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DOES FOREIGN AID IMPROVE HUMAN CAPITAL? FERTILITY RATES AS A MODERATOR

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This paper aims to analyze the effect of foreign aid on human capital and examines whether the fertility rate moderates this relationship. Using dynamic panel data from 119 aid recipient countries from 2002 to 2022, the results indicate that foreign aid is positively associated with human capital development measured by Human Development Index (HDI). The findings also show that fertility rates negatively moderate the impact of foreign aid on human capital. This suggests that foreign aid is less effective in improving human capital in countries with high fertility rates, highlighting the importance of incorporating measures that account for fertility rates in aid policies.

Keywords: Foreign Aid, Human Capital, Fertility Rates, Official Development Assistance (ODA), Human Development Index (HDI), Aid Effectiveness
JEL Classification: F35, O15, J13, C23

1. INTRODUCTION

Human capital is a key factor in promoting growth and development in developing countries (Schultz, 1961). According to the World Bank (2018), human capital is the skills, knowledge, health, and resilience that enable productivity, flexibility, and innovative capability. It is integral to a nation's development trajectory, influencing productivity and economic growth (Mincer, 1984). An educated and healthy population is more likely to be productive, innovative, and adaptable.

For this reason, many developed countries are providing aid to the developing world in hopes of improving human capital. Human capital investments that are designed to enhance economic growth, provide employment opportunities, and strengthen social integration, are at the core of OECD aid policies (OECD, 1998). In recent years, Official Development Assistance (ODA) has shown an increasing trend, reaching 183 billion US dollars of total ODA in 2022, of which 64 billion US dollars are social sector ODA (sector code 100) (OECD, 2023). While large amounts of foreign aid are provided to

recipient countries, its effectiveness in improving human capital is not clear. The existing literature shows mixed results on the effect of foreign aid on human capital and its dimensions (Asiama and Quartey, 2009; Asongu and Odhiambo, 2020; Azarnert, 2008; Dash et al., 2023; Gomanee et al., 2005).

In addition, many countries in the developing world are characterized by high levels of fertility. Indeed, the average fertility rate of the ODA recipient countries in 2021 was 3.01 while the average fertility rate of OECD member states was 1.59 in the same year (World Bank, 2023). Since countries have limited resources, higher fertility means that there are fewer resources that can be spent on each individual. Thus, high levels of fertility can dilute resources for human capital investment and lead to lower levels of human capital accumulation (Becker and Lewis, 1973; Rosenzweig and Wolpin, 1980). Considering this negative relationship between fertility and human capital and the current trend of increasing foreign aid, one might wonder whether high fertility rates would impair the effectiveness of foreign aid on accumulating human capital. Thus, the following research question can be posed. What is the joint effect of foreign aid and fertility rate on human capital accumulation? The relationship between foreign aid and fertility rates, regarding human capital accumulation, has not been extensively studied.

This paper aims to examine the impact of foreign aid, as well as the joint interaction effect of foreign aid and fertility rate, on improving human capital levels in countries that receive ODA. It provides empirical analysis using a panel dataset of 119 ODA recipient countries between 2002 to 2022. Dynamic panel General Method of Moments (GMM) is employed as the main method of analysis to address reverse causation, endogeneity, and autocorrelation. This paper has two contributions. First, it provides an updated analysis of the effect of foreign aid on human capital measured by the Human Development Index (HDI) and its dimensions: life expectancy, years of education, gross national income (GNI) per capita. It also breaks down ODA into its sectors and investigates the effect that different sectoral ODAs have on human capital. Second, this paper is among the first to address a gap in existing literature by examining the moderating effect of fertility rates, assessing how fertility influences the relationship between aid and human capital. The results show that foreign aid has an overall positive effect on human capital. However, the interaction term between foreign aid and fertility diminishes the effect of ODA on HDI by more than 20% for every unit increase in fertility rate. This indicates that higher levels of fertility reduce the effectiveness of foreign aid on human capital in recipient countries.

This paper is structured as follows. Section 2 reviews the relevant literature. Section 3 provides an overview of the data and methodology used for the analysis. Section 4 presents and discusses the results of the analysis. Finally, section 5 provides final remarks to conclude.

2. LITERATURE REVIEW

2.1. Foreign Aid and Human Capital

Foreign aid supports economic development, alleviates poverty, and raises living conditions in recipient countries if it is effective. One potential mechanism through which foreign aid achieves these goals is by enhancing human capital. Consequently, there have been continuous efforts to evaluate aid effectiveness by measuring the impact on human development. Previous studies have shown mixed results regarding the effectiveness of foreign aid on human capital development.

In the literature, human capital is often represented by the HDI because HDI provides universal data coverage and uses health, education, and standard of living to comprehensively capture the various aspects. Some studies such as Gomanee et al. (2005), using quantile regression analysis, finds that foreign aid can positively influence HDI through the financing of public expenditures. Similarly, an updated study by Mohamed and Mzee (2017) confirms the positive effect of foreign aid on human capital by conducting quantile regression on 124 developing countries from 1980 to 2013. In contrast, Asongu (2014) and Githaiga and Kilong'i (2023) find that ODA has a negative impact on human capital development in Sub-Sahara Africa using panel quantile regression and system-GMM respectively. Nourou (2014) creates an index of social and human development and uses a dynamic panel model on 74 low- and middle-income countries, to find that net ODA has a negative impact on social and human development.

Such variations in results can be explained by several factors. One significant factor is the type of foreign aid. Overall, the studies that used disaggregated sectoral ODA point to a positive effect of foreign aid on human capital development, while the studies that used aggregated ODA are less clear. Using dynamic panel regression, Asiama and Quartey (2009) shows that sector-specific disaggregated aid improves HDI in Sub-Saharan Africa while aggregated bilateral aid has no significant impact. Asongu and Odhiambo (2020) also concludes that sector-specific aid has a positive impact on inequality adjusted HDI in Sub-Saharan Africa and finds that the various sectoral ODA complement each other in boosting their impact on inclusive human development. It is likely that disaggregated ODA which has a sector-focus is more effectively fostering human capital development.

Another factor contributing to divergent findings is the time horizon. Dash et al. (2023) conducts panel regression on 19 countries in South and Southeast Asia to conclude that foreign aid has a mixed impact on human development. In their GMM regressions, they conclude that aid does not have a significant effect on human development. However, their pooled mean group analysis showed that aid has a positive effect on human development in the short run, but a negative effect in the long run.

Other studies extended the scope of analysis by investigating the role of mediators and moderators. For example, Dash and Gupta (2023) conducted a system GMM analysis on a panel of six Southeast Asian countries to find that net foreign aid to GDP

has a negative direct impact on HDI, but aid can promote human development through indirect channels such as trade, infrastructure, and reduced corruption. Kosack (2003) finds that aid in its aggregate has no direct effect on HDI, but aid can indirectly improve HDI when combined with democracy. Based on this diverse body of previous literature, we seek to test whether foreign aid has a positive impact on human capital.

H1: Foreign aid has a positive impact on human capital.

As highlighted in the previous discussion, recent studies suggest that sector-specific aid is more effective, implying that the impact of aid may be clearer when examined at the sectoral level. While the HDI comprises of three components, foreign aid may not affect them equally. By dissecting HDI into its components, we can obtain a more detailed understanding of where foreign aid is most effective, thereby resolving the ambiguities coming from divergent conclusions of previous literature. For this reason, we would like to further extend our investigation into each component of human capital, namely health measured by life expectancy, education measured by years of schooling, and the standard of living measured by GNI per capita.

The literature regarding the impact of foreign aid on health is mixed. Williamson (2008) contends that foreign aid does not have a significant impact on health in recipient countries using life expectancy, infant mortality, death rate, and immunization as health indicators. Wilson (2011) finds that aid does not have a significant impact on mortality rates and claims that aid often goes to countries that have experienced mortality reductions but do not cause those reductions. On the other hand, other studies find positive effects of aid on health. Mishra and Newhouse (2009) demonstrates that aid is beneficial to reducing infant mortality rates. They find that aid to health policy and administrative management as well as aid to basic health care, such as increasing medicine and drug supplies, both contribute to reducing infant mortality. Feeny and Ouattara (2013) also find that foreign aid devoted to the health sector increases child immunization against measles and DPT by granting wider access to vaccines. A recent study by Pickbourn and Ndikumana (2019) finds that foreign aid targeted to the health sector reduces infant mortality in Sub-Saharan Africa and suggests that foreign aid may increase government spending on health to further reduce mortality. The results from Mishra and Newhouse (2009), Feeny and Ouattara (2013), and Pickbourn and Ndikumana (2019) are consistent with the literature indicating a positive relationship between disaggregated sectoral foreign aid and human capital accumulation. While there is no conclusive trend, more recent studies have pointed to a positive association between foreign aid and health outcomes. Thus, we hypothesize the following:

H1a: Foreign aid has a positive impact on life expectancy.

In terms of education, numerous studies have indicated a strong positive effect of foreign aid on education. d'Aiglepierre and Wagner (2013) finds that aid to education significantly improves access to first grade, primary school completion rate, quantity of

children in primary school, and gender equality. Dreher et al. (2008) shows aid measured in per capita amount increases primary school enrollment. They argue that improving the learning environment and quality of education through aid can create incentives to attend school. Birchler and Michaelowa (2016) also shows that foreign aid improves education enrollment and finds that aid for primary and secondary education has mutually reinforcing effects. This is because support for secondary education helps students see the prospects of continuing their education and incentivizes students to finish primary schooling. Wolf (2007) shows that aid to the education sector increases youth literacy rates and primary school completion rates, however total aid is negatively associated with those outcomes in the education sector. It is further implied that aid targeted to specific sectors may suffer less from corruption and accountability problems, providing an additional explanation for the different effects of aggregated and disaggregated aid. These findings lead us to formulate the following hypothesis.

H1b: Foreign aid has a positive impact on years of education.

The literature regarding the standard of living generally points to a negative relationship with foreign aid. The standard of living is measured by income per capita in the Human Development Index. Nowak-Lehmann et al. (2012) explains that foreign aid has a generally insignificant effect on per capita income and exerts a slight negative impact in countries with high aid dependency. However, this study has been met with some controversy over the inadequate use of log transformation of variables, leading to a large non-random omission of observations (Lof et al. 2015). Anwar and Cooray (2015) uses OLS, fixed effects and system GMM to show that the direct impact of foreign aid on income per capita is mostly negative. Casella and Eichengreen (1996) claim that the expectation of receiving foreign aid may delay economic stabilization and allow interest groups to resist reforms that may enhance economic growth. Ali and Isse (2007) show that foreign aid reduces the standard of living, measured by GDP per worker, in recipient countries and restricts their income-generating capacity. They argue that aid dependency interferes with the facilitation of competition and growth productivity enhancement. Considering the previous literature, we devise the following hypothesis:

H1c: Foreign aid has a negative impact on GNI per capita.

2.2. Foreign Aid, Fertility Rates, Human Capital

As discussed earlier, foreign aid related to human capital development is complex, often yielding divergent results. This inconsistency suggests the need to introduce a third variable into the model. One plausible factor is fertility, as it is a prominent demographic challenge in developing countries and is highly relevant to human capital development. Higher fertility rates are a key demographic factor which deters human capital development by diluting resources available for each person. The quality-quantity tradeoff theory put forth by Becker and Lewis (1973) posits that parents adjust

investment toward their children in response to exogenous changes in fertility. The main implication of this theory is that, since families have limited resources, a small family size allows more resources to be invested in each child, thus leading to human capital improvements for the next generation. Theoretical support by Galor and Weil (2000) and Moav (2005) builds off this framework to show that technological development and higher income levels can improve human capital through reduced fertility rates. Empirical studies by Rosenzweig and Wolpin (1980), use twin birth rates as exogenous variation in family size to determine that fertility has a negative causal impact on child quality. Studies in China, by Liu (2014) and Rosenzweig and Zhang (2009), support the quality-quantity tradeoff theory by using China's one-child policies as instrumental variables to show that family size has a negative effect on health and education. Hafner and Mayer-Foulkes (2013), through a panel of 72 countries between 1980 and 2007, also conclude that there is a negative causal long-run effect between fertility rates and human development.

Given the negative impact of fertility on human capital development, it is crucial to consider how fertility might influence the relationship between aid and human capital. While previous studies have investigated the relationship between fertility and human capital, few studies to date address whether fertility influences foreign aid's impact on human capital. The first theoretical model combining foreign aid and fertility to human capital was by Azarnert (2008). In this two-period overlapping generations model, parents face a quality-quantity decision between having more children verses investing in their children's education. Humanitarian aid given per child and per adult can reduce the cost of having more children (quantity cost) leading to higher fertility rates. This reduces parental investment per child, slowing human capital accumulation.

Building on this, Neanidis (2012) find that foreign aid not only lowers the quantity cost of children but also improves the chances of children surviving until adulthood using a panel of 66 developing countries from 1973-2007. Neanidis (2012) concludes that aid has a statistically zero effect on both fertility and growth rate of output per worker because there are two contradicting effects of aid on fertility using a two period overlapping generations model. Specifically, in-kind aid per child improves the probability of a child's survival and lowers the fertility rate by reducing the precautionary demand for children, while monetary aid per adult increases fertility by reducing the cost of having more children. In-kind aid per child improves the growth rate of output per worker by improving children's health status, while monetary aid per adult increases the growth rate of output by reducing the resources spent on improving each child's human capital. Such findings contrast with Azarnert (2008) that finds both aid per child and aid per adult increase fertility and contribute to lowering human capital levels.

Sirohi (2014) uses a 3-period overlapping generations model to explore how different aid policy designs may impact fertility and human capital. Overall, cash transfers in the form of child support improve human capital by increasing schooling for high income households, however this positive effect is weakened for low-income classes who have higher dependency on aid as a source of income. The fertility rate of

high-income households remains unaffected, but it increases for low-income households. Sirohi (2014) also finds that if aid is made conditional on schooling, the cash transfers no longer affect fertility, yet they continue to positively impact human capital through increased schooling.

The previous studies by Azarnert (2008), Neanidis (2012), and Sirohi (2014) consider fertility's role in mediating the effect of foreign aid on human capital. However, in light of their inconsistent results, it remains unclear whether fertility is best conceptualized as a mediator. Given the mixed evidence regarding the mediating effect of fertility, this study takes a different approach by considering fertility as a potential moderator. According to Baron and Kenny (1986), moderators are typically appropriate when the independent variable and dependent variable have a weak or inconsistent relationship, while mediators are used when there is a strong relationship between the independent and dependent variable. Based on Baron and Kenny's (1986) suggestion and the ambiguous results in the previously reviewed literature regarding the direct relationship between foreign aid and human capital in section 2.1, we investigate fertility's potential role as a moderator. High levels of fertility may weaken the beneficial spillovers of foreign aid and slow human capital accumulation. Considering that governments and institutions have limited resources, high rates of fertility are likely to strain resources and adversely affect the effectiveness of foreign aid. For instance, foreign aid for schools may not be effective in improving the academic performances of children if the schools are overcrowded (Earthman, 2002). Therefore, we hypothesize that higher fertility rates will have a negative moderating role in foreign aid's impact on human capital.

H2: Fertility negatively moderates foreign aid's effect on human capital

3. DATA AND METHODOLOGY

3.1. The Model

This study aims to identify the effects of foreign aid and fertility rate on human capital using a panel dataset of 119 countries from 2002 to 2022. An empirical model was constructed to analyze the effects. The dependent variable is human capital represented by HDI and its three components. The independent variables of interest are foreign aid represented by net ODA received and fertility rate. Following previous studies, the model also uses government spending, urbanization, unemployment rate and inward FDI as control variables. Government spending as a percentage of GDP is expected to improve human capital since much of a country's investment in human capital stems from government spending (Gohou and Soumaré, 2012). Urbanization is expected to improve human capital as urban centers provide more opportunities for improving living standards (Tripathi, 2021). The unemployment rate is expected to have

a negative impact on human capital because workers often accumulate human capital through their job, and unemployment may delay skill formation and productivity (Doppelt, 2019). Finally, FDI generates various impacts on host countries' human capital through increased economic activities and productivity, employment creation, and corporate social responsibility (Forte and Abreu, 2023). Thus, FDI is expected to have a positive effect on human capital.

The basic model is as follows:

$$\begin{aligned} HDI_{i,t} = \ & \beta_0 + \beta_1 HDI_{i,t-1} + \beta_2 Fertility_{i,t-1} + \beta_3 \ln ODA_{i,t-1} \\ & + \beta_4 (Fertility * lnODA)_{i,t-1} + \beta_5 Governmentspending_{i,t-1} \\ & + \beta_6 Urbanization_{i,t-1} + \beta_7 Unemployment_{i,t-1} + \beta_8 FDI_{i,t-1} \\ & + \tau_t + \varepsilon_t. \end{aligned}$$

The year lag of HDI is included in the model since previous levels of HDI are strong determinants of current levels of HDI. This raises issues of endogeneity which are adequately addressed through our use of dynamic panel methods. Total bilateral ODA received is calculated with a natural logarithm so that it shows a normal distribution. The model also includes the interaction term between fertility rates and ODA to identify the joint effects of fertility rate and foreign aid on HDI. τ_t is a full set of year dummies which were included to control for unobserved time-specific effects. All independent variables on the right-hand side of the equation are lagged by 1-year to control for reverse causation.

To analyze the effects of sectoral ODA, the analysis was repeated after replacing total ODA with social infrastructure and services sector ODA, economic infrastructure and services sector ODA, production sector ODA, and multi-sector ODA. Similarly, to understand the effect of ODA on the various dimensions of HDI, the analysis was repeated after replacing HDI with each of its three components.

3.2. Methodology

The dynamic panel General Method of Moments (GMM) approach is a common approach used in aid literature (Dalgaard et al., 2004; Roodman, 2007) and was chosen for this study, based on four main reasons. First, having a persistent dependent variable is a requirement for GMM. Considering that the correlation between HDI and its lagged value is 0.998, the persistence is apparent. Second, there are substantially more cross-sections than there are the number of years in each cross-section, since there are 119 countries, and the period is between 2002-2022. This means that N is much higher than T, allowing for more robust overidentification tests and more consistent results due to the law of large numbers. Third, GMM effectively addresses potential endogeneity through time-invariant variables that control unobserved heterogeneity and instrumental

variables that mitigate issues regarding reverse causality and simultaneity. Fourth, GMM accommodates cross-country differences and is consistent with panel data. The system-GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) is used over the difference-GMM estimator (Arellano and Bond, 1991) because system-GMM addresses both first differences and levels, and has been shown to produce less biased outcomes (Hayakawa, 2007).

The "xtabond2" command in STATA is used, with the "gmm" option in accordance with Roodman (2009). The basic formula is "xtabond2 [dependent variable] [independent variables], gmm[(endogenous variables)] iv[instrumental variables]". The dependent variable and all independent variables are suspected of being endogenous, while time dummies are acknowledged to be time-invariant and exhibit exogeneity. Thus, the dependent variable and all independent variables were included in the "gmm" option while time dummies were included in the "iv" option. This is consistent with recent aid literature that employs GMM (Asongu and Odhiambo, 2020; Kim, 2019). Based on the Akaike Information Criterion (AIC), the "lag (1 1)" specification is used within the "gmm" option to use the first lag of the specified variables as instruments. Moreover, the "two-step" specification is also used to account for heteroscedasticity. In addition, robust standard errors are used to ensure standard errors are consistent.

The GMM results are validated through the application of two specification tests. The Hansen J-test of overidentifying restrictions is used to examine the validity of the instruments used in the model. The Arellano-Bond test is used to verify the absence of autocorrelation. However, the model includes the first lag of each variable to conduct first-differencing, which increases the likelihood of first-order autocorrelation. Therefore, the Arellano-Bond test is only relevant regarding second-order autocorrelation.

3.3. Data

Human capital is measured by the Human Development Index, extracted from the United Nations Development Programme (UNDP). HDI is the measure of a country's development in key aspects of human living conditions. It is the geometric mean of normalized indices of 3 dimensions of human development: health, education, and standard of living. Health is assessed through life expectancy at birth, education is measured by taking the arithmetic mean of mean years of schooling for adults and expected years of schooling for children, and standard of living is measured by GNI per capita. A higher index represents a higher level of human capital. Foreign aid was measured using total disbursements of total ODA, which is an official aid targeting recipient countries' welfare and development. We also consider various sectoral ODA: social infrastructure and services sector (e.g. education, health, water supply), economic infrastructure and services sector (e.g. energy, transportation, financial services), production sector (e.g. agriculture, industry, mining), and multi-sector (e.g. environmental protection, urban development). All ODA data were collected from the OECD Creditor Reporting System (CRS). For the data for fertility rates, "fertility rate,

total (births per woman)" was used from World Development Indicators (WDI). The model also includes control variables, based on previous studies. Government spending is measured using general government final consumption expenditures (% of GDP) and FDI is measured using net inflows of foreign direct investment (% of GDP). Urbanization is the percentage of urban population out of the total population. GDP per capita growth is measured using the annual percentage. All control variables were extracted from World Development Indicators (WDI). The descriptive summary statistics of the variables are shown in Table 1.

Table 1. Descriptive Summary Statistics

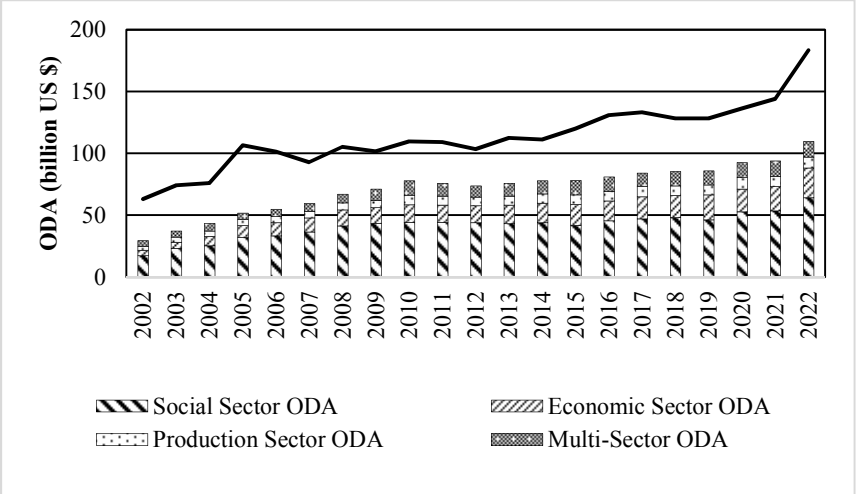
Variable	Number of Obs.	Mean	Standard Deviation	Min	Max
HDI	2,060	0.624	0.128	0.271	0.853
Life Expectancy	2,060	67.112	7.679	42.125	80.079
Years of Education	2,060	9.259	2.556	2.065	15.062
GNI per capita	2,060	8367.853	6550.154	672.744	45712.940
ln($Total\ ODA$)	2,060	6.005	1.331	-0.853	10.204
ln($Social\ Sector\ ODA$)	2,060	5.167	1.288	-1.057	8.788
ln($Economic\ Sector\ ODA$)	2,051	3.769	1.951	-5.280	8.039
ln($Production\ Sector\ ODA$)	2,057	3.176	1.634	-8.574	6.997
ln($Multi-Sector\ ODA$)	2,060	3.301	1.352	-3.329	6.974
Fertility Rate	2,060	3.354	1.480	1.160	7.671
Government Spending	2,060	14.820	8.043	2.047	115.924
Urbanization	2,060	49.653	20.046	9.139	95.045
Unemployment	2,060	8.166	6.383	0.120	37.320
FDI	2,060	3.807	4.899	-37.173	55.073

3.4. Data Trends

In recent years, ODA spending has shown an overall increasing trend. Figure 1 shows the overall ODA trends between 2002-2022. Total bilateral ODA disbursements reached an all-time high of 183 billion dollars in 2022. In addition, out of the four main ODA sectors, the social infrastructure and services sector takes up the biggest proportion of ODA throughout the whole period. HDI levels have generally been increasing during this period, although there is some variation between regions.

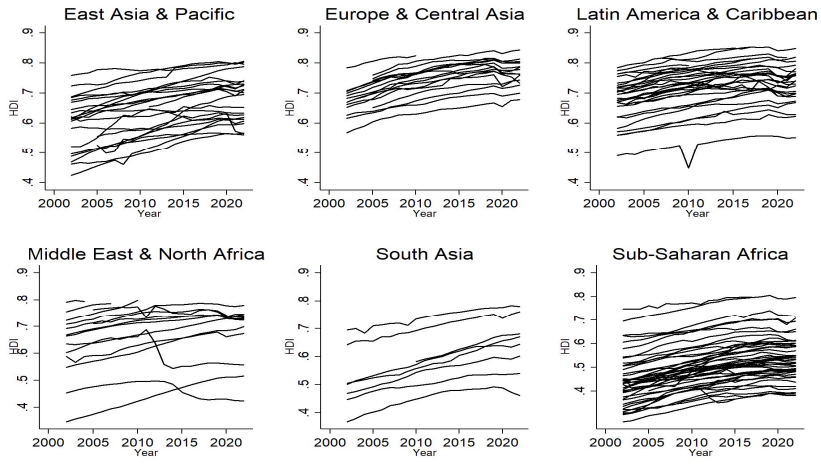
Figure 2 shows HDI levels for all recipient countries in each of their respective regions. Overall, all regions show signs of increasing HDI levels. East Asia and Pacific, South Asia, and Europe and Central Asia show clear signs of increasing HDI throughout the whole period. Sub-Saharan Africa, Latin America and Caribbean have shown signs

of HDI growth in the past but have been relatively stagnant since 2015. Middle East and North Africa have an overall increasing trend, with a few countries experiencing sharp drops during periods of armed conflict.



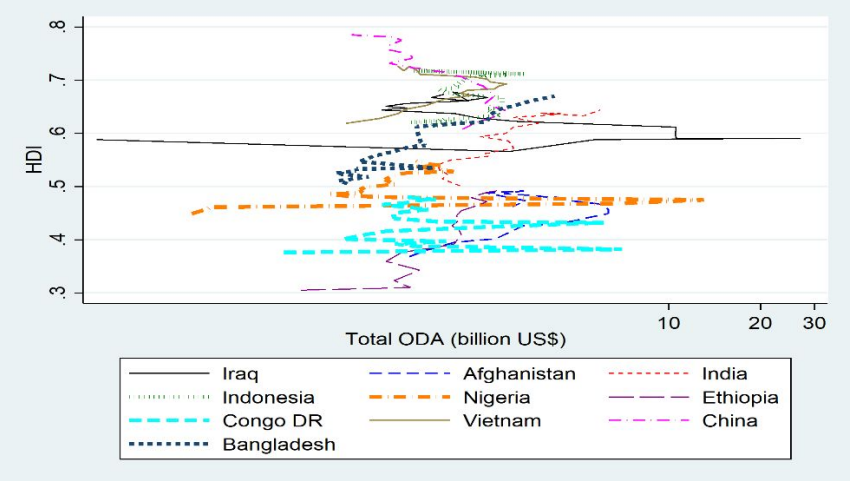
Source: OECD, Creditor Reporting System

Figure 1. Amount of Total ODA and Sector ODA (2002-2022)



Source: Human Development Reports, UNDP, 2024.

Figure 2. HDI Trends by Region



Source: OECD, Creditor Reporting System and Human Development Reports, UNDP, 2024.

Figure 3. Trends in ODA and HDI in Top 10 Recipient Countries (2002-2022)

The current trends also indicate that ODA spending and HDI levels have both been increasing over the past couple of decades. Figure 3 shows trends of ODA and HDI for the 10 largest ODA recipients, cumulative between 2002-2022. The x-axis was logged for better visual comparison. Though there is some fluctuation in the amount of ODA received by countries, there seems to be an overall positive correlation between ODA and HDI. Except for China, most countries show a trend of increasing HDI as ODA increases.

4. RESULTS

4.1. GMM Results

Table 2 shows the GMM estimation results. Column (1) shows that the coefficient of the year lagged HDI variable is 0.783 indicating that HDI levels of previous years are the strongest determinant of human capital. The coefficient for total ODA is 0.026 indicating that a 1% increase in total ODA is associated with a 0.026 point increase in HDI. However, the coefficient for the interaction term between fertility rate and total ODA is -0.005 meaning that the effect of total ODA on HDI decreases by 0.005 when the fertility rate increases by 1. This means that the positive effect of ODA on HDI decreases by about a fifth if fertility rate increases by 1. These coefficients are statistically significant at the 1% level, indicating that more ODA increases HDI but fertility rates have a negative moderating effect on its impact.

Table 2. Impact of Foreign Aid on Human Capital Development, GMM

Dependent Variable: HDI	(1) $\ln(Total\ ODA)$	(2) $\ln(Social\ ODA)$	(3) $\ln(Economic\ ODA)$	(4) $\ln(Production\ ODA)$	(5) $\ln(Multi-Sector\ ODA)$
$\ln ForeignAid_{t-1}$	0.0268***	0.0227***	0.0077**	0.0078*	0.0116***
	[0.0095]	[0.0082]	[0.0035]	[0.0042]	[0.0041]
$\ln ForeignAid \times Fertility)_{t-1}$	-0.0055***	-0.0059**	-0.0021**	-0.0017*	-0.0028**
	[0.0020]	[0.0025]	[0.0010]	[0.0010]	[0.0013]
HDI_{t-1}	0.7831***	0.6840***	0.7707***	0.7426***	0.7821***
	[0.1355]	[0.1575]	[0.1398]	[0.1287]	[0.1325]
$Fertility_{t-1}$	0.0149	0.0055	-0.0069	-0.0096	-0.0063
	[0.0102]	[0.0099]	[0.0134]	[0.0091]	[0.0106]
$GovernmentSpending_{t-1}$	0.0000	0.0000	0.0001	-0.0004	-0.0004
	[0.0007]	[0.0007]	[0.0007]	[0.0006]	[0.0006]
$Urbanization_{t-1}$	-0.0006	-0.0005	0.0001	0.0001	-0.0003
	[0.0008]	[0.0008]	[0.0008]	[0.0007]	[0.0007]
$Unemployment_{t-1}$	0.0019	0.0022*	0.0023	0.0016	0.0016
	[0.0013]	[0.0012]	[0.0019]	[0.0015]	[0.0018]
FDI_{t-1}	0.0002	0.0002	0.0001	0.0001	0.0002
	[0.0002]	[0.0002]	[0.0002]	[0.0002]	[0.0002]
Constant	0.0544	0.1756	0.1417	0.1798*	0.1609
	[0.0945]	[0.1264]	[0.1317]	[0.1057]	[0.1097]
N	1956	1956	1943	1951	1956
Instruments	35	35	35	35	35
Hansen	0.7844	0.854	0.3737	0.4728	0.5043
AR2	0.1968	0.1956	0.3190	0.3380	0.3566
F	1687.069	1321.122	2650.254	1990.506	2174.465

Note: Standard errors are in square brackets. *, **, and *** indicate statistical significance at the 10, 5, and 1% level, respectively.

Table 3. Impact of Foreign Aid on Education, GMM

Dependent Variable: HDI	(1) $\ln(Total\ ODA)$	(2) $\ln(Social\ ODA)$	(3) $\ln(Economic\ ODA)$	(4) $\ln(Production\ ODA)$	(5) $\ln(Multi-Sector\ ODA)$
$\ln ForeignAid_{t-1}$	0.4994*	0.3211	0.1951**	0.1011	0.1611
	[0.2675]	[0.2308]	[0.0867]	[0.0901]	[0.1107]
$\ln ForeignAid \times Fertility)_{t-1}$	-0.1111*	-0.1114*	-0.0538**	-0.0309	-0.051
	[0.0603]	[0.0657]	[0.0247]	[0.0244]	[0.0345]
HDI_{t-1}	0.8428***	0.7552***	0.8169***	0.8303***	0.8117***
	[0.1693]	[0.1890]	[0.1457]	[0.1546]	[0.1609]
$Fertility_{t-1}$	0.3331	0.1523	-0.0067	-0.0256	-0.0927
	[0.3546]	[0.2998]	[0.2553]	[0.2369]	[0.2155]
$GovernmentSpending_{t-1}$	-0.0033	-0.0024	-0.0045	-0.0025	-0.0041
	[0.0176]	[0.0192]	[0.0141]	[0.0131]	[0.0146]
$Urbanization_{t-1}$	-0.0108	-0.0064	0.0044	0.0133	0.0043
	[0.0316]	[0.0284]	[0.0236]	[0.0231]	[0.0230]
$Unemployment_{t-1}$	0.0344	0.0482	0.0498	0.0364	0.0409
	[0.0397]	[0.0336]	[0.0380]	[0.0350]	[0.0384]
FDI_{t-1}	0.0012	0.0005	-0.0013	-0.0028	-0.0002
	[0.0039]	[0.0033]	[0.0029]	[0.0032]	[0.0031]
Constant	0.0245	2.0886	1.1843	0.8117	1.6784
	[2.5736]	[3.0248]	[2.3433]	[2.3099]	[2.0163]
N	1956	1956	1943	1951	1956
Instruments	35	35	35	35	35
Hansen	0.7183	0.7877	0.6835	0.4642	0.3612
AR2	0.8360	0.5021	0.6780	0.9890	0.8122
F	315.7411	276.5091	439.7712	395.9264	499.9766

Note: Standard errors are in square brackets. *, **, and *** indicate statistical significance at the 10, 5, and 1% level, respectively.

In columns (2) through (5) total ODA was replaced with sector-specific ODA to find out how different sectoral ODA impacts HDI. The coefficients for ODA in the social infrastructure and services sector, economic infrastructure and services sector, production sector and multi-sector ODA were statistically significant. All four sectors have positive effects on HDI with the social infrastructure and services sector having the biggest impact on human capital. Moreover, their interaction terms with fertility also show similar effects as with total ODA. This supports the literature (Asiama and Quartey, 2009; Gomanee et al., 2005) that disaggregated sectoral ODA positively affects HDI through its impact on public expenditures. The p-value for the Arellano-Bond test for second-order autocorrelation is statistically insignificant, thus rejecting the null hypothesis of second-order autocorrelation. In addition, the p-value for the Hansen test is also statistically insignificant, indicating a rejection of the null hypothesis of invalid instruments.

In order to identify which areas of HDI were most affected by ODA, GMM estimation was also conducted on each of the three components of HDI. Of the three components of HDI, only the results for education showed valid results. The coefficients of foreign aid on health were insignificant and the results for standard of living had significant Hansen test values indicating that the instruments may not be valid. The results in Table 3 show that total ODA has a significant positive impact on education. Education was measured by the average of mean years of schooling for adults and expected years of schooling for children, consistent with the HDI index. Table 3 indicates that a 1% increase in total ODA is associated with a half year increase in years of schooling for adults and children. Interestingly, the coefficient for economic infrastructure and services ODA was significant, while the coefficient for social infrastructure and services ODA was not. This may imply that developing economic infrastructure is also important to developing human capital. The interaction term coefficient also shows a negative moderating effect of fertility on ODA. The impact of the negative moderation is around a fifth of the impact of total ODA on education, which is consistent with our main findings. The Arellano-Bond test and Hansen test results were both insignificant for these results, indicating that there is no second-order autocorrelation and that the instruments used were valid.

4.2. Robustness Check by Excluding Outliers

One potential issue that should be considered is the possibility of outliers. Aid recipient countries that experience armed conflicts can be considered outliers, for such conflicts might disrupt public institutions such as schools and hospitals. Thus, undermining the effect of foreign aid on human capital accumulation. Moreover, donor countries may provide uncommonly large amounts of foreign aid to war-torn countries to support rebuilding processes. These complexities could interfere with the results of the data, making it necessary to test the robustness of the results by excluding the countries involved in armed conflicts.

Table 4. Robustness Check without Outliers

Dependent Variable: HDI	(1) $\ln(Total\ ODA)$	(2) $\ln(Social\ ODA)$	(3) $\ln(Economic\ ODA)$	(4) $\ln(Production\ ODA)$	(5) $\ln(Multi-Sector\ ODA)$
$\ln ForeignAid_{t-1}$	0.0179**	0.0179**	0.0065**	0.0058*	0.0098**
	[0.0081]	[0.0069]	[0.0025]	[0.0035]	[0.0040]
$\ln ForeignAid \times Fertility)_{t-1}$	-0.0036**	-0.0048**	-0.0017***	-0.0013*	-0.0027**
	[0.0015]	[0.0019]	[0.0006]	[0.0008]	[0.0011]
HDI_{t-1}	0.8413***	0.7403***	0.8092***	0.7769***	0.8286***
	[0.1116]	[0.1210]	[0.0991]	[0.1166]	[0.1101]
$Fertility_{t-1}$	0.0099	0.0038	-0.001	-0.0067	-0.0027
	[0.0075]	[0.0068]	[0.0077]	[0.0073]	[0.0082]
$GovernmentSpending_{t-1}$	-0.0003	-0.0001	-0.0005	-0.0004	-0.0003
	[0.0005]	[0.0006]	[0.0004]	[0.0004]	[0.0005]
$Urbanization_{t-1}$	-0.0003	-0.0003	0.0003	0.0002	-0.0002
	[0.0006]	[0.0005]	[0.0005]	[0.0005]	[0.0006]
$Unemployment_{t-1}$	0.0014	0.0015*	0.0022**	0.0013	0.0013
	[0.0009]	[0.0008]	[0.0011]	[0.0009]	[0.0011]
FDI_{t-1}	0.0001	0.0001	0.0001	0.0001	0.0001
	[0.0002]	[0.0001]	[0.0001]	[0.0001]	[0.0002]
Constant	0.0327	0.1488*	0.0922	0.1494*	0.1220
	[0.0652]	[0.0841]	[0.0779]	[0.0893]	[0.0874]
N	1854	1854	1842	1849	1854
Instruments	35	35	35	35	35
Hansen	0.4413	0.6047	0.5064	0.3574	0.4556
AR2	0.4307	0.4279	0.4996	0.4424	0.4172
F	3401.3993	2763.9038	3795.0038	3129.8066	3495.2478

Note: Standard errors are in square brackets. *, **, and *** indicate statistical significance at the 10, 5, and 1% level, respectively.

Using data on battle-related deaths from the Uppsala Conflict Data Program website (Davies et al., 2024), a total of 129 observations from countries that have experienced armed conflicts with over 1000 or more battle-related deaths within a given year were removed from the panel dataset. The results are shown in Table 4. The results indicate that the coefficient of foreign aid and its interaction with fertility remain statistically significant. Foreign aid continues to show a positive impact, and the interaction term continues to show a smaller negative impact on human capital. Therefore, these results indicate that our main findings are robust, regardless of whether countries are experiencing armed conflicts or not.

5. CONCLUSION

This study explored the effect of foreign aid on human capital and how fertility rate moderates this effect. The dynamic panel GMM analysis shows that foreign aid has a positive impact on human capital. It indicates that HDI increases by 0.026 points when ODA increases by 1%. This is in line with the strand of literature that finds a positive relationship between foreign aid and human capital (Asiama and Quartey, 2009; Asongu and Odhiambo, 2020; Gomanee et al., 2005; Mohamed and Mzee, 2017). In addition, ODA to the social infrastructure and services sector, economic infrastructure and services sector, production sector and multi-sector all have a significant and positive impact on human capital.

This study also shows how the interaction between foreign aid and fertility rate affects human capital. The results indicate that the fertility rate has a negative moderating effect on human capital. Foreign aid's effect on HDI decreases by almost a fifth when fertility rate increases by 1. These results are consistent with the views of the quality-quantity theory (Becker and Lewis, 1973; Rosenzweig and Wolpin, 1980; Rosenzweig and Zhang, 2009) that claim higher levels of fertility can dilute resources and lead to less human capital investment for each individual. These results are robust even after accounting for states involved in armed conflicts.

These results imply that while foreign aid increases human capital accumulation overall, it will be less effective for recipient countries with high fertility rates. In order to improve the effectiveness of aid, donor countries should provide holistic aid that includes components to address high fertility rates such as funding for family planning, reproductive health education, and increasing the availability of contraceptives. Furthermore, aid in social infrastructure and services, such as schools, hospitals, and water supply, have the most effect on improving human capital. Finally, policymakers in recipient countries should consider legal and cultural reforms that reduce fertility rates, such as encouraging later marriage, to increase the effectiveness of foreign aid.

Though this study conducted an empirical analysis on the moderating role of fertility, it lacks a theoretical framework for understanding the exact mechanism of this moderation effect. Thus, theoretical studies on this topic can complement this research.

Moreover, since this study has shown how fertility rate can moderate the effectiveness of foreign aid on human capital development, future research can investigate the potential moderating role of other demographic variables, such as gender equality.

APPENDIX

Table A. List of Countries by Region

East Asia and Pacific		South Asia	Europe and Central Asia	
Cambodia	Mongolia	Afghanistan	Albania	Kazakhstan
China	Philippines	Bangladesh	Armenia	Kyrgyzstan
Fiji	Samoa	Bhutan	Azerbaijan	Moldova
Indonesia	Thailand	India	Belarus	Montenegro
Laos	Timor-Leste	Nepal	Bosnia and Herzegovina	Serbia
Malaysia	Tonga	Pakistan	Croatia	Tajikistan
Papua New Guinea	Vanuatu	Sri Lanka	Georgia	Turkmenistan
Solomon Islands	Vietnam		North Macedonia	Ukraine
			Uzbekistan	
Latin America and Caribbean		**Middle East and North Africa**	**Sub-Saharan Africa**	
Argentina	Guyana	Algeria	Angola	Guinea
Barbados	Haiti	Bahrain	Benin	Ivory Coast
Belize	Honduras	Djibouti	Botswana	Kenya
Bolivia	Jamaica	Egypt	Burkina Faso	Lesotho
Brazil	Mexico	Iran	Burundi	Madagascar
Chile	Nicaragua	Iraq	Cabo Verde	Mali
Colombia	Panama	Jordan	Cameroon	Mauritania
Costa Rica	Paraguay	Lebanon	Central African Republic	Mauritius
Dominican Republic	Peru	Libya	Chad	Namibia
Ecuador	Suriname	Morocco	Comoros	Niger
El Salvador	Uruguay	Oman	Congo	Rwanda
Guatemala	Venezuela	Saudi Arabia	Congo Dem	Senegal
		Syrian Arab Republic	Djibouti	Sierra Leone
		Tunisia	Eritrea	South Africa
		Yemen	Eswatini	Sudan
			Ethiopia	Tanzania
			Gabon	Togo
			Gambia	Uganda
			Ghana	Zambia
			Guinea-Bissau	Zimbabwe

Note: World Bank (2023) classification of countries.

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