

# *Empowering Social Protection in Developing Economies: The Role of Climate Finance; Insights from COP28*

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Global challenges resulting from climate change, economic distress, and social confrontation are rising. In this scenario, Social Protection (SP) provides a mechanism to deal with all such issues. This research study aims to analyse the impact of SP on Conference of the Parties (COP28) Climate Financing (CF). The study is based on a panel of 32 countries that met the CF criteria for a period of 19 years. To empirically validate the impact, the Two Step System GMM method has been used. This approach deals with the endogeneity issue and provides robust analysis to account for autocorrelation and heteroscedasticity problems. The results show that CF has a significant impact on empowering SP. However, in the case of low-income countries, the impact is negative. This paper offers a novel analysis of the COP28 CF and SP framework. The study also highlights the broader policy relevance of COP28 financing frameworks. It suggests the potential to inform global climate finance, enhance cross-country allocation, and guide the integration of climate-related funding with social protection beyond developing economies.

*Keywords:* social protection, climate finance, Two-Step System GMM, developing economies

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## **Introduction**

Social protection (SP) represents a system through which governments safeguard individuals against income loss and social vulnerability while promoting equitable access to healthcare, education, and welfare servic-

es (Hidrobo et al. 2018). In developing economies, traditional SP mechanisms are constrained by economic limitations, weak institutional capacity, and growing exposure to climate-induced shocks (Levitt 2022). In this context, Climate Finance (CF), particularly within the framework of the Conference of the Parties (COP28), has emerged as a potential mechanism with which to strengthen SP systems by mobilizing external resources that support adaptive, resilient, and inclusive development (Gao et al. 2024). Although the literature on SP and CF has expanded considerably, empirical work connecting these two domains remains limited. Specifically, the post-COVID-19 period and the COP28 agenda have opened a new research gap, one which highlights the requirement to integrate environmental financing with social welfare objectives. Instruments such as debt-for-climate or debt-for-nature swaps increasingly serve as policy tools with which to free fiscal space for social spending, yet the extent to which such mechanisms translate into measurable SP outcomes is still uncertain (Hatab 2023). To illustrate this emerging relationship, figure 1 presents the conceptual framework linking COP28 Climate Finance with SP outcomes, depicting how CF interventions, through green initiatives (i.e. green employment and climate-resilient infrastructure), can generate co-benefits that enhance social resilience and reduce inequality.

At the same time, the conceptual framework in figure 1 remains largely theoretical and untested across diverse national contexts, reflecting a key limitation of the existing literature. Most previous studies have treated CF and SP as parallel policy arenas without empirically verifying whether climate funding actually strengthens SP systems in developing economies. The current study responds to this limitation by testing part of the framework empirically, focusing mainly on COP28 commitments, identifying not only the potential interactions between environmental and social policy domains but also the institutional and economic constraints that may delay their alignment. The primary objective of this study is to examine the relationship between COP28 Climate Finance and Social Protection across 32 developing economies over a 19-year period. Specifically, the study aims to: (i) test whether CF is significantly associated with improvements in SP outcomes; and (ii) assess how institutional and economic structures mediate this relationship. In doing so, the paper contributes to the emerging discourse on integrating sustainability and equity agendas within global development finance. To explicitly connect the conceptual framework with the quantitative analysis in Section 4,

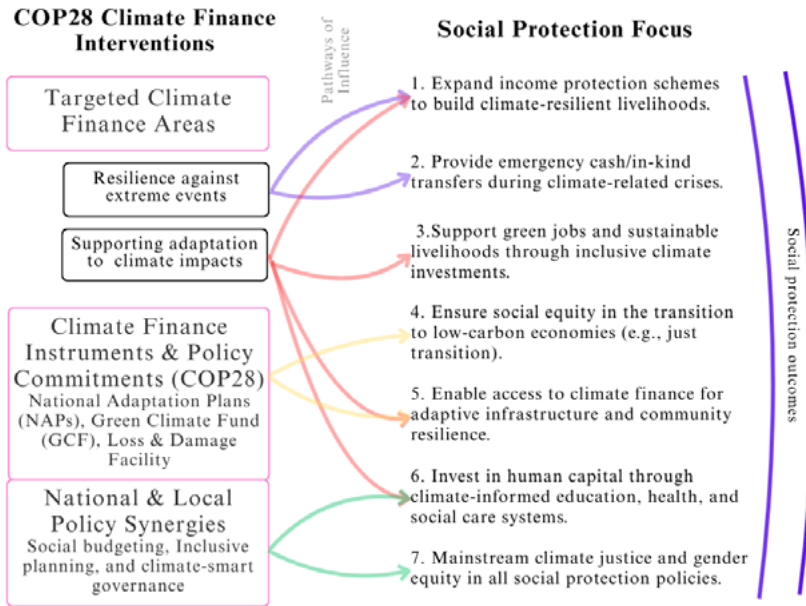


FIGURE 1 Strengthening the Conceptual-Empirical Link Between COP28 Climate Finance-Driven Interventions with Social Protection Outcomes

the pathways are outlined in figure 1. It shows the connection between climate finance and social protection system. Targeted climate finance areas like resilience and adaptation serve income protection schemes and emergency cash scheme. So climate finance should be brought to the national policy. Climate finance as policy instrument ensure social equity through green jobs and sustainable livelihood, necessary for human capital. Therefore, climate informed education, health and social care (human capital investment) ensure social budgeting, inclusive planning and climate smart governance as solid policy framework.

Specifically, the contribution of this study is threefold. Firstly, it provides one of the first empirical assessments of how COP28-aligned climate finance flows influence social protection outcomes in developing economies, thereby advancing knowledge in an underexplored gap in the research. Secondly, it introduces a comprehensive analytical framework that integrates economic, institutional, and environmental dimensions to evaluate the social effectiveness of climate finance. Thirdly, it offers comparative evidence across income groups, highlighting structural differences in climate finance effectiveness and drawing policy insights to enhance institutional capacity and the economic alignment between

climate and social objectives. Collectively, these contributions bridge the gap between climate finance and social policy literature while offering actionable implications for sustainable and inclusive development.

The remainder of this paper is organized as follows: Section 2 reviews the relevant literature and theoretical foundations; Section 3 details the data sources and econometric methodology; Section 4 presents and discusses the empirical results, and Section 5 concludes with key policy implications for aligning climate finance with social protection frameworks in developing economies.

## Literature Review

### THEORETICAL PERSPECTIVES ON CLIMATE FINANCE AND SOCIAL PROTECTION

At COP28, where the dialogue strongly emphasized climate justice and the loss of damage financing, the integration of Social Protection (SP) systems into Climate Finance (CF) emerged as a critical, yet insufficiently addressed, area. This gap raises important questions about how CF can more effectively support vulnerable populations beyond physical infrastructure. The hypothesis that CF positively contributes to the empowerment of SP systems in developing economies is especially relevant in this context (Trunk and Stubelj 2022).

CF holds the potential to scale up climate-resilient SP systems that not only reduce income insecurity but also strengthen the capacity of individuals and communities to recover from recurring climate shocks, such as floods, heatwaves, etc. However, despite this promise, few COP28 negotiations operationalized strategies for channelling climate funds directly into SP mechanisms (Doku and Phiri 2023). Instead, the dominant focus remained on infrastructure and technological interventions, often overlooking the essential human and social dimensions of climate resilience. This highlights the importance of empirically testing the proposed hypothesis to determine whether CF can serve as a transformative tool for empowering SP in developing economies. Such analysis is vital in bridging the gap between global climate commitments and inclusive social outcomes (see Appendix for detailed analysis of the global social protection system).

Regarding the discussion related to the CF and SP, scholars remained critical of the assumption that CF directly contributes to the empowering of SP systems. Critics argue that the current architecture of CF is fragmented and project-based. It is therefore detached from national SP

strategies that do not lead to social protection. Dmuchowski et al. (2023) point out that many CF mechanisms prioritize short-term climate objectives over long-term social resilience, leading to a mismatch between financial mechanisms addressing climate infrastructure and social needs.

Additionally, Xiao et al. (2023) and Sepetis et al. (2024) emphasize that donor-driven CF programmes frequently have poor functionality, failing to coordinate with welfare, health, or labour (i.e. social protection). As a result, potential synergies between CF and SP are often underutilized. Various concerns have also been raised about the accessibility of climate funds, with complex application procedures and limited capacity in recipient countries to effectively implement them into SP systems. Moreover, some researchers highlight that, without robust governance and inclusive planning, CF risks reinforcing existing inequalities, rather than alleviating them. These criticisms suggest that, while CF holds the theoretical potential to strengthen social protection, its practical impact remains constrained (Ozili 2022) unless structural and institutional challenges are addressed through a proper policy framework.

In Africa, prior studies have found that SP schemes are rapidly evolving and that they aim to provide predictable needs, and secure basic needs, for vulnerable populations (Bailey 2010). For example, Ethiopia's Productive Safety Net Programme (PSNP), established in 2005, illustrates a successful transition from reactive emergency responses to proactive, sustainable development initiatives (Gilligan et al. 2009). Specifically, the PSNP's efforts have significantly reduced food insecurity and improved community resilience, benefiting over 8.3 million chronically food-insecure households by 2007 (Tambe et al. 2023). However, despite such successes, most SP systems lack obvious disaster response mechanisms (e.g. to COVID-19), even though mitigating the impacts of shocks is still an implicit goal. This gap is particularly pronounced in regions that are frequently affected by climate and social safety disasters (Nosheen et al. 2021).

According to the International Labour Organization, only 47% of the global population was covered by at least one SP benefit by 2022. In low-income countries, this value was even lower, at around 18%. The COVID-19 pandemic tightened the fiscal space and increased the debt servicing to a high level. International financial institutions, like the IMF and the World Bank, emphasized shock-responsive SP that addressed the actual implementation, which is constrained by limited fiscal space and debt burdens (Langry and Rena 2023).

## INSTITUTIONAL FRAMEWORK AS A THEORETICAL LENS

The institutional framework provides a useful theoretical lens for understanding the relationship between CF and SP. This theoretical lens helps to conceptualize how governance quality, policy coherence, and administrative capacity shape the effectiveness of CF in strengthening SP systems. In other words, institutional theory emphasizes that policies and outcomes are not determined by financial inputs alone but also by the rules, norms, and organizational capacities through which these resources are managed.

In the context of CF, institutions determine whether external funds are transparently allocated, effectively monitored, and integrated into national SP strategies. Strong institutions facilitate accountability, inclusiveness, and equitable distribution, ensuring that CF translates into tangible welfare benefits. Conversely, weak or fragmented institutional arrangements may lead to the misallocation of resources, short-termism, or donor dependency, thus undermining the potential social gains of CF. The institutional framework thus highlights why some developing economies are more successful than others in leveraging CF for social protection. This framework provides an interpretive tool with which to complement the empirical analysis by situating observed outcomes within broader governance and policy structures.

However, while these global shifts signalled progress towards more adaptive and inclusive systems, they also exposed significant limitations when tested against real-world crises. The structural weaknesses of existing programmes, particularly those in low-income countries, became more visible during the pandemic. Building on these observations, the study hypothesizes that CF could play a transformative role in strengthening SP systems, though its effectiveness may vary across income groups, depending on institutional capacity and fiscal space.

The hypotheses state:

- H1 *CF has a significant impact on empowering SP in developing economies.*
- H1A *CF positively influences SP in middle-income developing economies.*
- H1B *CF has a weaker or negative influence on SP in low-income developing economies.*

There is an existing body of literature exploring the structures and functions of SP systems and the increasing attention to CF. Particularly in the wake of COP28, a significant gap remains in the understanding of the intersection between these two critical policy domains. Most studies have treated CF and SP as parallel but disconnected arenas. There is limited empirical analysis examining how international climate commitments translate into concrete social welfare outcomes at the national level. While the existing literature acknowledges the potential of CF to support adaptive and climate-resilient SP systems, it often remains normative or conceptual, lacking robust empirical validation across developing economies (Fedele et al. 2019).

Moreover, there is insufficient investigation into the heterogeneous effects of CF on SP outcomes across different income groups and governance contexts. Importantly, while COP28 positioned climate justice and social equity at the centre of global discussion, the operational mechanisms for integrating SP into CF allocations remain vague and under-researched. This research addresses that gap by testing whether CF actually contributes to the strengthening of SP systems, using a cross-country econometric approach across 32 developing economies over a 19-year period. Additionally, the integration of endogenous growth parameters and structural constraints offers a unique dimension through which to understand the broader policy effectiveness of CF on SP.

To conclude, no prior study has comprehensively evaluated the empirical linkage between COP28 CF and the resilience or expansion of SP systems, especially in the context of differing income classifications. This research thus fills a critical gap by offering both theoretical advancement and practical policy insights into how CF can be leveraged to achieve inclusive and sustainable social outcomes in developing countries.

### **Data and Methodology**

This section outlines the data sources, the selection of variables, and the methodological framework that has been employed to examine the relationship between COP28 Climate Finance (CF) and Social Protection (SP) systems. The empirical investigation is grounded in a panel dataset obtained from reputable international sources, such as the World Development Indicators (WDI), the International Monetary Fund (IMF), and the International Labour Organization (ILO).

The study emphasizes numerous key variables: CF, physical and human capital, GDP per capita, endogenous growth parameters, IMF structural

adjustment programmes, and debt servicing. Given the dynamic nature of the data and the potential presence of endogeneity, the Two-Step System Generalized Method of Moments (GMM) technique is employed. This approach ensures robust estimation by addressing issues of autocorrelation, heteroscedasticity, and unobserved heterogeneity. It thus provides reliable insights into the structural determinants of SP in the context of evolving CF mechanisms.

#### DATA

This research was conducted using a sample of 32 developing countries for the period of 19 years, from 2002 to 2020. The basis for the selection of these countries depended upon their eligibility and participation in COP28 CF initiatives, with a particular focus on low-income, lower-middle-income, and upper-middle-income economies. The data on CF was obtained in the context of a debt-for-nature swap (DNS); an initiative by the donor countries to support the countries with limited financial mechanisms for climate resilience programmes.

The exercise of DNS serves two functions, providing fiscal infrastructure and improved sustainability actions. The dependent variable SP system was used as an index, which was constructed through the Keyser-Meyer-Olkin methodology. Countries focusing on an SP system and qualifying for CF are listed in table 1, providing the relevant numerical facts, like debt servicing, CF, and GDP.

#### VARIABLES AND MODELS

As discussed above, the SP system is the dependent variable, while explanatory variables include COP28 CF, physical capital formation, human capital development, GDP per capita, endogenous growth parameters, IMF Structural Adjustment Programmes (SAPS), and debt servicing. In order to test the hypotheses of the study, the empirical procedure was used through the application of the Two-Step System GMM approach.

For empirical investigation, the advanced methodology Two-Step System GMM is suitable under certain conditions; for example, the number of parameters should be greater than the number of moment conditions. Failing to fulfil the conditions leads to inefficient results and does not give a robust analysis. The System GMM uses endogenous regressors in a panel data model and accurate measurement in the presence of heterogeneity. The System GMM addresses the weakness of the difference GMM (difference GMM works on the assumption that (i) explanatory variables

TABLE 1 List of Countries

Country	Developing Economies				Emerging Economies									
	Column A	Column B	Column C	Column D	Country	Column A	Column B	Column C	Column D					
Bangladesh (₹)	1.8 ②	17.5	2233.3	5.5	Philippines(₱)	1.4 ③	34	3224.4	6.3	Albania (₯)	1.5 ①	22.9	5332.2	17.7
Cambodia (₱)	1.7 ③	52.6	1577.9	1.7	Sri Lanka(₱)	1.4 ②	6.1	3893.8	33	Armenia (₯)	1.5 ①	1.1	4505.9	13.1
Iran (₯)	1.2 ⑤	0.8	2746.4	0.1	Sudan(₱)	1.8 ⑥	4	608.3	2.9	China (₯)	1.9 ③	43.1	10408.9	1
Kenya (₱)	1.8 ⑥	28.7	1936.4	26.6	Tajikistan(₯)	2.0 ①	6.9	852.3	6.4	Costa Rica (₯)	1.0 ④	2.1	12132.9	7.9
Kyrgyzstan(₱)	1.6 ①	0.8	1182.5	8.4	Tunisia(₱)	1.1 ⑤	14	3497.6	16	Ecuador (₯)	1.0 ④	8.2	5645.2	23.1
Madagascar(₯)	1.9 ⑥	11.7	462.4	4.3	Uganda(₯)	1.8 ⑥	34	846.7	5.5	Indonesia (₱)	1.5 ③	80.1	4628.1	6.9
Mongolia(₱)	1.5 ③	4.2	4041.1	14.3	Ukraine(₱)	1.4 ①	32	3751.7	11	Jamaica(₯)	1.1 ④	3.4	4897.2	32.6
Morocco(₱)	1.7 ⑤	14.1	3258.1	11	Vietnam(₱)	1.4 ③	15	3586.3	1.6	Kazakhstan(₯)	1.4 ①	2	9121.6	3.89
Mozambique(₯)	2.0 ⑥	28.2	449.9	13.9						Peru(₯)	1.0 ④	29.8	6056.3	2.55
Nepal(₯)	2.0 ②	9.8	1139.2	11.6						Serbia(₯)	1.2 ①	64.5	7733.8	10.32
Nigeria(₱)	1.8 ⑥	244.2	2074.6	3.8						Thailand(₯)	1.3 ③	5	6990.9	2.03
Pakistan(₱)	1.9 ②	32.1	1322.3	29.8						Turkey(₯)	1.0 ①	85.5	8561.1	8.63

Column A: Average Social Protection (SP) index 2002–2020.

Column B: COP28 Climate Finance (CF).

Column C: GDP per capita 2020.

Column D: Debt service 2020.

(₯) Low Income Countries

① Europe and Central Asia

④

Latin America and the Caribbean

(₱) Lower-middle-income countries

② South Asia

⑤

Middle East and North Africa

(₯) Upper-middle-income countries

③ East Asia and the Pacific

⑥

Sub-Saharan Africa

are weakly endogenous, and (ii) that explanatory variables are not correlated with error terms). Proceeding using all these assumptions in a base model of GMM, the Two-Step System GMM is asymptotically normal. It has a smaller asymptotic variance and is more asymptotically powerful than a One-Step System GMM equation:

$$SP_{it} = (CF_{it}, PH_{it}, HU_{it}, GDPC_{it}, EGP_{it}, SAP_{it}, DE_{it})$$

$$SP_{it} = \alpha_0 + \alpha_1 CF_{it} + \alpha_2 PH_{it} + \alpha_3 HU_{it} + \alpha_4 GDPC_{it} + \alpha_5 EGP_{it} + \alpha_6 SAP_{it} + \alpha_7 DE_{it} + \varepsilon_{it}$$

The equation above is a dynamic model, where subscript ‘*i*’ shows the cross section, ‘*t*’ shows the time series,  $\alpha_0$  shows the interception and constant value,  $\alpha_1$  to  $\alpha_7$  are the slope coefficients of explanatory variables,

TABLE 2 Details of Variables of the Study

Variable Name	Description	Proxy / Measurement
Social Protection System (SP)	Measures the strength and coverage of social protection mechanisms.	Social Protection Index (1 to 2 scale) based on national and ILO datasets constructed through Keyser- Meyer-Olkin methodology.
COP28 Climate Finance (CF)	Financial inflows under COP28 initiatives aimed at supporting climate and SP.	Annual amount of climate finance (USD millions) allocated per country (in simple terms, the Official Development Assistance to support the debt-for-nature swap initiative).
Physical Capital (PH)	Captures investment in infrastructure relevant to public service delivery.	Gross Fixed Capital Formation as % of GDP.
Human Capital (HU)	Reflects the population’s education and skill level.	Education index or average years of schooling (UNDP/World Bank).
GDP Per Capita (GDPC)	Overall economic productivity and income level.	GDP per capita in constant 2015 USD (World Bank).
Endogenous Growth Parameters (EGP)	Represents internal growth drivers.	A composite of population growth, technological growth, and physical capital depreciation rate.
IMF Structural Adjustment Programmes (SAP)	Indicates conditional reforms from IMF lending.	SAP compliance is the amount received (USD millions) in favour of structural programmes.
Debt Service (DE)	Financial burden of repaying external and internal debt.	Total debt service as % of GDP.

and  $\varepsilon_i$  is the error term. *SP* shows the dependent variable social protection system, while other variables are explanatory: *CF* represents COP28 climate finance; *PH* is physical capital; *HU* is human capital; *GDPC* represents GDP per capita; *EGP* is the endogenous growth parameter consisting of technological growth, population growth and the depreciation of the fixed stock of capital; *SAP* represents the IMF structural adjustment programme; and *DE* is debt servicing. Details of all variables are given in table 2. This table provides a comprehensive overview of the variables concerned with the proxy used and detailed definitions and notation.

## Results and Discussion

This section contains the empirical findings of the study, which explores the topic with a primary focus on the relationship between COP28 Climate Finance (*CF*) and Social Protection (*SP*). The econometric findings of the study start from the descriptive statistics, correlation analysis, and regression outputs from Fixed Effects, Random Effects, and, finally, Two-Step System GMM models.

The results section is a comprehensive empirical picture of the dynamic influence of *SP* systems. The variables of the study assess the respective impacts of these systems on *SP* and on the differentiated effects of *CF* on low- and lower-income countries, as aggregated by the World Bank. The subsections below elaborate upon these findings, beginning with descriptive statistics and the correlation analysis.

### DESCRIPTIVE STATISTICS

The descriptive statistics provide a preliminary overview of the key variables. These variables offer insights into their central tendencies and variability across the sample. This section summarizes the descriptive statistics to help contextualize the *SP* and *CF* characteristics of the countries being studied.

Table 3 provides summary statistics for the variables concerned across the full sample of developing countries. *SP* has a mean value of 1.55, with a standard deviation of 0.49 on a scale from 1 to 2. The table measures the extent or strength of *SP* programmes (e.g. social safety nets, welfare coverage). The mean value suggests that, on average, countries in the sample are at a moderate level of social protection, closer to well-developed systems than to minimal ones. COP28 *CF* averages 41.88 units, but with moderate variability (Std. Dev. = 66.62), ranging from 0.20 to 725.22 units. A high standard deviation indicates large disparities. Some coun-

tries receive substantial climate finance (up to 725.22), while others contribute or benefit very little (minimum 0.20). This reflects uneven global access to climate funds.

Physical capital has a mean of 26.37 and a standard deviation of 8.62, also showing moderate levels of physical capital investment. The physical infrastructure and productive assets suggest moderate capital intensity. The wide range (8.93–60.06) shows that some developing economies are highly capitalized, while others still face underinvestment in infrastructure. Human capital averages 2.37, with some variability (Std. Dev. = 0.61). Human capital measures the education, skills, and health quality of the labour force. The mean value (on a typical 1–4 index scale, e.g. Penn World Table's Human Capital Index) implies moderate human capital development, development that is neither very low nor high. The range (1.14–3.60) highlights significant differences in workforce quality among developing economies.

GDP per capita shows substantial variation, with an average of 3,175.83 USD and a standard deviation of 2,780.71. These figures reflect the average income level of the population, figures which suggest that the sample mainly includes lower-middle-income countries. The large variation in GDP per capita (462–12,132 USD) shows economic heterogeneity, from low-income to upper-middle-income developing economies. The endogenous growth parameter has a mean of 9.89, with a standard deviation of 1.72. As a proxy for total factor productivity (TFP) indicates moderate endogenous growth parameter (EGP) across the sample, with some variation (6.46–15.39); this suggests that innovation and internal growth dynamics differ widely between countries.

IMF SAP averages 8.75, with minimal variation (Std. Dev. = 0.60). The IMF Structural Adjustment Programme implies that there is relatively high participation in IMF structural adjustment policies. It also shows that most countries are moderately to strongly engaged in such programmes. Debt servicing averages 7.67, with significant variability (Std. Dev. = 7.01), which indicates that most countries maintain manageable debt burdens, but some face significant debt servicing pressures. A wide range (0.15–44.02) shows that debt servicing potentially constrains the fiscal space for social and climate-related spending.

The values of skewness and kurtosis indicate that all variables fall within the accepted thresholds for normality. Skewness values for all indicators range between –0.49 and 0.44. This is an indication that distributions are largely symmetric with no meaningful left or right skew. The

TABLE 3 Descriptive statistics: COP28 Climate Finance (CF) and Social Protection (SP) System (Full Sample)

Variable	Observations	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
Social Protection (SP)	608	1.55	0.49	1.00	2.00	0.35	2.82
COP28 Climate Finance (CF)	608	41.88	66.62	0.20	725.22	-0.01	3.45
Physical Capital (PH)	608	26.37	8.62	8.93	60.06	0.07	2.76
Human Capital (HU)	608	2.37	0.61	1.14	3.60	0.23	3.21
GDP Per Capita (GDPC)	608	3,175.83	2,780.71	462.4	12,132.9	-0.49	2.73
Endogenous Growth Parameter (EGP)	608	9.89	1.72	6.46	15.39	0.16	3.02
IMF Structural Adjustment Programme (SAP)	608	8.75	0.60	7.17	10.38	0.18	2.99
Debt Service (DE)	608	7.67	7.01	0.15	44.02	0.44	3.03

normal ranges for the skewness value is  $-0.5$  to  $+0.5$ . Likewise, kurtosis values fall between 2.73 and 3.45. These values also remain close to the theoretical value of 3 for a normal distribution and within the acceptable range of 2.5 to 3.5. Therefore, the dataset satisfies the standard assumptions of approximate normality.

The correlation matrix reveals that there are significant relationships between SP and other variables in the full sample of the study (see table 4). SP is positive and is significantly correlated with COP28 CF, having a coefficient value of 0.1057. This indicates that countries with better SP tend to receive more CF. There is also a positive correlation between SP and physical capital, which has a coefficient value of 0.1136, suggesting that higher SP is associated with greater physical capital investment. Similarly, a strong positive and significant correlation of 0.3525 shows that better SP is linked to higher levels of human capital.

GDP per capita is also associated positively with the SP system, with a coefficient value of 0.62. Countries focusing on better SP, in general, demonstrate higher economic progress. A positive correlation has been found between SP and the growth parameter. Its coefficient value is 0.11, implying that higher SP is associated with better growth parameters. For the IMF Structural Adjustment Programme, a negative correlation has been found. Its coefficient value is  $-0.14$ . This suggests that higher SP is

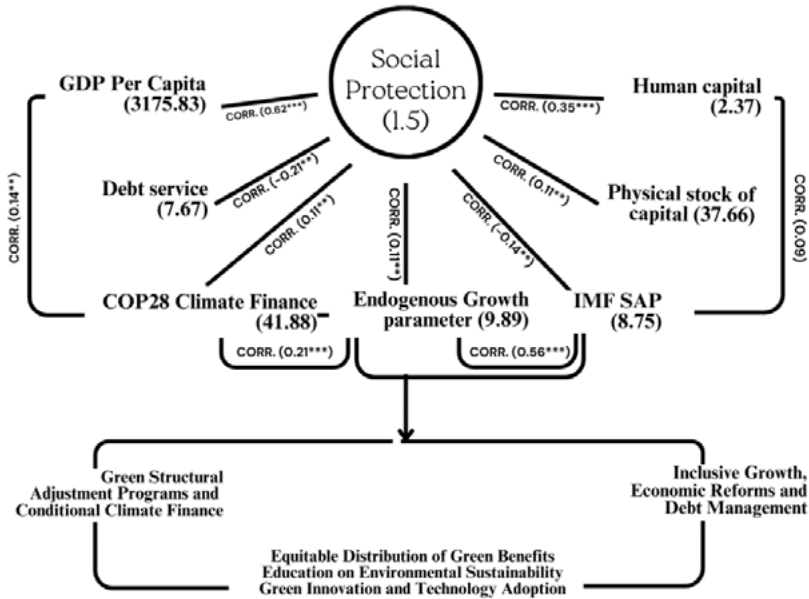


FIGURE 2 Visual Understanding of COP28 Climate Finance and Social Protection

linked to lower IMF SAP scores. Debt servicing also has a negative association with SP, as it has a  $-0.21$  coefficient value. From this, we can extract the notion that better SP is associated with lower debt servicing levels. Figure 2 is the graphical representation of variables with their mean and correlation coefficient values.

At the centre of the diagram is social protection, which includes systems such as healthcare, pensions, unemployment benefits, and safety nets. The figure highlights that improving SP in developing countries depends not just on direct financial resources but also on broader structural and policy-based dynamics.

**INSIGHTS FROM FIXED AND RANDOM EFFECTS MODEL**

In order to deal with fixed and random effects, table 5 was developed. The coefficient of COP28 CF is 0.0249 for fixed effects and 0.0164 for random effects, with standard errors of 0.0284 and 0.0207, respectively. An increase in CF improves Social Protection; the coefficient is not significant, revealing that it does not cause a meaningful impact on social protection. The contribution of physical capital is significant, with values of 0.0062 for fixed effects and 0.0044 for the random effects model. The coefficient value of human capital is both positive and significant.

TABLE 4 Correlation Matrix

Matrix	Social protection (SP)	Climate Finance (CF)	Physical capital (PH)	Human Capital (HU)	GDP Per Capita (GDPC)	Endogenous Growth Parameter (EGP)	IMF Structural Adjustment Programme (SAP)	Debt Service (DE)
Social protection (SP)	1							
Climate Finance (CF)	0.1057**	1						
Physical Capital (PH)	0.1136**	0.0559	1					
Human Capital (HU)	0.3525***	0.2818***	-0.0501	1				
GDP Per Capita (GDPC)	0.6174***	0.1394***	0.0929**	0.4328***	1			
Endogenous Growth Parameter (EGP)	0.1148**	0.2133***	0.1607**	-0.0145	0.3411***	1		
IMF Structural Adjustment Programme (SAP)	-0.1443**	0.1238**	-0.0648	0.0927*	0.3110***	0.5558***	1	
Debt Service (DE)	-0.2144***	-0.0847**	-0.2313***	0.0385	0.0833**	-0.0954**	0.1207**	1

NOTE \*\*\*, \*\*, \* show the significance at 1%, 5% and 10%, respectively.

In a comparative analysis, the coefficient value of human capital is greater than that of physical capital. This indicates that improvement in education and skills exerts a stronger influence on social protection outcomes than infrastructure investment does. Enhancing human capital is therefore pivotal to maximizing the developmental impact of climate finance in developing economies, considering that, among all of the explanatory variables, GDP per capita exhibits the highest and statistically most significant coefficient. This suggests that income level exerts the strongest effect on the dependent variable. In contrast, the endogenous growth parameter and the IMF SAP programme are statistically insignificant, while debt servicing is significant. Both the IMF Structural Adjustment Programme and Debt Servicing have negative impacts on Social Protection.

TABLE 5 Impact of COP28 Climate Finance on Social Protection (Full Sample): Fixed Effects/Random Effects (Dependent Variable: Social Protection Index)

Variables	(1)	(2)
	Fixed Effect	Random Effect
COP28 Climate Finance (CF)	.0249 (.0284)	.0164 (.0207)
Physical Capital (PH)	.0062 (.0022)**	.0044 (.0017)**
Human Capital (HU)	.0311 (.0576)	.0357 (.0269)
GDP Per Capita (GDPC)	.6413 (0941)***	.4341 (.0513)***
Endogenous Growth Parameter (EGP)	.0015 (.0203)	.0003 (.0106)
IMF Structural Adjustment Programme	-.0055 (.0416)	-.0452 (.0295)
Debt Service (DE)	-.0096 (.0030)**	-.0064 (.0021)**
Social protection (-1)	.2781 (.0406)***	.4383 (.0371)***
Constant	3.2265 (.4267)***	1.9394 (.2595)***
Observations	608	608
R-squared	0.28	0.26
Wald Chiz	18.70	35.50
No. of countries	32	32

NOTE \*\* ( $p < 0.05$ , significant at 5% level); \*\*\* ( $p < 0.01$ , significant at 1% level).

This finding reflects a fiscal reality, one in which increased public debt and austerity measures have constrained developing countries' ability to expand social protection, despite the growing demand for safety nets during and after the pandemic. Hence, we believe that the pandemic not only heightened vulnerability but also led to increased borrowing, resulting in fiscal tightening that continues to affect the capacity of states to invest in social welfare (Choong and Firouz 2020).

#### THE IMPLICATION OF ROBUST ANALYSIS (SYSTEM GMM)

In order to build the connection between the conceptual framework (fig. 1) and the empirical strategy, it is important to highlight how the conceptual pathways work. These pathways are translated into measurable econometric components, Two-Step System GMM approach. This approach deals with the primary channels like direct financing, indirect economic transmission through physical and human capital, and institutional mediation. These channels correspond to the variables included in the GMM models. They are: CF captures the direct financing pathway; PH, HU, GDPC, and endogenous growth parameters operationalize the indirect economic mechanisms. On the other hand, SAP and DE reflect the institutional and fiscal constraints. All of these shape the realization of climate-finance-driven social protection. The significant coefficient in the GMM result represents empirical validations. They demonstrate conceptual mechanisms discussed in figure 1 in the context of developing economies and which remain constrained due to institutional or fiscal bottlenecks.

Table 6 demonstrates the results of Two-Step System GMM, where the dependent variable is the SP index. COP28 CF positively contributes to the SP system. Of 11 specifications (see complete discussion of specification in the notes of table 6), 7 models prove the significant relation of SP, with ranges between 0.0150–0.0440. This shows that a 1 percent increase in CF is associated with a 0.0150 to 0.0440 percent increase in social protection, with different specifications, holding other variables constant. Although the change in SP is too small, the CF has a potential that can be directed towards adaptation and mitigation. It may also strengthen social resilience, e.g. through job creation in green sectors and community adaptation projects. However, the impact is often indirect, as the coefficient is small, reflecting issues such as inefficiency in fund allocation and the institutional constraints of developing economies (Davies et al. 2012).

TABLE 6 Impact of COP28 Climate Finance on Social Protection (Full Sample): Two-step sys GMM (Dependent Variable: Social protection index)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
COP28 Climate Finance (CF)	.0325 (.0256)	.0315 (.0079)***	.0166 (.0260)	.0413 (.0269)	-.0438 (.0224)*	.0430 (.0221)*	.0158 (.0264)	.0417 (.0256)	.0239 (.0114)*	.0145 (.0409)	.0282 (.0369)
Physical Capital (PH)			.0018 (.0027)**	.0012 (.0016)		.0011 (.0005)*		.0015 (.0008)*	.0019 (.0006)***		.0017 (.0011)
Human Capital (HU)	.1028		.1022		.1188	.12143	.0946		.1139		.1096
GDP Per Capita (GDPC)		.5672	.5117	.4500	(.0396)***	(.0654)	(.0462)*	.4219	(.0474)**	.5970	(.0548)*
Endogenous Growth Parameter (EGP)		(.1890)***	(.2559)*	(.1927)*		.0176 (.0104)	.0175 (.0063)**	(.2343)	(.2065)**	(.2223)**	(.2195)**
IMF Structural Adjustment Programme	-.0251			-.0107	-.0343		-.0378		-.0297	-.0343	-.0144
Debt Service (DE)			.0422 (.0134)*		(.0057)	(.0114)**	(.0252)		(.0149)*	(.0553)	(.0624)
Developing country		-.0401 (.0134)*			-.0428 (.0472)		-.0360 (.0463)	-.0041 (.0022)*		-.0045 (.0031)*	-.0044 (.0036)
Upper Middle Income										.2380 (.0959)**	
Social protection (-1)	-.7859 (.0518)***	-.7866 (.0505)***	-.7245 (.0738)***	-.7450 (.0603)***	-.7905 (.0552)***	-.7960 (.0522)***	-.7399 (.0743)***	-.7812 (.0561)***	.6796 (.0782)***	.4834 (.0848)***	-.5678 (.0647)***

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Constant	.2694 (.0848)*	.2225 (.1002)*	.6289 (.2206)**	.2540 (.1206)**	.4355 (.1595)*	.4212 (.1468)**	.5918 (.2216)**	.4839 (.1571)**	.6791 (.2200)**	1.1432 (.5327)**	.7057 (.5833)
Observations	576	576	576	576	576	576	576	576	576	576	576
Number of Groups	32	32	32	32	32	32	32	32	32	32	32
F /Wald test	126.48	91.91	141.81	103.62	74.62	95.13	126.45	93.72	136.91	62.47	63.25
Arellano-Bond test (AR1) Test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Arellano-Bond test (AR2) Test	0.443	0.438	0.420	0.535	0.426	0.450	0.394	0.417	0.527	0.707	0.622

NOTES: \*\*\*, \*\*, \* show the significance at 1%, 5% and 10%, respectively. Parenthesis () shows the robust standard errors in the model. The 11 models collectively test whether the results are consistent and reliable across different model forms.

- Model 1: Measures the unconditional impact of climate finance on SP along with role of human capital.  $SP = (CF, HU, IMF, SP_{t-j})$ .
- Model 2: Captures economic development and fiscal effect effects.  $SP = (CF, GDP_C, EGP, DE, SP_{t-j})$ .
- Model 3: Establishes core economic specification.  $SP = (CF, PH, HU, GDP_C, EGP, DE, SP_{t-j})$ .
- Model 4: Deals with the Institutional reform influence on SP.  $SP = (CF, PH, GDP_C, IMF, SP_{t-j})$ .
- Model 5: Considers all endogenous growth parameters (technological growth, depreciation rate and population growth rate) at once. It incorporates long term growth mechanism.  $SP = (CF, HU, EGP, IMF, DE, SP_{t-j})$ .
- Model 6: Measures persistence of social protection outcome as in the previous and succeeding model through lagged value of SP. Additionally, it considers primary growth variables PH and HU along with endogenous growth mode.  $SP = (CF, PH, HU, EGP, SP_{t-j})$ .
- Model 7: Addresses the key pillars of the economy, human development (HU), role of institutional (IMF) and fiscal stability measures (DE).  $SP = (CF, HU, EGP, IMF, DE, SP_{t-j})$ .
- Model 8: Incorporates economic development (GDP\_C) and fiscal measures (DE).  $SP = (CF, PH, GDP_C, EGP, DE, SP_{t-j})$ .
- Model 9: Idealizes the core theme in one frame.  $SP = (CF, PH, HU, GDP_C, IMF, SP_{t-j})$ .
- Model 10: Investigates the Country-group-specific effect for upper middle income countries (higher absorptive capacity).  $SP = (CF, GDP_C, EGP, IMF, DE, UMI, SP_{t-j})$ -UMI- Upper middle income countries.
- Model 11: Highlights the coefficient for developing countries while taking into account the other core variables.  $SP = (CF, PH, HU, GDP_C, IMF, DE, SP_{t-j})$ -DC- Developing countries.

The agenda of COP28 focused on climate mitigation and adaptation projects. It helps in implementing policies that improve environmental sustainability and that are resilient to climate change. However, it stimulates other economic indicators due to the multiplier effect and therefore contributes to the welfare of the society. From a policy perspective, these findings highlight that climate finance alone is insufficient to improve social protection outcomes. It needs support through stronger governance frameworks and better integration of climate and social policy planning. Policymakers should focus on improving transparency in fund allocation. A practice that designs climate finance instruments that explicitly incorporate social protection components is indispensable. This includes linking adaptation projects with social safety nets and ensuring that climate finance delivery mechanisms are prioritized. Such steps could further amplify the social returns to COP28-aligned climate finance (Hassan et al. 2024).

While physical capital shows a significant and positive relationship with the SP system, this ranges between 0.0011 to 0.0019, which is a small contribution towards the SP system. Resources and infrastructure are related to the physical stock of capital that is vital for the delivery of the effective implementation of the SP system (Nosheen et al. 2021). Physical capital supports SP through healthcare infrastructure, educational programmes, and emergency aid, helping to distribute them efficiently to the most vulnerable sections of the population. Physical capital also contributes to poverty reduction and social equity.

Human capital also significantly contributes towards SP, corresponding to an average 0.1069 percentage change in social protection. This demonstrates that human capital empowers SP through skills, education, and the health of the targeted population. It builds the capacity to secure jobs, increase productivity, and achieve economic self-resilience. Research proves that a well-educated and skilled labour force is more resilient to economic shocks (Hidrobo et al. 2018; Devereux 2021).

Similarly, GDP per capita has a positive and significant relation with SP, and the coefficient value ranges between 0.4219 and 0.5970. As GDP per capita increases, people have more money to avail themselves of quality education, good health, and an improved standard of living, all of which are determined by the SP system. Higher income levels also tend to encourage more sustainable consumption patterns, such as investing in environmentally friendly or energy-efficient products, which indirectly support climate resilience and long-term social well-being. The endoge-

nous growth parameter value ranges between 0.0175 and 0.0192, showing also a modest but positive and significant influence on social protection. This implies that higher endogenous growth is driven by internal factors, like innovation, demographics, and capital usage, which can support and enhance SP systems in developing economies.

In considering the components, this study suggests that technological and population growth rates are the dominant factors behind the positive effect. This reflects the fact that working-age population growth increases lead to greater demand for expanding SP, especially for vulnerable groups. Technological growth also enhances productivity. Policy-makers should thus capitalize on demographic trends by aligning population growth with expanded technological growth and with human capital investment and targeted SP programmes.

The IMF Structural Adjustment Programme is negatively correlated with SP as it poses an extra burden for economically weak economies by repaying the extra cost of outstanding debt. In the wake of this programme, the recipient countries implement austerity measures, such as reduced public expenditure, thus cutting subsidies. These conditions are not favourable to SP as they reduce countries' fiscal space and divert resources from welfare programmes towards debt servicing and deficit control (Razavi et al. 2021; Bianchino 2019). The coefficient value ranges between  $-0.0107$  to  $-0.0378$ , with an effect on social protection. Debt servicing also has a negative impact on the SP system, having a coefficient value that ranges between  $-0.0041$  and  $-0.0428$ . Increased debt servicing consumes a significant portion of the public budget and leaves limited fiscal capacity for investment in health, education, and income support, thereby weakening the foundations of SP systems.

#### INSIGHTS FROM LOW-INCOME COUNTRIES

Table 7 is the overview of the nexus between COP28 CF and SP for low-income countries. For these countries, the coefficient is negative, showing that COP28 CF does not translate into improved SP outcomes. The possible reason for this is that CF may be channelled more towards environmental or mitigation projects with limited short-term social benefits. It also reflects deeper institutional and fiscal weaknesses. These weaknesses create a bridge that constrains the climate resources into social protection gains. Thus, it inhibits the integration of climate funding into national social protection strategies. Additionally, fragmented governance structures reduce absorptive efficiency. Even though climate

TABLE 7 Impact of COP28 Climate Finance on Social Protection in Low-Income Countries (Disaggregated analysis; Dependent Variable: Social protection index)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
COP28 Climate Finance (CF)	-.0126 (.0366)	-.0644 (.0263)**	-.0084 (.0467)	-.0261 (.0552)	-.0105 (.0035)***	-.0510 (.0399)
Physical Capital (PH)	.0018 (.0028)		.0028 (.0040)	.0014 (.0007)*		.0001 (.0056)
Human Capital (HU)		.0155 (.0572)*	.0123 (.0683)	.0195 (.0108)		.0142 (.0093)
GDP Per Capita (GDPC)	.3957 (.1884)*		.4749 (.2385)	.3538 (.4282)	.3100 (.1551)*	
Endogenous Growth Parameter (EGP)	.0001 (.0000)	.0001 (.0000)	.0002 (.0000)			
IMF Structural Adjustment Programme				-1.1309 (.0881)	-.2417 (.0926)*	-.0183 (.1220)
Debt Service (DE)		.0555 (.0179)***		-.0062 (.0054)	-.0053 (.0027)*	-.0175 (.0092)*
Social protection (-1)	.6749 (.0857)***	.5431 (.1340)**	.6218 (.1247)**	.5017 (.0971)***	.4521 (.2261)*	.4794 (.1291)**
Constant	.5189 (.2055)**	1.2001 (.3538)**	.5326 (.2482)**	2.0295 (.7837)**	1.5248 (.6353)**	1.5926 (1.1056)
Observations	360	360	360	360	360	360
Number of Groups	20	20	20	20	20	20
F/Wald test	22.46	50.86	17.89	13.90	15.01	18.41
Arellano-Bond test (AR1) Test	0.001	0.002	0.001	0.001	0.002	0.003
Arellano-Bond test (AR2) Test	0.664	0.681	0.715	0.738	0.437	0.471

NOTES \*\*\*, \*\*, \* show the significance at 1%, 5% and 10%, respectively. Parenthesis ( ) shows the robust standard errors in the model.

- Model 1 is the baseline GMM with core variables (CF, PH, HU, GDPC) focusing on core impact of climate finance  $SP = (CF, PH, GDPC, EGP, SP_{t-1})$ .
- Model 2 focuses on fiscal factors and add control variable debt service.  $SP = (CF, HU, EGP, DE, SP_{t-1})$ .
- Model 3 focuses on complementarity effect considering the human capital.  $SP = (CF, PH, HU, GDPC, EGP, SP_{t-1})$ .
- Model 4 deals with the complementarity effect without accounting for the EGP explanatory variable.  $SP = (CF, PH, HU, GDPC, IMF, DE, SP_{t-1})$ .
- Model 5 excludes both primary variables of endogenous growth PH and HC while considering institutional factors like the IMF structural adjustment programme.  $SP = (CF, GDPC, IMF, DE, SP_{t-1})$ .
- Model 6 focuses on both institutional, fiscal variables and endogenous growth model variables along with core impact of climate finance.  $SP = (CF, PH, HU, IMF, DE, SP_{t-1})$ .

funds are available, they are not effectively aligned with community-level social needs. Another factor is the high debt-servicing burdens and compressed fiscal space. Both of these prevent governments from providing the financing required to leverage climate finance for social outcomes. In conclusion, both institutional and fiscal bottlenecks explain why climate finance fails to deliver positive social protection effects in low-income economies (Grigoryev et al. 2020).

Physical capital has a positive relation with SP, although its effect is small. To increase its scope in a wider context emphasizes healthcare access and educational programmes that are vital as social safety nets. The coefficient for human capital is also positive in low-income economies, with the implication that higher investment in human capital is associated with enhanced SP (Kamb 2020; United Nations Department for Economic and Social Affairs 2013). Spending on human capital, if targeted efficiently, serves SP in these economies. GDP per capita has a positive and significant association with SP, confirming that economic development supports welfare programmes in low-income countries. Debt servicing crowds out the SP budget, based on country-specific debt management. This shows that there is a need for debt relief, restructuring, or debt-for-social-protection swap programmes, to ensure fiscal space.

This becomes particularly urgent in the post-COVID-19 context, as the pandemic significantly increased public debt levels and exposed institutional weaknesses in SP systems across low-income countries. The crisis created heightened demands for support, yet many governments faced constrained fiscal space and competing budgetary priorities, limiting their ability to absorb or effectively channel CF towards social outcomes (Zahariev et al. 2021). Accordingly, we believe that strengthening institutional frameworks and ensuring better policy coherence between CF and SP becomes essential to translating international environmental commitments into tangible social welfare improvements.

### **Conclusions and Policy Implications**

This study is based on the empirical analysis of the Social Protection (SP) system and COP28 Climate Finance (CF). The findings are supported by the Two-Step System GMM analysis for developing economies. CF, especially from the COP28 perspective, positively influences social protection. This suggests that CF has the potential to improve the SP of the developing economies. CF can act as a lever for social resilience, as it not only contributes towards climate mitigation and adaptation, but

also towards co-benefits, like poverty reduction, job creation, and social stability.

CF can serve as an indirect enabler of SP systems, especially when linked to green job programmes (e.g. renewable energy employment), climate-resilient infrastructure (e.g. health centres, shelters), and cash transfer schemes that are tied to climate adaptation. Two prime determinants of growth in both physical and human capital also play significant roles in strengthening the SP system. Physical capital has a modest impact; it ensures the infrastructure necessary for the effective delivery of welfare services.

On the other hand, human capital demonstrates a stronger influence, indicating that investments in education and health enhance the resilience and productivity of the population, which are necessary for the SP system. Additionally, GDP per capita also contributes positively to SP, emphasizing that broader economic growth can support welfare expansion. By contrast, IMF Structural Adjustment Programmes and debt servicing are detrimental to social protection. They act as fiscal constraints that limit the government's ability to invest in welfare systems. There is thus a decline in long-term social development goals.

The analysis for low-income countries reveals that the relationship between COP28 CF and SP is complex. The negative coefficient for CF implies that such funding does not effectively translate into improved SP outcomes. The situation is coupled with weak institutional capacity and insufficient integration between environmental and social policies. It is thus necessary to prioritize long-term environmental and mitigation projects over immediate SP needs. Physical capital and GDP per capita remain positively associated with social protection. However, debt servicing has a negative association with social protection. The necessity for debt relief, restructuring, or innovative mechanisms like debt-for-social-protection swaps to expand fiscal space thus increases.

The study provides a policy framework that can leverage CF for integrated development goals, especially social protection. Firstly, policy-makers should align CF with national social priorities. The way to reach out with these priorities is to integrate SP objectives into climate adaptation and mitigation projects. Then, climate funds will yield direct socio-economic benefits, such as job creation, health improvements, and educational access. In order to maximize the impact of CF, governments need to improve institutional capacity (financial institutions).

The findings align with the argument that climate finance and social protection priorities should be based on strengthening institutional capacity. Governments should also develop expenditure frameworks that integrate climate finance, which focus on welfare programmes that enable co-financing. For developing economies, debt servicing pressures significantly constrain the effectiveness of climate finance. Thus, a transformative role can be played through debt-for-social-protection or debt-for-climate swaps. However, in order to align the objective of social protection with COP28 climate finance frameworks, improved transparency in fund distribution should be ensured. Such measures would ensure support of climate finance for an equitable social development across all country groups.

Taking into account the findings for the full sample, the empirical analysis advocates a strong and significant influence of human capital on the SP system. Investment in education and public health should be a cornerstone of national strategies. A skilled workforce contributes to economic productivity, along with building long-term resilience against economic and environmental shocks. The physical stock of capital also plays a crucial role in the process of SP and welfare delivery. The state should thus prioritize infrastructure that supports health systems, schools, emergency response mechanisms, and digital platforms to deliver targeted benefits, especially in rural and vulnerable areas. SP systems and economic growth are conducive to each other. As countries become economically prosperous, the fiscal space expands, making it easier to finance a comprehensive welfare system. It would thus be preferable to make a country economically strong and to gain the benefits of the full potential of the determinants of growth, like human and physical capital. Furthermore, policymakers should use this demographic trend and technology (endogenous growth parameters) as a development opportunity. The growing population and rapid technological growth rate can play their role in expanding long-term sustainability. On the other hand, the IMF Structural Adjustment Programme and debt servicing are burdens that should be reconsidered, or austerity measures should be taken that do not compromise welfare budgets.

Taking into account the negative influences of COP28 CF and SP in low-income countries shows that climate funds are often not aligned with social outcomes. It is thus compulsory for policymakers to reframe CF into explicit SP objectives. This policy objective should ensure that funds also generate immediate and tangible social benefits. Financial in-

stitutions can be the main players in this integration, where the SP performance framework confirms the opportunity offered by multidisciplinary benefits.

The policy implications of COP28 climate finance for developing economies extend beyond environmental mitigation. It highlights the critical opportunities and challenges for social protection. Climate finance can potentially strengthen social safety nets and enhance resilience among vulnerable populations; however, it faces multiple constraints that need to be addressed. The practical implementation, including limited institutional capacity, fragmented governance, and competing development priorities, is one of them. As one of the main characteristics of COP28, climate finance is intended to limit global warming and promote low-carbon alongside climate-resilient development, contributing toward social safety. Unfortunately, COP28 climate resources are frequently allocated to large-scale mitigation projects, leaving social protection and adaptive programmes underfunded. To maximize the social impact of climate finance, policymakers must prioritize integrating climate initiatives with social protection strategies. Investment in local capacity-building and enhanced coordination across sectors ensures that the financial flows not only address climate goals but also safeguard the livelihoods and well-being of at-risk communities.

The current study has some limitations that also present promising directions for future research. First, although the Two-Step System GMM provides robust empirical insights, the analysis relies primarily on macro-level panel data. This approach has various constraints that may overlook country-specific institutional dynamics and regional disparities. The implementation of micro-level challenges within social protection systems is a limitation of the study. Future studies could employ micro-level household data. Or it can be expanded to regional case studies or mixed-method designs to capture the social protection and climate finance mechanisms more accurately. Second, the limited significance of climate finance in some model specifications suggests potential measurement constraints. They are supposed to have lagged effects that may require a longer gestation period to materialize the impacts of climate finance on social protection. This opens avenues for longitudinal studies or subnational analyses. Last but not least, future research should explore innovative financing tools such as debt-for-social-protection swaps. In comparative or country-level frameworks, it will help to ex-

plore the potential for expanding fiscal space and strengthening social resilience.

### Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### **Appendix: Key Global Indicators Related to Social Protection Coverage and Financing**

Indicator	Details
Global Population Unprotected	50% (Approximately 4.1 billion people) remain unprotected.
World Bank Financing (as of February 2024)	\$29 billion in total financing for social protection and jobs programmes.
Estimated Working-Age Population Increase (2019–2035)	700 million people.
Average Cost of Social Protection Programmes	About 1.5% of GDP.