International monetary funds
Other expenditure	OTHExp	Government expenditure for recreation, environment, housing and community, public order and safety, economic affairs (code: GF03, GF04, GF05, GF06, GF08)	GFS, International monetary funds
Non-development expenditure	NDE	Government expenditure for general public services and defence (code: GF01, GF02)	GFS, International monetary funds
ODA health	ODA_H	Official development assistance for health (Code: 120, I.2 Health, total)	OECD, creditors reporting system
ODA education	ODA_Edu	Official development assistance for education (Code: 110, I.1 Education, total)	OECD, creditors reporting system
ODA HE	ODA_HE	Official development assistance for health and education (Code: 120, I.2 and 110, I.1)	OECD, creditors reporting system
ODA HES	ODA_HES	Official development assistance for health, education, social protection (Code: 120 I.2, 110 I.1, and 16010)	OECD, creditors reporting system
ODA others	ODA_oth	Official development assistance for culture, housing, environment, peace and order, water, and sanitation (Code: 16061, 16040 + 16030, 410: IV.1, 152: I.5b, 140: I.4)	OECD, creditors reporting system
Total revenue	R	Total revenue excluding grants	WDI, World Bank
Debt servicing	DS	Debt servicing on external debt	WDI, World Bank
Foreign direct investment	FDI	Foreign direct investment, net inflows (balance of payments, current USD)	WDI, World Bank
Urban population	UP	Urban population in millions	WDI, World Bank
Infant mortality rates	IM	Infant mortality rates (per 1,000 live births)	WDI, World Bank
Human Development Index	HDI	Human Development Index	UNDP, United Nations
Government effectiveness	Geff	Estimates ranging from approximately -2.5 to 2.5	WGI, World Bank
Rule of law	RoL	Estimates ranging from approximately -2.5 to 2.5	WGI, World Bank

Note: GFS = government finance statisitics, WGI = world governance indicators, WDI = world development indicators, OECD = Organisation for Economic Co-operation and Development.

Source: authors' own calculation (source for individual variable mentioned in the table).

Appendix C

Table C1: Summary statistics for fungibility

Summary statistics for fungibility calculations								
Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max	Median
Year	548	2,011.01	4.95	2,002	2,007	2,015	2,019	2011
$\partial\widehat{HES}$	548	0.0023	0.166	-2.4008	0.0002	0.0265	0.435	0.00898
$\partial\widehat{OTH}$	548	-0.024	0.475	-5.257	-0.0013	0.0358	1.715	0.0074
FUN	548	1.02	0.62	-1.13	0.93	1.00	7.40	0.9809
FUN_HES	548	0.99	0.22	0.33	0.96	1.00	4.09	0.9870
ODA_HES_{NF}	548	3.91	12.28	-63.75	0.05	7.24	111.13	1.8479
ODA_HES_{F}	548	247.66	273.52	1.97	64.38	311.52	1,396.18	141.595

Source: authors' own calculation.

Table C2: Aggregate welfare dynamic autoregressive quantile model for infant mortality

	IM model (without interaction term)										
	Dependent variable: IM										
	FE	GMM	IVQR								
			τ = 0.1	τ = 0.2	τ = 0.3	τ = 0.4	τ = 0.5	τ = 0.6	τ = 0.7	τ = 0.8	τ = 0.9
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Intercept			1.49499	0.08182	0.12272	0.24951**	0.23888***	0.20452***	0.19478**	0.22036	0.38357***
			(2.85010)	(0.14062)	(0.11763)	(0.10152)	(0.08057)	(0.07285)	(0.08058)	(0.13761)	(0.19325)
HES_{Exp}	-0.0002*	-0.0011***	-0.00002	0.00001	0.00002**	0.00001	0.00001	0.00000	0.00000	-0.00001	-0.00001
	(0.0001)	(0.0001)	(0.00085)	(0.00005)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)	(0.00001)	(0.00001)
ODA $HES_{F(n-1)}$	-0.0000	-0.0058**	0.00126	0.00071	0.00057	0.00017	-0.00007	-0.00037***	-0.00019	-0.00049	-0.00043
	(0.002)	(0.002)	(0.00438)	(0.00032)	(0.00014)	(0.00027)	(0.00028)	(0.00008)	(0.00018)	(0.00031)	(0.00033)
R	-0.0000	0.000	-0.00022	-0.00001	0.00000	0.00000	0.00000	0.00001	0.00001***	0.00001	0.00001
	(0.0000)	(0.000)	(0.00017)	(0.00003)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
NDE	0.0001*	0.000	0.00015	0.00000	-0.00002***	-0.00002***	-0.00002***	-0.00002***	-0.00003***	-0.00003	-0.00002***
	(0.0001)	(0.000)	(0.00018)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00001)
Geff	-4.42***	1.632	0.08931	-0.358***	-0.1755	-0.16179	-0.06294	-0.03323	-0.00186	-0.21253	-0.53721**
	(1.28)	(3.04)	(2.52603)	(0.10147)	(0.13189)	(0.12873)	(0.09908)	(0.09011)	(0.10183)	(0.13702)	(0.29822)
UP	0.01	0.0109**	0.03793	0.00450	0.00254	0.00171	0.00069	0.00065	-0.00083	0.00102	0.00393
	(0.01)	(0.002)	(0.03482)	(0.00637)	(0.00163)	(0.00115)	(0.00169)	(0.00161)	(0.00222)	(0.00378)	(0.00440)
$IM_{(n-1)}$	0.90***	-0.296***	0.93192***	1.00914***	1.01795***	1.02782***	1.03513***	1.04254***	1.04810***	1.05322***	1.06041***
	(0.02)	(0.00264)	(0.11851)	(0.00628)	(0.00358)	(0.00339)	(0.00319)	(0.00224)	(0.00238)	(0.00414)	(0.00354)
FDI	-0.0000	-0.0000	0.00035	0.00003	0.00001	-0.00001	-0.00001	-0.00002	-0.00004**	-0.00002	-0.00003
	(0.0001)	(0.0003)	(0.00058)	(0.00008)	(0.00003)	(0.00002)	(0.00002)	(0.00001)	(0.00002)	(0.00003)	(0.00004)
RoL	2.50**	1.645	-0.14149	0.08630	0.03007	0.18904	0.12413	0.12147	0.12739	0.24920	0.50071**
	(1.18)	(1.531)	(3.01155)	(0.13134)	(0.15918)	(0.14817)	(0.12350)	(0.10752)	(0.12074)	(0.17292)	(0.27946)
Obs.	547	547	547	547	547	547	547	547	547	547	547
Adj. R^2	0.86										

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Source: authors' own calculation.

Table C3: Aggregate welfare dynamic autoregressive quantile model for HDI with interaction

HDI model (with interaction term)											
Dependent variable: HDI											
	FE	GMM	IVQR								
			$\tau = 0.1$	$\tau = 0.2$	$\tau = 0.3$	$\tau = 0.4$	$\tau = 0.5$	$\tau = 0.6$	$\tau = 0.7$	$\tau = 0.8$	$\tau = 0.9$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Intercept			0.95095***	0.98425***	0.99302***	0.99872***	1.00685***	1.01943***	1.02149***	1.02436***	1.02479***
			(0.02414)	(0.01151)	(0.01482)	(0.01130)	(0.01152)	(0.01104)	(0.00971)	(0.00990)	(0.00914)
HES_{Exp}	0.00000*	0.0000***	0.00000**	0.00000***	0.00000***	0.00000***	0.00000***	0.00000***	0.00000	0.00000**	0.00000
	(0.00000)	(0.0000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
ODA $HES_{F(t-1)}$	-0.00002	0.000008	0.00006***	0.00003***	0.00003**	0.00001	0.00001	0.00000	-0.00001	-0.00002***	0.00001
	(0.00002)	(0.000007)	(0.00003)	(0.00001)	(0.00002)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00001)	(0.00003)
R	0.0000**	0.0000**	0.00000	0.00000	0.00000***	0.00000***	0.00000***	0.00000***	0.00000	0.00000***	0.00000***
	(0.00000)	(0.0000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
NDE	-0.000	0.0000**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000***
	(0.00000)	(0.0000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Geff	0.032***	0.0913***	0.01073	-0.00102	-0.00747	-0.01705***	-0.01156	-0.00690	-0.00302	0.01428***	0.02519***
	(0.007)	(0.0124)	(0.01177)	(0.00670)	(0.00937)	(0.00844)	(0.00911)	(-0.00040)	(0.00826)	(0.00720)	(0.01040)
UP	-0.002**	-0.00082**	-0.00068***	-0.00039***	-0.00040***	-0.00041***	-0.00041***	0.00006***	-0.00039***	-0.00042***	-0.00059***
	(0.0001)	(0.00029)	(0.00032)	(0.00010)	(0.00007)	(0.00005)	(0.00005)	(-0.00314)	(0.00008)	(0.00006)	(0.00012)
$HDI_{(t-1)}$	-0.003***	-0.0254***	-0.00316***	-0.00326***	-0.00322***	-0.00314***	-0.00311***	0.00009***	-0.00308***	-0.00298***	-0.00291***
	(0.0001)	(0.0034)	(0.00018)	(0.00008)	(0.00012)	(0.00008)	(0.00008)	(0.00009)	(0.00008)	(0.00007)	(0.00008)
FDI	-0.0000	-0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
RoL	-0.017**	-0.111***	0.02313**	0.02872***	0.02314***	0.03293***	0.03179***	0.02092***	0.01133	-0.00050	-0.01282
	(0.007)	(0.0125)	(0.01341)	(0.00858)	(0.01068)	(0.00876)	(0.00908)	(0.00894)	(0.00868)	(0.00742)	(0.00856)
$I(RoL*AHES_{(t-1)})$	0.0000	-0.0000	-0.00004	-0.00004	-0.00002	-0.00002	-0.00002	-0.00002	-0.00001	-0.00002	0.00001
	(0.00002)	(0.0000)	(0.00003)	(0.00001)	(0.00002)	(0.00001)	(0.00002)	(0.00001)	(0.00002)	(0.00001)	(0.00002)
Obs.	544	544	544	544	544	544	544	544	544	544	544
Adj. R^2	0.84										

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Source: authors' own calculation.

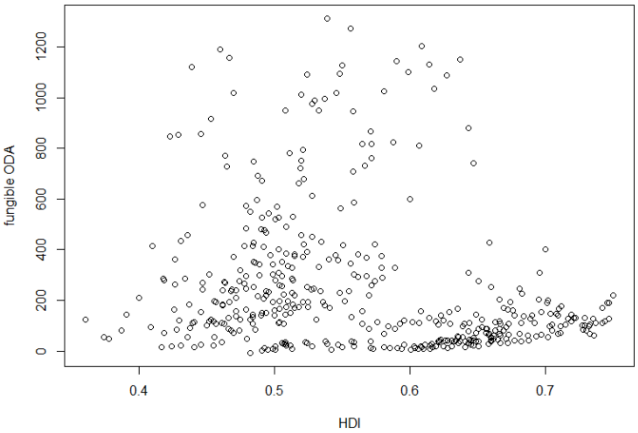
Table C4: Aggregate welfare dynamic autoregressive quantile model for IM with interaction

	IM model (with interaction term) Dependent variable: IM										
	FE	GMM	IVQR								
			Ʈ = 0.1	Ʈ = 0.2	Ʈ = 0.3	Ʈ = 0.4	Ʈ = 0.5	Ʈ = 0.6	Ʈ = 0.7	Ʈ = 0.8	Ʈ = 0.9
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Intercept			7.46274*	1.30091	1.19026***	1.07703***	0.93026***	0.79785***	0.54889**	0.84191***	1.13399
			(2.90638)	(2.36969)	(0.32876)	(0.24825)	(0.22266)	(0.16839)	(0.20091)	(0.25073)	(0.70870)
HES_{Exp}	-0.0002*	-0.0009***	-0.00110	0.00001	0.00004	0.00002	0.00002	0.00001	0.00000	-0.00002	-0.00002
	(0.0001)	(0.0001)	(0.00167)	(0.00067)	(0.00011)	(0.00004)	(0.00001)	(0.00001)	(0.00001)	(0.00002)	(0.00003)
ODA $HES_{F(t-1)}$	0.002	-0.006**	0.00171	0.00340	0.00048	-0.00078	-0.00064	-0.00006	0.00048	0.00022	0.00096
	(0.005)	(0.0019)	(0.01763)	(0.01131)	(0.00134)	(0.00086)	(0.00058)	(0.00070)	(0.00060)	(0.00086)	(0.00099)
R	0.00002	0.00003	0.00003	-0.00020	-0.00007	-0.00001	0.00000	0.00001	0.00002	0.00003***	0.00001
	(0.00004)	(0.00007)	(0.00047)	(0.00018)	(0.00008)	(0.00004)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00003)
NDE	0.0002*	-0.00007	0.00006	0.00015	0.00002	-0.00004	-0.00005***	-0.00005**	-0.00005***	-0.00005**	-0.00005**
	(0.0001)	(0.0001)	(0.00028)	(0.00015)	(0.00007)	(0.00004)	(0.00002)	(0.00002)	(0.00001)	(0.00002)	(0.00003)
Geff	-7.654***	1.985	-4.02433	-0.06583	-0.69793**	-0.85814***	-0.46647***	-0.29533**	-0.01495	-0.60414*	-1.53170
	(1.757)	(3.79)	(2.83992)	(1.80320)	(0.40431)	(0.21706)	(0.24214)	(0.16429)	(0.29710)	(0.34190)	(1.10029)
UP	0.008	0.1023*	0.11996	0.03215	0.01917**	0.01182	0.00800**	0.00581	0.00381	0.00196	0.01314
	(0.021)	(0.0044)	(0.09745)	(0.05162)	(0.00867)	(0.00980)	(0.00427)	(0.00392)	(0.00441)	(0.00416)	(0.01406)
$IM_{(t-1)}$	0.814***	-0.287***	0.34966***	0.95875***	1.00653***	1.03261***	1.05395***	1.06703***	1.08752***	1.09448***	1.11155***
	(0.024)	(0.003)	(0.10616)	(0.09672)	(0.01225)	(0.00942)	(0.00755)	(0.00704)	(0.00526)	(0.00561)	(0.01286)
FDI	-0.0002	0.0004	0.00020	0.00026	0.00011	0.00002	-0.00001	-0.00003	-0.00008**	-0.00013***	-0.00014
	(0.0002)	(0.00037)	(0.00048)	(0.00059)	(0.00007)	(0.00009)	(0.00003)	(0.00004)	(0.00004)	(0.00005)	(0.00012)
RoL	4.698**	6.739**	-1.33183	-1.23525	0.56727	1.10633***	0.56545**	0.31062	-0.12335	0.37144	0.85422
	(1.873)	(2.407)	(3.98449)	(3.93003)	(0.74452)	(0.35447)	(0.33233)	(0.23500)	(0.37407)	(0.40492)	(1.13580)
I(RoL*$AHES_{(t-1)}$)	-0.002	-0.0399***	0.00144	0.00305	-0.00081	-0.00180	-0.00084	0.00003	0.00132*	0.00170**	0.00325***
	(0.004)	(0.008)	(0.01658)	(0.01354)	(0.00197)	(0.00137)	(0.00075)	(0.00048)	(0.00073)	(0.00063)	(0.00164)
Obs.	547	547	547	547	547	547	547	547	547	547	547
Adj. R^2	0.73										

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Source: authors' own calculation.

Figure C1: HDI vs. fungible ODA



Source: authors' own calculation.

Table C5: Test for valid instrument[11]

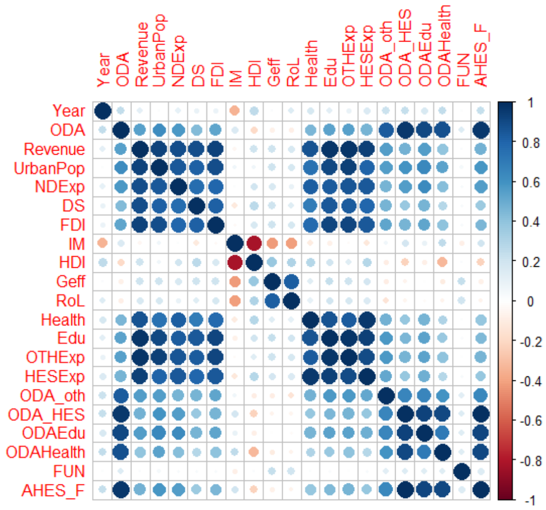
		Test for valid instrument		
Test	df	statistics	p-value	Reject H_0
Weak instrument	534	831.122	<2e-16 ***	Yes, the instrument is strong
Wu-Hausman	533	9.569	0.002	Yes, OLS is inconsistent

Source: authors' own calculation.

[11] The test is done on OLS IV regression just to check the strength of the instrument as done by Chernozhukov and Hansen (2008).

Appendix D

Figure D1: Correlation coefficient matrix plot for all variables



Source: authors' own calculation from the dataset.