Does Fiscal Policy Shape Gender Equity? An Analysis of Infrastructure Investments

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1 INTRODUCTION

Gender inequality is not one homogenous phenomenon, but a collection of disparate and inter-linked problems. (Amartya Sen, 2001: p.466)

Over the past few decades, gender inequality has remained a central concern for many countries across the globe. It has been a key focus within international development discourse, attracting significant attention to both gender-equal outcomes and the broader implications of gender inequity for development, economic performance, and well-being.

A central strand of this focus concerns how governments, through macroeconomic policy, can advance gender equality in opportunities and outcomes, moving beyond the microeconomic domain to address structural and distributional issues at the macro level. In this regard, several scholars, including Sen (1995), Klasen (2000), Duflo (2005), and Abramovsky and Selwaness (2023), have examined the impact of public policy on equitable income distribution, particularly as it affects women. This inquiry is far from misplaced, given that one of the core objectives of fiscal policy is to promote efficiency, fairness, and equity in resource allocation and income distribution.

Despite this increased focus and the considerable progress achieved over the past two decades, progress towards gender parity remains uneven across countries. Significant divergences persist between high-, middle-, and low-income contexts, with the greatest challenges often observed in women's economic participation and political empowerment, particularly in middle- and lower-income economies (Abramovsky and Selwaness, 2023). Middle-income countries, for instance, continue to face structural constraints similar to those observed in low-income countries where persistent inequalities are reflected in women's limited access to education, high maternal mortality rates, and barriers to labour market entry and advancement.

These varying degrees of gender inequality across income levels highlight the distinct structural and institutional challenges that countries face at different stages of development. Gender inequality manifests in complex, context-specific ways, ranging from cultural norms and institutional biases to gaps in access to resources and representation. While high-income countries are not exempt from these challenges, the mechanisms through which inequality operates often differ, at times producing more subtle yet enduring disparities. The existing literature has provided extensive insights into how fiscal and economic policies influence gender outcomes, though much of this work remains concentrated on labour market indicators such as female labour force participation, wage disparities, and women's integration into global markets.

This study extends the analysis by examining gender inequality as a multidimensional construct, drawing from the sociological and feminist economics literature that conceptualises gendered well-being in terms

of capabilities, livelihoods, and empowerment. Rather than viewing gender equity solely through the lens of economic participation, this approach considers the enabling conditions that allow such outcomes to materialise. Following Robeyns (2005), capabilities are defined as the human abilities necessary to access and maintain good living conditions. Enhancing women's capabilities is therefore central to improving their economic performance and participation in productive life.

In this context, we focus on how fiscal and macroeconomic policies influence women's capabilities, which in turn affect their livelihoods, defined here as the tangible opportunities to generate income, access employment, and participate in economic life. We further incorporate empowerment, recognising that the role of infrastructure extends beyond access to education or work opportunities to encompass agency and decision-making power. Women's Economic Empowerment and Agency (WEEA) is defined here as the collective ability of women to shape decision-making in productive (e.g., managerial) roles, political spaces, and within the household. This definition follows Eyben et al. (2008), who describe empowerment as "the capacity of poor women and men to participate in, contribute to, and benefit from growth processes on terms which recognise the value of their contributions, respect their dignity, and make it possible for them to negotiate a fairer distribution of the benefits of growth."

Another contribution of this paper lies in its broad comparative analysis across a diverse panel of countries, where we stratify the analysis by income level to account for institutional structures and differing stages of development. This approach enables us to examine how various components of macroeconomic policy, particularly fiscal policy, affect distinct dimensions of gender equality and outcomes. In doing so, the paper seeks to identify the channels and transmission mechanisms through which fiscal policy interacts with structural and institutional contexts to shape gendered outcomes. Rather than assuming a uniform relationship between fiscal policy and gender equity, we highlight the nuanced and context-dependent nature of these interactions.

To achieve this, we distinguish between two key categories of public expenditure—social infrastructure spending and physical infrastructure spending. This distinction is analytically significant, as previous studies (e.g. Onaran et al., 2023) have shown that public investment in social infrastructure and the care economy can have substantial employment effects with clear gender-differentiated outcomes, particularly in emerging economies. Such distinctions are vital in understanding the sectoral composition of fiscal policy and its implications for gender equality.

Within the feminist macroeconomic tradition, labour is conceptualised as a produced means of production; from this perspective, reproductive and care work which is predominantly undertaken by women therefore constitutes a fundamental input into the functioning of the broader economy. As such, investments that reduce women's unpaid care burden and expand their productive capabilities can thus enhance private sector productivity and aggregate output, rendering such expenditure an investment rather than a consumption cost.

Conventionally, government spending has often been classified as either "productive" or "non-productive," with social expenditure (e.g. spending on health, education, and care) typically regarded as the latter. However, within the feminist macroeconomic tradition, social spending that alleviates gender constraints and expands women's capabilities is viewed as an investment rather than a cost, and as such social expenditure is therefore economically productive, particularly when we recognise that labour, especially reproductive and care work, disproportionately undertaken by women, constitutes a *produced means of production*. Consequently, investment in women's capabilities through social infrastructure may be vital in enhancing overall productivity and macroeconomic performance, rendering the conventional distinction between productive and non-productive expenditure analytically untenable.

This study, as such, provides an important contribution to the literature by introducing novel indicators of women's capabilities, livelihoods, and empowerment using a dynamic factor analysis framework. In doing so, it extends the empirical discourse on fiscal policy and gender equality through a multidimensional lens that captures both structural and temporal relationships. The methodology employed combines

Dynamic Factor Analysis (DFA) for the construction of time-varying latent variables with a Common Correlated Effects (CCE) threshold autoregressive distributed lag (ARDL) model. This approach allows for the examination of both the long-run equilibria and short-run dynamics of fiscal policy impacts on gendered outcomes. As such, we are able to explore how fiscal policy influences the different dimensions of gender equality, while also engaging in structural analysis to uncover how variations in the sectoral composition of public spending (particularly between social and physical infrastructure) shape these outcomes. The remaining part of this study, as such, explores the broader context, theoretical foundations, and methodological framework that underpin this analysis, followed by the empirical estimation and interpretation of results.

2 THE DISTRIBUTIONAL EFFECTS OF PUBLIC EXPENDITURE

Fiscal policy is central to shaping the distributional outcomes within an economy, but debates surrounding its optimal implementation remain contentious among economists and policymakers. The dichotomy between neo-classical and Keynesian economic thought underscores these debates. Neo-classical economists often advocate for reduced government expenditure, asserting that market forces allocate resources most efficiently (McCreadie and Smith, 2009). Conversely, Keynesian economists argue for the necessity of government intervention, particularly during economic downturns, to correct market failures, stimulate aggregate demand, and promote economic growth.

This debate is mirrored in empirical research, which has produced mixed results regarding the relationship between public expenditure and economic growth. For example, studies by Afonso and Jalles (2014) and Hakro (2009) demonstrate a positive correlation between public expenditure and GDP per capita across various countries. On the other hand, Slemrod et al. (1995) report a negative association between increased public expenditure and real GDP per capita, highlighting the complexities of this issue. A review by Huidrom et al. (2018) further illustrates the variability of these findings across different economies.

Furthermore, the literature has also focused on the composition of government expenditure as a determinant of its impact on economic growth. Earlier works, such as those by Barro and Sala-i-Martin (1995) and Easterly and Rebelo (1993), argue that government spending on productive activities—such as infrastructure and education—significantly enhances economic growth, while spending on non-productive activities may have negligible or even adverse effects. This perspective contrasts with development literature, which suggests that even expenditures traditionally deemed non-productive, such as those on social infrastructure, can yield positive long-term growth outcomes.

In recent years, this traditional view has been increasingly challenged. Feminist economics and other critical perspectives argue that investments in social infrastructure are crucial for human capital development and macroeconomic performance. For instance, Bellentini and Ceroni (2000) assert that public social infrastructure expenditure stimulates human capital formation, driving improvements in economic outcomes. Empirical support for this view is provided by Belgrave and Craigwell (1995) and Jung and Thorbecke (2003), who find that increased public education spending positively impacts long-term economic growth. The work of Reljic and Zezza (2024) further reinforce the importance of social infrastructure, showing that such spending not only delivers long-term collective benefits but also boosts female employment in high-income countries like Italy.

Moreover, Enami et al. (2018) show that the redistributive potential of a country's fiscal policy is contingent on both the size and composition of government expenditure, as well as the mechanisms used to finance such spending. This aligns with theoretical considerations suggesting that fiscal policies can simultaneously reduce inequality and increase poverty, depending on how resources are allocated and

taxed across different income groups.Given the significance of government revenue and expenditure in shaping distributional outcomes, it is crucial to assess policy objectives against their potential impact on inequality and poverty. Social spending, in particular, may be more effective than physical infrastructure investment in achieving these goals. Mosley et al. (2004) demonstrate that higher levels of pro-poor expenditure are associated with reduced poverty, though not necessarily with enhanced economic growth. Similarly, Gomanee et al. (2005) find that public expenditure specifically targeted at poverty reduction can significantly improve economic welfare.

2.1 Public Expenditure, Macroeconomic Performance and the Gender Distribution of Well-Being

The impact of government expenditure on macroeconomic performance and the gender distribution of well-being has been increasingly examined in the literature. While traditional analyses of fiscal policy often overlook gendered impacts, a growing body of research highlights the nuanced ways in which fiscal interventions can differentially affect men and women, as well as various income groups.

Fiscal policy is typically viewed as a mechanism for promoting fairness and efficiency within society. However, its effectiveness in reducing income inequality is not straightforward, as fiscal interventions can have heterogeneous effects across different economic agents. For example, government expenditure directed at households can yield contrasting outcomes depending on the intra-household allocation of resources (Basu, 2006; IMF, 2005a; b). On a broader scale, fiscal policy influences trade balances and inflation, which can directly affect societal living conditions through realised income or wealth effects. These macroeconomic shifts may, in turn, have differential impacts on various social groups, including by gender, income, and class.

Several empirical studies have provided evidence that government expenditure can significantly promote economic growth. For instance, studies by Nuruden and Usman (2010), Al-Yousif (2000), Abdullah (2000), and Cooray (2009) suggest that increases in public spending, particularly in health and education, enhance labour productivity and contribute to economic growth. García, Meseguer, and Tuesta (2017) add to this body of evidence by showing how public expenditure on physical infrastructure can reduce costs for the private sector, thereby boosting investment and profitability, which in turn fosters economic development.

Despite these positive correlations between public expenditure and economic growth, the relationship between gender equality and economic performance remains complex. The World Economic Forum's 2017 Global Gender Gap Report warns that at the current pace, gender parity is unlikely to be achieved for another 217 years. This projection underscores the persistent challenge of addressing gender inequality globally. This concern is particularly pressing given the substantial body of research indicating that gender equality is integral to achieving sustainable economic growth and improved global health outcomes (Knowles et al., 2002; Klasen and Lamanna, 2009; Cuberes and Teignier, 2016). Although the direction of causality between gender equality and economic growth remains debated, empirical evidence suggests that improvements in women's educational attainment, health, and access to credit are key drivers of economic development and poverty reduction (Schultz, 2002; Löfström, 2009; Kabeer and Natali, 2013). Therefore, integrating gender considerations into macroeconomic policy is essential for fostering both economic growth and societal well-being.

Historically, macroeconomic policies were presumed to be gender-neutral, often overlooking the potential distributional impacts on different social groups. However, a growing body of literature now recognises how power dynamics within households influence resource allocation and how macro-level policies can alter these dynamics by producing different outcomes for men and women (Becker, 1974; Grossbard-Shechtman, 2001; Pollak, 2002). This recognition has significant implications for the design and effectiveness of fiscal policy, particularly in addressing gender inequalities. Although research on the gendered

impacts of fiscal policy is still developing, several key insights can be drawn from the existing literature. One of the primary objectives of fiscal policy is to stabilise employment levels, but due to entrenched gender norms in labour market participation, such policies may inadvertently affect the gender composition of employment. For example, during economic recessions, men are often more likely to lose their jobs, leading to the term "man-cessions" (Engemann and Wall, 2009; Contessi and Li, 2014; Bredemeier et al., 2017). Expansionary fiscal policies, commonly employed to counteract economic downturns, may create more job opportunities for women, particularly in sectors where they are overrepresented, such as healthcare and education (Fabrizio and Tsolmon, 2014). However, this is not always beneficial, as women may face increased overall labour burdens when they are forced to compensate for lost family income due to male job losses. This additional work, often at lower wages and under distressing conditions, can exacerbate gender inequalities, especially when considering the unpaid care work that women typically undertake (Seguino and Braunstein, 2019[1]). Moreover, fiscal spending on so-called "productive activities," such as infrastructure development, tends to favour male-dominated sectors like construction, potentially widening gender disparities. Conversely, austerity measures and budget cuts can have a disproportionate impact on women, particularly when these cuts target the social sector, which employs a higher proportion of women (Ertürk and Çağatay, 1995).

2.2 The Role of Social and Physical Infrastructure in Promoting Gender Equity

Social and physical infrastructure investments play a critical role in promoting gender equity and overall economic well-being. Investments in social infrastructure—such as education, healthcare, and social care services—are particularly effective in reducing the time burden of unpaid care work, increasing access to essential services, and enhancing overall well-being. Chakraborty (2022) and Onaran et al. (2023) argue that gender-responsive budgeting, which allocates resources to address gender-specific needs, can effectively narrow gender gaps in education, health, and employment, particularly in low- and middle-income countries. For instance, the provision of accessible healthcare and education not only boosts women's participation in the labour force (LF) but also improves their health outcomes and long-term economic prospects. These investments in social infrastructure are crucial for addressing the systemic barriers that women face in accessing economic opportunities, particularly in contexts where unpaid care work disproportionately falls on women.

Physical infrastructure investments, such as those in electricity, water, sanitation, and transportation, also have a significant impact on gender equality. For example, Dinkelman (2011) found that rural electrification in South Africa significantly increased women's employment by reducing the time spent on domestic chores. Similarly, Sedai et al. (2021) demonstrated that reliable electrification in India improved women's employment opportunities and reduced their time spent on unpaid home production. These findings highlight the importance of targeted infrastructure investments in addressing gender disparities and promoting economic participation.Also, findings by Rost and Koissy-Kpein (2018) for the Philippines, Uganda, and Zimbabwe highlight the importance of water infrastructure in enhancing women's economic participation and improving health outcomes. These studies suggest that by alleviating physical infrastructural problems, such as the burden of water collection as one example, women have more time to pursue education, work, and other activities that contribute to their economic and personal development.

Moreover, transportation and ICT infrastructure contribute to gender equity by improving women's mobility and access to economic opportunities. Inadequate transportation infrastructure in developing countries often limits women's mobility, restricting their access to education, healthcare, and employment. Research by Seki and Yamada (2020) in India found that proximity to metro stations significantly

[1]Seguino (2012) discusses how women's unpaid care work tends to increase during economic crises, intensifying their overall labour burden.

increased female employment rates, further emphasizing the role of transportation infrastructure in facilitating women's economic participation. Additionally, ICT infrastructure has the potential to bridge gender gaps in access to information and economic opportunities, as demonstrated by Venkatesh et al. (2017) in India and by Suri and Jack (2016) in Kenya.

2.3 Gender Budgeting in Developed and Emerging Economies

The relationship between gender equality, economic growth, and fiscal policy is complex and multifaceted. While economic growth is generally associated with improvements in gender equality, the effects are not always gender-neutral. In some cases, economic growth may exacerbate gender inequalities, particularly if growth-oriented policies do not explicitly address the specific needs of women and other marginalized groups (Onaran et al., 2019).

This bidirectional relationship between gender and economic performance necessitates a gender-sensitive approach to fiscal policy. Gender Responsive Budgeting (GRB), which has gained significant traction in recent decades, provides a framework for incorporating gender perspectives into fiscal policies. Originating in Australia in the mid-1980s, GRB has since been adopted in over 80 countries, with varying levels of complexity and scope (Rubin and Bartle, 2023). GRB involves the systematic analysis of government budgets to assess their impact on gender equality, ensuring that fiscal policies contribute to reducing gender disparities rather than reinforcing them.

Recent literature emphasises the importance of GRB in promoting gender equity. Abramovsky and Selwaness (2023) demonstrate that gender-focused fiscal policies, particularly in education and healthcare, can significantly reduce gender income gaps, especially in emerging economies. Gullo et al. (2024) highlight the role of gender-inclusive fiscal laws in promoting equitable access to infrastructure and public services, which are essential for enhancing women's economic opportunities.

The success of GRB in various contexts has been well-documented. In South Korea, gender budgeting initiatives have focused on reducing the burden of unpaid care work on women, thereby increasing their participation in the labour force (LF) (IMF Economic Outlook, 2017). In India and Rwanda, GRB has played a pivotal role in increasing female school enrolment and attendance, contributing to long-term gains in gender equality (Chakraborty, 2022). Austria's GRB experience illustrates how targeted tax reforms and reallocations of public spending towards combating domestic violence have bolstered women's economic participation and well-being (Onaran et al., 2023).

Despite these successes, the implementation of GRB faces challenges, including political resistance and the need for strong institutional capacity to enforce gender-sensitive fiscal policies (Rubin and Bartle, 2023). Nonetheless, the broader adoption and effective implementation of GRB are crucial for achieving gender-equitable outcomes. These efforts must be grounded in the understanding that addressing women's economic empowerment through fiscal policy can positively impact long-term economic growth (Elborgh-Woytek et al., 2013) and that fiscal policy must be carefully managed to ensure it promotes both gender equality and broader social outcomes (Nishi and Okuma, 2023).

Overall, the existing literature on the distributional effects of public expenditure reveals a complex and evolving understanding of how fiscal policies shape gendered economic outcomes. While earlier studies have established foundational insights into the general impact of government spending on economic growth and inequality, recent research has increasingly emphasised the importance of the composition of public expenditure, particularly in terms of social and physical infrastructure. Investments in education, healthcare, water, sanitation, and transportation have been shown to disproportionately benefit women, especially in low- and middle-income countries, by enhancing their economic opportunities and reducing the burden of unpaid care work. Furthermore, the adoption of gender-responsive budgeting in various countries underscores the critical role of targeted fiscal policies in narrowing gender gaps and promoting more inclusive economic growth. However, despite significant progress, gaps remain in fully

understanding the nuanced effects of fiscal policy on gender equity, particularly in diverse socio-economic contexts.

This study aims to address these gaps by offering an empirical analysis of how different types of public expenditure influence gender outcomes across a broad range of countries. By disaggregating gender inequality into dimensions such as capabilities, livelihoods, and empowerment, and by stratifying our analysis according to income levels, we seek to provide a nuanced understanding of the ways in which fiscal policies can be leveraged to promote gender equality in various economic settings. Through this approach, we aim to contribute to the ongoing discourse on gender equity and fiscal policy, offering insights that are both theoretically grounded and empirically robust.

3 DATA AND METHODS

3.1 Methodological Framework

This study employs a rigorous econometric framework to explore the impact of fiscal policy on gendered dimensions of well-being across 45 countries from 1990 to 2023. To capture the multifaceted and evolving nature of gender equality, the analysis integrates Dynamic Factor Analysis (DFA), Auto-Regressive Distributed Lag (ARDL) modeling with Common Correlated Effects Mean Group (CCE-MG) estimation, and Structural Equation Models (SEM). These methods are chosen to provide a robust understanding of both the temporal and structural effects of fiscal policy on gender outcomes.[2]

To capture the multidimensional nature of gendered outcomes, Dynamic Factor Analysis (DFA) was employed to construct latent variables representing the key dimensions of gender well-being in this study: capabilities (**cap**), livelihoods (**liv**), and empowerment/agency (**emp**). DFA is particularly suited for this analysis as it allows us to derive these latent variables from a set of observed indicators for each specific country in the panel. This method enables us to model the time-series dynamics of the observed indicators and provides a robust framework for extracting these dynamic factors that represent the underlying trends and latent constructs for each period in the panel dataset:

$$\mathbf{y}_t = \mathbf{\Lambda}\mathbf{f}_t + \mathbf{u}_t$$

where $\mathbf{y}_t$ represents the vector of observed indicators at time t, $\mathbf{\Lambda}$ is the matrix of factor loadings, $\mathbf{f}_t$ is the vector of latent factors (i.e., capabilities, livelihoods, or empowerment/agency), and $\mathbf{u}_t$ is the vector of idiosyncratic errors.

To explore the relationship between fiscal policy and the gender well-being indicators, we employ the Auto-Regressive Distributed Lag (ARDL) model, using the Common Correlated Effects Mean Group (CCE-MG) estimator. This model is particularly suited for our panel dataset with cross-sectional dependence as it allows it to capture both short-run and long-run dynamics across countries. The CCE-MG ARDL model is specified in its Error Correction Model (ECM) form as follows:

$$\Delta y_{it} = \alpha_i + \sum_{p=1}^{P} \phi_{ip} \Delta y_{it-p} + \sum_{q=0}^{Q} \beta_{iq} \Delta x_{it-q} + \lambda_i \left(y_{it-1} - \gamma_i x_{it-1} \right) + \delta_i \overline{y}_t + \theta_i \overline{x}_t + \epsilon_{it}$$

where y_{it} is the dependent variable (e.g., the gender well-being indices), x_{it} represents the independent

[2]Before proceeding with the econometric analysis, several panel data diagnostic tests were conducted to ensure the appropriateness of the models used. These included panel unit root tests, such as the Levin-Lin-Chu and Im-Pesaran-Shin tests, to confirm the stationarity of the data series. Additionally, multicollinearity was assessed using Variance Inflation Factor (VIF) analysis, and cross-sectional dependence was tested to account for potential dependencies across countries in the panel. All variables were transformed to their natural logarithms to address skewness and potential non-linearities, which also aids in achieving a more linear relationship between variables.

variables (e.g., fiscal policy variables), λ_i is the error correction term, capturing the speed of adjustment back to the long-run equilibrium.- $\overline{y}_t$ and $\overline{x}_t$ are the cross-sectional averages of the dependent and independent variables, respectively, which are included to account for cross-sectional dependence, and ϵ_{it} is the error term. The CCE-MG approach accounts for cross-sectional dependence by including cross-sectional averages of the dependent and independent variables as additional regressors.

To explore potential non-linearities in the relationship between fiscal policy and gender well-being, we also implement a threshold-based ARDL model using CCE-MG estimators (TARDL). Using a quartile-based approach, the threshold ARDL model is useful for understanding how the magnitude of government expenditure influences gender well-being differently across different income levels or other categorical thresholds. The general form of the TARDL model is specified as follows:

$$\Delta y_{it} = \alpha_i + \sum_{p=1}^{P} \phi_{ip} \Delta y_{it-p} + \sum_{q=0}^{Q} \beta_{iq}^{+} \Delta x_{it-q}^{+} I(x_{it-q} > \tau) + \beta_{iq}^{-} \Delta x_{it-q}^{-} I(x_{it-q} \leq \tau) + \lambda_i \left(y_{it-1} - \gamma_i x_{it-1} \right) + \epsilon_{it}$$

where $I(x_{it-q} > \tau)$ is an indicator function that takes the value of 1 if the condition is met (i.e., the variable exceeds the threshold τ) and 0 otherwise.

Finally, to further explore the pathways through which fiscal policy impacts gender outcomes, Structural Equation Modeling (SEM) is emploed. SEM allows for the simultaneous estimation of multiple relationships between observed and latent variables, capturing both direct and indirect effects. This approach is especially useful for understanding the complex interdependencies within the model, where government expenditure might influence capabilities, livelihoods, and empowerment through different channels. Post-estimation diagnostics, including tests for autocorrelation and heteroskedasticity, were performed to validate the reliability of the models. For robustness checks, additional models such as fixed effects and random effects were estimated, allowing for comparison across different specifications to ensure the consistency of the findings.

3.2 Data Sources and Collection

This study draws on a balanced panel dataset covering 45 countries over the period from 1990 to 2023, designed to examine the relationship between fiscal policy and gendered dimensions of well-being. The countries in the dataset are categorised into three groups based on their income levels: high-income, middle-income, and low- to lower-middle-income countries. This categorisation allows for a nuanced analysis of how fiscal policy impacts gender equity differently across varying economic contexts.

Data on fiscal policy variables are sourced from the International Monetary Fund's Government Finance Statistics (IMF GFS), providing an overview of government expenditure across both social and physical infrastructure. Social infrastructure expenditure includes government spending on areas such as education, health, and social protection, which are crucial for human capital development and promoting gender equity. Physical infrastructure expenditure encompasses investments in essential physical assets like transport, energy, and communication, etc., which are critical for supporting economic activities and may directly or indirectly influence gender outcomes.

Gender-specific indicators, selected from the World Bank's World Development Indicators (WDI), the World Bank's Gender Statistics Database, and the International Labour Organisation's (ILO) Statistics Database, are designed to capture three key dimensions of well-being: capabilities, livelihoods, and empowerment/agency. These dimensions are grounded in the frameworks established by Sen (1999) and Kabeer (1999), emphasising the importance of resources, agency, and achievements in evaluating gender equality. Table 1 provides a summary of the indicators used to obtain and construct our expenditure and gender well-being variables. Notably, our gender dimensions indicators often show negative values for

specific countries during certain periods, suggesting that gender-related outcomes in these instances fall below the average baseline. These negative values highlight areas where gender equality may be lagging, offering valuable insights into whether these dimensions are improving or worsening over time within each country and across the panel. This observation suggests the need for targeted policy interventions to address the disparities and promote progress in gender well-being.[3][4]

Table 1: Summary of Key Variables for Constructing Capabilities, Livelihoods, Empowerment, Social and Physical Infrastructure Expenditure

Dimension	**Key Variables**
Capabilities *(cap)*	Maternal Mortality Ratio (per 100,000 live births) Educational Attainment, at Least Completed primary to Lower Secondary Educational Attainment, at Least Bachelor's or Equivalent, Population 25 Labour Force with Advanced Education, Female (% of female working-age labour force (LF), Female (% of total labour force (LF))
Livelihoods *(liv)*	Wage and Salaried Workers, Female (% of female employment) (modeled I Ratio of Female to Male Wages Self-Employed, Female (% of female employment) Part-Time Employment, Female (% of total female employment) Employment to Population Ratio, 15+, Female (%) (modeled ILO estimat Unemployment, Female (% of female labour force (LF))
Empowerment/Agency *(emp)*	Female Share of Employment in Senior and Middle Management (%) Proportion of Seats Held by Women in National Parliaments (%) Female Employers (% of female employment) Ratio of Female to Male Labor Force Participation Rate (%) (national est Female Decision-Making in Household Major Purchases (%) Proportion of Time Spent on Unpaid Domestic and Care Work, Female (%
Social Infrastructure Expenditure *(sinf)*	Expenditure on Education Expenditure on Health Expenditure on Family and Children Expenditure on Sickness and Disability Expenditure on Old Age Expenditure on Unemployment Expenditure on Social Services Expenditure on Recreation, Culture, and Religion Expenditure on Environmental Protection Expenditure on Community Development Expenditure on Public Health Services
Physical Infrastructure Expenditure *(pinf)*	Expenditure on Transport Expenditure on Communication Expenditure on Defense Expenditure on Fire Protection Services Expenditure on Fuel & Energy Expenditure on Police Services Expenditure on Agriculture, Fishing, Forestry, and Hunting Expenditure on Street Lighting Expenditure on Housing Development Expenditure on Energy Expenditure on Public Services Expenditure on Water Supply Expenditure on Waste Management Expenditure on Mining, Manufacturing, and Construction

[3]Data preparation involved handling missing values through low-order polynomial interpolation and replacing zero values with empty cells. Datasets were merged to extend the time span of key variables.

[4]Note that all explanatory variables are logged to reduce skewness and to aid in linearising the dateset

3.2.1 Fiscal Policy Variables

The study focuses on two primary types of fiscal policy variables: social infrastructure expenditure and physical infrastructure expenditure. These categories are central to our focus of understanding how government spending influences gender equality across different socio-economic contexts. Further control variables include GDP per capita and the ratio of female to male labour force (LF) participation to account for overall economic conditions and gender disparities in economic participation, respectively.

Social Infrastructure Expenditure is defined as government spending on services that directly contribute to human capital formation and social welfare. This includes expenditure on education, health, and social protection, among others. Such investments are vital for reducing gender disparities, as they often target areas where women are disproportionately affected by inequality (Fedderke and Garlick, 2008). The rationale for including social infrastructure in the analysis is based on the premise that increased access to education, healthcare, and social protection can empower women, enhance their capabilities, and promote more equitable economic outcomes.

Physical Infrastructure Expenditure includes spending on essential infrastructure such as transport, communication, energy, and housing. These investments are crucial for economic development and can have significant gendered impacts. For instance, improvements in transport infrastructure can reduce the time burden on women, who are often responsible for household chores and caregiving, thereby increasing their opportunities for paid employment (Folbre and Nelson, 2000). The inclusion of physical infrastructure expenditure in the analysis allows us to assess the broader economic effects of government spending on gender equality.

3.2.2 Gender Well-Being Variables

The gender well-being variables in this study are constructed using Dynamic Factor Analysis (DFA) to capture the multi-dimensional aspects of gender equality, focusing on three critical dimensions: capabilities, livelihoods, and empowerment/agency. These dimensions are aligned with established frameworks in the literature — such as those proposed by Sen (1999) and Kabeer (1999), which emphasise the importance of health, education, economic participation, and political representation in assessing gender equality. The empirical validity of these constructs is further supported by correlation analysis, which examines the associations and interrelatedness among the indicators within each dimension, ensuring that the constructed variables accurately reflect the interconnected aspects of gender well-being.

A. Capabilities

Capabilities represent the foundational dimension of gender equality, capturing women's ability to lead healthy, educated lives and to participate fully in economic and social activities. Within our gendered analytical framework, following Braunstein et al. (2011) and Seguino (2012), capabilities are understood as the necessary preconditions required to engage in market production or be employed in paid or unpaid productive labour. These capabilities are proxied using a latent combination of health and education indicators, specifically: life expectancy at birth for females (LE_f), the inverse logarithm of maternal mortality ratio (MMR_{loginv}, where higher values indicate better maternal health outcomes), expected years of schooling for females (EYS_f), mean years of schooling for females (MYS_f), the proportion of females with at least lower secondary educational attainment (EAL_f), and the proportion of females with bachelor's degree or equivalent qualifications (AQ_f).

The selection of these indicators is grounded in the theoretical frameworks of Sen (1999) and Klasen and Lamanna (2009), who emphasise the interconnected nature of health and education in shaping women's capabilities. While data limitations at the aggregate cross-country level constrain the inclusion of the full spectrum of capability measures (e.g. such as freedom from violence, reproductive autonomy, or

access to quality healthcare facilities) the selected indicators provide a robust and representative proxy for the multidimensional concept of capabilities within the available empirical framework.

Formally, the latent *Capabilities* variable for country i at time t can be expressed as a weighted function of these observed indicators:

$$C_{it} = \alpha_0 + \lambda_1 LE_{f,it} + \lambda_2 MMR_{f,it} + \lambda_3 EYS_{f,it} + \lambda_4 MYS_{f,it} + \lambda_5 EAL_{f,it} + \lambda_6 AQ_{f,it} + \varepsilon_{it}, \quad (1)$$

where C_{it} represents the unobserved (latent) capabilities factor, and the coefficients λ_j capture the factor loadings estimated through Dynamic Factor Analysis (DFA), reflecting the relative contribution of each indicator to the underlying construct. All indicators are expected to load positively on C_{it}, as improvements in health outcomes (captured through life expectancy and reduced maternal mortality) and educational attainment jointly enhance women's foundational capabilities.

To capture the time-dependent evolution of women's capabilities, we assume that the latent factor follows a first-order autoregressive process:

$$C_{it} = \rho_C \, C_{i,t-1} + \eta_{it}, \quad (2)$$

where $\rho_C \in [0, 1]$ is the persistence parameter, and η_{it} denotes new shocks or improvements arising from changes in social policy, healthcare infrastructure, or educational investments. When ρ_C approaches unity, it suggests that gains in education and health accumulate gradually over time rather than dissipating quickly, thus reinforcing the notion that women's capabilities represent a stock of long-term human capital rather than a transitory flow variable. This persistence reflects both biological realities—such as the long-term benefits of maternal health improvements on subsequent generations—and institutional continuities in educational systems.

To validate the internal consistency and theoretical coherence of the capabilities construct, we examine the pairwise correlations among the selected indicators. The results, reported in Table 2, reveal strong and theoretically consistent associations that support the specification of a unified latent factor.

Table 2: Correlation Matrix – Capabilities Variables

Variable	LE_f	MMR_{loginv}	EYS_f	MYS_f	EAL_f	AQ_f
LE_f	1.00	0.31	0.84	0.82	0.36	0.22
MMR_f		1.00	0.30	0.23	0.62	0.47
EYS_f			1.00	0.82	0.33	0.24
MYS_f				1.00	0.27	0.17
EAL_f					1.00	0.55
AQ_f						1.00

Table 3: Variable Abbreviations – Capabilities Dimension

Abbreviation	**Description**	**Expected Sign in C_{it}**
LE_f	Life Expectancy at Birth, Female (years)	+
MMR_f	Inverse Log Maternal Mortality (higher = better)	+
EYS_f	Expected Years of Schooling, Female	+
MYS_f	Mean Years of Schooling, Female	+
EAL_f	Female Attainment: $\geq$ Lower Secondary (%)	+
AQ_f	Female Attainment: Bachelor's or Equivalent (%)	+

The correlation analysis reveals several important structural relationships. First, life expectancy exhibits remarkably strong positive correlations with both expected years of schooling (0.84) and mean years of schooling (0.82) indicating that improvements in female education are closely associated with better health outcomes and increased longevity. This finding aligns with the extensive literature documenting the protective effects of female education on health, including delayed marriage and childbearing, improved health-seeking behaviour, and better nutrition practices (Caldwell, 1986; Gakidou et al., 2010). Formally, this strong co-movement likely arises because both life expectancy and educational indicators load positively on the same latent factor C_{it}, such that their covariance satisfies:

$$\text{Cov}(LE_{f,it}, EYS_{f,it}) = \lambda_{LE_f} \lambda_{EYS_f} \text{Var}(C_{it}) > 0, \tag{3}$$

where the magnitude of the correlation depends on both the factor loadings and the variance of the underlying capabilities construct.

Second, maternal health as measured by the inverse logarithm of the maternal mortality ratio, displays moderate to strong positive correlations with educational attainment indicators, particularly with lower secondary completion (EAL_f: 0.62) and bachelor's attainment (AQ_f: 0.47). These associations reflect the well-documented pathways through which education improves maternal health outcomes: educated women are more likely to access antenatal care, deliver in health facilities, and adopt safer childbirth practices (Karlsen et al., 2011). The slightly weaker correlation between maternal health and continuous schooling years (expected and mean) compared to attainment thresholds suggests that discrete educational milestones, such as completing secondary education, may be particularly salient for maternal health, possibly because they represent critical transitions in health literacy and autonomy. This can be expressed through differential sensitivities implying that threshold completion effects dominate average schooling effects in determining health outcomes:

$$\frac{\partial C_{it}}{\partial EAL_{f,it}} \cdot \frac{\partial \text{Maternal Health}}{\partial C_{it}} > \frac{\partial C_{it}}{\partial MYS_{f,it}} \cdot \frac{\partial \text{Maternal Health}}{\partial C_{it}}, \tag{4}$$

Also, the correlation structure among educational indicators themselves warrants attention. Expected and mean years of schooling are highly correlated (0.82), as anticipated given that they measure similar dimensions of educational investment across different temporal perspectives. Lower secondary attainment and bachelor's attainment display a moderate positive correlation (0.55), indicating that countries with higher rates of basic educational completion tend also to have higher rates of tertiary attainment, though the relationship is not deterministic. This pattern reflects the hierarchical nature of educational systems, where foundational investments in secondary education create the pipeline for tertiary enrolment, while also acknowledging that expansion at higher levels requires additional institutional and financial capacity beyond universal secondary access.

Interestingly, the correlation between maternal health and continuous schooling indicators (expected and mean years) is positive but relatively modest (0.30 and 0.23, respectively), while the correlations with attainment thresholds are considerably stronger. This divergence suggests that the *completion* of discrete educational stages(particularly lower secondary and tertiary degrees) may have more pronounced associations with health outcomes than incremental increases in average schooling duration. One plausible explanation is that credential completion signals not only accumulated knowledge but also persistence, institutional access, and socioeconomic mobility, all of which independently contribute to improved health behaviours and outcomes. Formally, this distinction can be modelled by differentiating between intensive and extensive margins of education:

$$C_{it} = f(\text{Years of Schooling}_{it}) + g(\text{Completion Thresholds}_{it}), \tag{5}$$

where $g'(\cdot) > f'(\cdot)$ in the context of maternal health outcomes, reflecting the relatively larger marginal contribution of threshold completion.

The positive correlations between life expectancy and educational attainment thresholds (0.36 with EAL_f and 0.22 with AQ_f) further corroborate the complementarity between health and education, though these associations are weaker than those with continuous schooling years. This may reflect the fact that life expectancy captures broader population-level health dynamics—including infant mortality, infectious disease burden, and healthcare infrastructure—that extend beyond the direct effects of individual educational credentials. Nevertheless, the consistent positive direction of all correlations supports the conceptual unity of the capabilities construct, wherein improvements in any dimension of health or education tend to reinforce progress in others.

Within the latent variable framework, these empirical correlations emerge naturally from the shared variance structure imposed by the common factor C_{it}. Specifically, for any pair of indicators X_{it} and Y_{it}, their observed correlation arises from their joint dependence on the underlying capabilities factor:

$$\text{Corr}(X_{it}, Y_{it}) = \frac{\lambda_X \lambda_Y \,\text{Var}(C_{it})}{\sqrt{(\lambda_X^2 \,\text{Var}(C_{it}) + \text{Var}(\varepsilon_{X,it}))(\lambda_Y^2 \,\text{Var}(C_{it}) + \text{Var}(\varepsilon_{Y,it}))}}, \tag{6}$$

where $\varepsilon_{X,it}$ and $\varepsilon_{Y,it}$ denote indicator-specific measurement errors or idiosyncratic shocks. The strength of the observed correlation thus depends on both the magnitude of the factor loadings (λ_X and λ_Y) and the relative importance of common versus idiosyncratic variance. Indicators with high factor loadings and low idiosyncratic variance such as life expectancy and expected years of schooling, will exhibit strong pairwise correlations, while those with lower loadings or greater measurement error will display weaker associations, even if they are conceptually related through the latent factor.

In summary, the correlation analysis confirms that the selected health and education indicators co-vary in theoretically consistent ways, justifying their aggregation into a unified latent capabilities construct. Life expectancy and schooling years exhibit strong co-movement, reflecting their mutual reinforcement in promoting human development. Maternal health improvements are closely linked to educational attainment, particularly at key completion thresholds, highlighting the protective role of education in reducing maternal mortality. The moderate correlations among educational indicators themselves reveal a hierarchical structure of human capital accumulation, where foundational investments in secondary education enable subsequent tertiary expansion. Collectively, these patterns validate the use of Dynamic Factor Analysis to extract a single, persistent capabilities factor that captures the multidimensional and cumulative nature of women's health and educational endowments over time.

B. Livelihoods

In this study, **Livelihoods** is constructed to provide information on women's ability to employ their capabilities in order to generate employment and income, as such signalling whether women can translate skills and educational endowments into stable jobs and earned resources. This dimension addresses the economic realisation of potential, reflecting the conditions under which women participate in labour markets and the quality of employment they secure.

The latent livelihoods factor is proxied using seven indicators that collectively characterise women's economic participation and employment quality: the female-to-male labour force participation ratio ($LFPR$), the proportion of female wage and salaried workers (WSW), inverted female self-employment rates (SE), where higher values indicate less reliance on self-employment), inverted female unemployment (U), where higher values reflect lower unemployment), the ratio of female to male wages (RFW), female part-time employment rates (PTE), and the female employment-to-population ratio ($ETPR$). These indicators collectively provide a view of women's economic security and their capacity to leverage health and educational capabilities in productive activities, consistent with the frameworks developed

by Braunstein et al. (2011) and Heintz and Pickbourn (2012).

Formally, the latent livelihoods factor for country i at year t is expressed as:

$$L_{it} = \beta_0 + \lambda_1 LFPR_{ratio,it} + \lambda_2 WSW_{it} + \lambda_3 SE_{it} + \lambda_4 U_{it} + \lambda_5 RFW_{it} + \lambda_6 PTE_{it} + \lambda_7 ETPR_{it} + \nu_{it}, \quad (7)$$

where self-employment and unemployment have been inverted prior to estimation so that all indicators align positively with improved livelihood outcomes. This transformation ensures that the Dynamic Factor Analysis captures a coherent upward-trending construct, wherein increases in L_{it} reflect improvements across employment quality, wage equity, and labour market attachment. As with capabilities above, the coefficients λ_j represent the factor loadings estimated through Dynamic Factor Analysis such that each observed indicator can be decomposed into a common component driven by the latent factor L_{it} and an idiosyncratic component $\nu_{j,it}$

Women's access to credit, which exhibits sparse and discontinuous coverage across countries and years, is treated separately as a structural policy shifter rather than a continuous indicator. Specifically, credit access is operationalised as a five-year, income-group-specific binary variable $D_{it} \in \{0, 1\}$, where unity denotes high access (defined relative to the median within each income group) and zero denotes low access. This dummy variable does not appear in the correlation matrix but instead enters the dynamic specification as an institutional determinant of livelihood levels. The full dynamic model thus becomes:

$$L_{it} = \rho_L \, L_{i,t-1} + \delta_C \, C_{i,t-1} + \gamma_D \, D_{it} + \boldsymbol{\delta}_Z' \mathbf{Z}_{it} + \xi_{it}, \quad (8)$$

where ρ_L captures persistence in realised economic participation, $C_{i,t-1}$ represents the lagged capabilities factor (linking prior educational and health endowments to current labour outcomes), γ_D measures the impact of improved credit access on livelihoods, and $\mathbf{Z}_{it}$ is a vector of macroeconomic or structural controls such as GDP growth and sectoral composition. TThis formulation reflects that livelihoods are both path-dependent and responsive to prior capabilities and institutional conditions, as such embedding the dynamic interdependence between foundational human capital and realised economic outcomes.

Table 4 reports the pairwise correlations among the continuous livelihoods indicators, used to assess internal consistency within the construct.

Table 4: Correlation Matrix – Livelihoods Variables

Variable	$LFPR_{ratio}$	WSW	SE_{inv}	U_{inv}	RFW	PTE	$ETPR$
$LFPR_{ratio}$	1.00	0.12	0.12	0.03	0.42	0.06	0.69
WSW		1.00	1.00	-0.01	0.04	-0.01	0.11
SE_{inv}			-0.28	-0.01	0.04	-0.01	0.11
U_{inv}				1.00	0.17	0.31	0.44
RFW					1.00	0.07	0.33
PTE						1.00	0.26
$ETPR$							1.00

Table 5: Variable Abbreviations – Livelihoods Dimension

Abbreviation	**Description**	**Expected Sign in L_{it}**
$LFPR$	Female-to-Male Labour Force Participation Ratio	+
WSW	Female Wage and Salaried Workers (% of female employment)	+
SE	Inverted Female Self-Employment (higher = less self-employment)	+
U	Inverted Female Unemployment (higher = less unemployment)	+
RFW	Ratio of Female to Male Wages	+
PTE	Female Part-Time Employment (% of female employment)	+
$ETPR$	Female Employment-to-Population Ratio (%)	+

The correlation analysis reveals several structural relationships that characterise women's economic participation. Most notably, the female-to-male labour force participation ratio exhibits a very strong positive correlation with the female employment-to-population ratio (0.69), indicating that countries with greater gender parity in labour force participation also achieve higher absolute employment rates for women. Within the latent factor framework, this strong association arises because both indicators load heavily on the underlying livelihoods factor L_{it}:

$$\text{Cov}(LFPR_{ratio,it}, ETPR_{it}) = \lambda_{LFPR_{ratio}} \lambda_{ETPR} \,\text{Var}(L_{it}) + \text{Cov}(\nu_{LFPR,it}, \nu_{ETPR,it}), \tag{9}$$

where the magnitude of the observed correlation suggests that both $\lambda_{LFPR_{ratio}}$ and λ_{ETPR} are large relative to idiosyncratic variance, as such implying that gender parity in participation and overall female employment rates are driven primarily by common structural factors. This is consistent with Heintz and Pickbourn (2012), who argue that increasing female labour force participation often translates into higher employment rates, particularly in contexts where labour markets provide sufficient formal sector opportunities.

The employment-to-population ratio displays strong positive correlations with inverted unemployment (0.44) and wage equality (0.33), confirming that higher employment rates systematically coincide with lower joblessness and more equitable wage structures, as such supporting the notion that pay equity can serve as an incentive for women's continued workforce participation (Demirgüç-Kunt et al., 2013). The female-to-male labour force participation ratio also exhibits a moderate positive correlation with wage equality (0.42), suggesting that gender parity in participation tends to coincide with more equitable wage structures. These patterns also reflect complementarities across multiple dimensions of labour market integration, as such reinforcing that improvements in participation, employment, and earnings tend to co-occur through their shared dependence on the common livelihoods factor.

The correlation structure reveals a notable trade-off between wage and salaried employment and self-employment, with WSW and SE_{inv} exhibiting a moderate negative correlation (-0.28). This pattern reflects the structural transition from self-employment to formal wage work as economies develop. Within the latent framework, this trade-off arises because:

$$\text{Cov}(WSW_{it}, SE_{inv,it}) = \lambda_{WSW} \lambda_{SE_{inv}} \,\text{Var}(L_{it}) + \text{Cov}(\nu_{WSW,it}, \nu_{SE_{inv},it}) < 0, \tag{10}$$

where the negative covariance may reflect either opposing factor loadings or a negative residual correlation in idiosyncratic components, as such capturing country-specific labour market structures that privilege one form of employment over another. As women move into wage and salaried positions, their reliance on self-employment, often considered a fallback option when formal jobs are scarce, tends to decline (Maloney, 2004).

Self-employment patterns reveal an interesting tension within the livelihoods construct. Whilst SE_{inv} exhibits significant correlations with wage employment (-0.26), wage equality (0.09), and part-time

work (0.08), it displays an essentially zero correlation with the employment-to-population ratio (−0.00). This suggests that whilst self-employment levels respond to the overall structure of women's economic participation captured by L_{it}, they vary independently of aggregate employment rates. Formally:

$$\text{Cov}(SE_{inv,it}, ETPR_{it}) \approx 0 \quad \Rightarrow \quad \lambda_{SE_{inv}} \lambda_{ETPR} \,\text{Var}(L_{it}) \approx -\,\text{Cov}(\nu_{SE_{inv},it}, \nu_{ETPR,it}), \tag{11}$$

implying that any positive covariance arising from joint dependence on L_{it} is approximately offset by negative residual correlation with the implicaton that self-employment serves diverse functions across contexts: such that in some countries, high self-employment may coexist with high overall employment as women engage in entrepreneurial activities, whilst in others, self-employment substitutes for formal employment when wage opportunities are scarce. As such, the relationship between self-employment levels and aggregate employment rates is highly context-dependent, generating near-zero correlation at the cross-country level even though self-employment patterns remain systematically related to other dimensions of labour market structure.

Part-time employment also exhibits moderate positive correlations with inverted unemployment (0.31) and the employment-to-population ratio (0.26), suggesting that part-time work is related to overall employment levels and potententially reduces joblessness. However, its weak correlations with wage equality (0.07) and wage employment (−0.01) indicate that part-time work does not strongly predict other dimensions of employment quality. This pattern likely reflects the dual nature of part-time employment: for some women, it offers valuable flexibility and work-life balance, whilst for others, it represents underemployment or involuntary reduced hours (McGinnity and McManus, 2007). The positive association with overall employment nonetheless suggests that part-time opportunities expand the extensive margin of labour force participation, even if they do not necessarily enhance the intensive margin of earnings or job security.

The wage and salaried employment share displays surprisingly weak correlations with most other livelihoods indicators, including the employment-to-population ratio (0.11), inverted unemployment (−0.01), and wage equality (0.04). This pattern suggests that WSW exhibits high idiosyncratic variance relative to common factor variance:

$$\frac{\text{Var}(\nu_{WSW,it})}{\text{Var}(WSW_{it})} \gg \frac{\lambda_{WSW}^2 \,\text{Var}(L_{it})}{\text{Var}(WSW_{it})}, \tag{12}$$

as such implying that the composition of employment evolves somewhat independently of the level of employment and wage structures. One possible explanation is that in middle-income countries undergoing structural transformation, both wage employment and self-employment can expand simultaneously as different sectors grow at different rates, thereby weakening aggregate correlations and increasing country-specific heterogeneity.

Collectively, the correlation analysis confirms that the livelihoods construct captures both complementarities and trade-offs in women's economic participation. Gender parity in labour force participation, higher employment rates, lower unemployment, and greater wage equality tend to co-vary positively through their shared dependence on L_{it}, reflecting a coherent pattern of inclusive labour market integration. Conversely, the transition from self-employment to wage employment represents a structural shift with context-dependent implications, whilst part-time employment occupies an intermediate position, contributing to participation without necessarily signalling improved job quality. These findings help to validate the use of Dynamic Factor Analysis to extract a unified livelihoods factor that synthesises diverse employment indicators whilst highlighting their distinct roles in shaping women's economic outcomes.[5]

[5]For this study, we distinguish Capabilities (what women *can do*, given their access to education, health, and skills) from Livelihoods (what women *are doing* in terms of current economic activities and income generation, as well as the conditions that make labour market substitution possible and favourable, such as equal pay for equal work). We frame this relationship such that capabilities provide the foundation for potential economic participation, whilst livelihoods represent

C. Empowerment and Agency

The role of women's economic empowerment (WEE) in advancing gender equality has attracted growing attention among policy and development communities in recent years (Jones et al., 2012; Rahman, 2010; Jacobson et al., 2016). Whilst the idea of women's economic empowerment is widely endorsed, there remains no universally agreed definition of the term. In this study, we define WEE as the collective ability of women to influence decision-making in productive roles, political spaces, and within the household. This follows Eyben et al. (2008, p. 9), who describe empowerment as "the capacity of poor women and men to participate in, contribute to and benefit from growth processes on terms which recognise the value of their contributions, respect their dignity and make it possible for them to negotiate a fairer distribution of the benefits of growth." As such, gender equality in empowerment implies that women, like men, are able to recognise and exercise agency and choice in shaping their economic and social outcomes.

The empirical measure of empowerment and agency in this study draws on five indicators that capture distinct but interconnected domains of women's agency: the proportion of seats held by women in national parliaments (PR, capturing formal political representation and institutional power), the female share of employment in senior and middle management ($FSEM$, reflecting managerial decision-making power and progress against glass-ceiling barriers), the proportion of female employers (EF, proxying entrepreneurship, ownership, and capital control beyond wage work), female gross national income per capita (GNI_{pc}, measuring women's command over and contribution to economic resources/output), and the ratio of male to female unpaid domestic and care work ($Unpaid_{ratio}$, where higher values indicate more equitable time-use and reduced care burdens for women). These indicators capture formal and informal dimensions of women's agency, grounded in the conceptual frameworks of Kabeer (1999) and Eyben et al. (2008), who emphasise that decision-making power and control over time and resources are central to achieving genuine gender equality.

Formally, the latent empowerment factor for country i at time t is represented as:

$$E_{it} = \gamma_0 + \lambda_1 PR_{it} + \lambda_2 FSEM_{it} + \lambda_3 EF_{it} + \lambda_4 RFW_{it} + \lambda_5 Unpaid_{ratio,it} + \varepsilon_{it}, \tag{13}$$

where E_{it} denotes the unobserved empowerment and agency score. All indicators are expected to load positively on E_{it}, as improvements in political representation, managerial presence, entrepreneurship, wage equality, and more balanced unpaid work distribution collectively enhance women's agency across multiple domains.

To capture persistence and interconnections across domains, empowerment is modelled dynamically as:

$$E_{it} = \rho_E \, E_{i,t-1} + \phi_C \, C_{i,t-1} + \phi_L \, L_{i,t-1} + \boldsymbol{\phi}_Z' \mathbf{Z}_{it} + \omega_{it}, \tag{14}$$

where ρ_E measures the inertia in empowerment over time, ϕ_C and ϕ_L capture the contributions of prior capabilities and livelihoods respectively, and $\mathbf{Z}_{it}$ represents institutional and policy controls such as gender quotas or legislative reforms. This formulation reflects that empowerment builds cumulatively on women's human-capital capacities and their realised economic participation, as such embedding the hierarchical relationship wherein capabilities enable livelihoods, which in turn facilitate agency and decision-making power.

Table 6 presents the pairwise correlations among the empowerment and agency indicators.

the actual realisation of that potential.

Table 6: Correlation Matrix – Empowerment and Agency Variables

Variable	PR	$FSEM$	EF	RFW	$Unpaid_{ratio}$
PR	1.00	0.12	0.21	0.32	0.58
$FSEM$		1.00	0.07	0.17	−0.02
EF			1.00	−0.07	−0.30
RFW				1.00	0.67
$Unpaid_{ratio}$					1.00

Table 7: Variable Abbreviations – Empowerment and Agency Dimension

Abbrev.	**Description**	**Expected Sign -** E_{it}
PR	Proportion of Seats Held by Women in Parliament (%)	+
$FSEM$	Female Share of Employment in Senior and Middle Management (%)	+
EF	Female Employers (% of total employers)	+
RFW	Ratio of Female to Male Wages	+
$Unpaid$	Ratio of Male to Female Unpaid Work Time (higher = more equitable)	+

The correlation analysis reveals several structural relationships that characterise different dimensions of women's empowerment and agency. Most notably, political representation exhibits a very strong positive correlation with equitable unpaid work distribution, indicating that countries with greater female representation in parliament also display more balanced divisions of domestic and care work between men and women. This strong association suggests that political empowerment and household-level agency are deeply interconnected, as such reflecting that legislative environments supportive of women's political participation may also foster cultural shifts toward more equitable gender norms in domestic spheres. Within the latent factor framework:

$$\mathrm{Cov}(PR_{it}, Unpaid_{ratio,it}) = \lambda_{PR}\lambda_{Unpaid_{ratio}} \mathrm{Var}(E_{it}) + \mathrm{Cov}(\nu_{PR,it}, \nu_{Unpaid,it}), \tag{15}$$

the magnitude of the observed correlation (0.58) suggests that both indicators load heavily on the underlying empowerment factor E_{it}, with relatively small idiosyncratic variance. Krook and O'Brien (2012), support this assumption arguing that greater political inclusion often aligns with women's access to leadership in economic and institutional spaces, as well as with broader societal transformations in gender relations.

Political representation also displays moderate positive correlations with female entrepreneurship (0.21) and female economic resources measured by GNI per capita (0.15), suggesting that formal political power tends to coincide with economic agency and ownership. These patterns reflect complementarities across multiple domains of empowerment, as such reinforcing that improvements in political representation, entrepreneurship, and economic resources tend to co-occur through their shared dependence on the common empowerment factor. The positive association between firm ownership and management participation, though weaker (0.07), further indicates that women's presence in corporate governance complements their broader representation in decision-making positions, consistent with the findings of Terjesen et al. (2009).

The relationship between female economic resources and unpaid work distribution reveals an interesting dynamic. GNI per capita exhibits a moderate positive correlation with the unpaid work ratio (0.28), suggesting that as women's command over economic resources increases, unpaid domestic work becomes more equitably distributed between men and women. This may reflect that higher female incomes enable greater bargaining power within households or facilitate access to market-based care services that reduce women's time burdens, as such creating conditions for more egalitarian domestic arrangements. Within

the covariance framework:

$$\text{Cov}(GNI_{pc,it}, Unpaid_{ratio,it}) = \lambda_{GNI_{pc}} \lambda_{Unpaid_{ratio}} \text{Var}(E_{it}) + \text{Cov}(\nu_{GNI,it}, \nu_{Unpaid,it}), \tag{16}$$

where the moderate correlation reflects both common factor loadings and potentially some positive residual correlation capturing economic mechanisms linking income and time-use patterns.

In stark contrast, female entrepreneurship displays a significant negative correlation with equitable unpaid work distribution (-0.30), suggesting that countries with higher rates of female business ownership tend to exhibit less equitable divisions of domestic labour. This seemingly counterintuitive pattern likely reflects the "double burden" faced by female entrepreneurs, who must simultaneously manage business operations and household responsibilities in contexts where supportive infrastructure or cultural norms for shared domestic work remain underdeveloped. This is also consistent with cross–country structural realities, especially in many lower-income or informally organised economies where high rates of female entrepreneurship often arise under conditions of labour-market exclusion and weak social infrastructure, with the emergence of women "entrepreneurs" out of necessity rather than opportunity operating micro-businesses while simultaneously bearing the majority of unpaid care responsibilities. In such settings, a rise in the share of female employers would be expected to coincide with persistently feminised domestic labour, producing a negative association between entrepreneurial activity and household time equality.

At higher income levels, by contrast, the distribution of unpaid work tends to equalise reflected in a higher male-to-female unpaid-work ratio even though the proportion of female employers within total female employment may decline as women transition from self-employment into wage and salary work within formal sectors. Consequently, countries with greater gender equality in domestic labour may display *lower* female-employer shares simply because the denominator of total female employment changes.

Cultural and institutional dynamics may also reinforce this pattern., for example, where gender norms relax and men assume a larger share of domestic care, women frequently enter secure formal employment rather than entrepreneurship. Conversely, entrepreneurship often flourishes where institutional care systems are weak and family labour substitutes for public provision. The negative sign very likely gives us further insights into these dynamics, reflecting distinct pathways of economic development and gendered labour allocation.

Formally:

$$\text{Cov}(EF_{it}, Unpaid_{ratio,it}) = \lambda_{EF} \lambda_{Unpaid_{ratio}} \text{Var}(E_{it}) + \text{Cov}(\nu_{EF,it}, \nu_{Unpaid,it}) < 0, \tag{17}$$

where the negative covariance may arise either from opposing factor loadings (if entrepreneurship in some contexts reflects necessity rather than empowerment) or from a strong negative residual correlation capturing country-specific institutional failures to support female entrepreneurs with adequate childcare or domestic services. This finding underscores that entrepreneurship alone does not guarantee broader empowerment gains, particularly in the absence of complementary policies addressing unpaid care work (Seguino, 2012; Seguino and Braunstein, 2019).

The female share of employment in senior and middle management exhibits relatively weak correlations with most other empowerment indicators, including political representation (0.12), entrepreneurship (0.07), and unpaid work distribution (-0.02, not significant). This pattern suggests that managerial representation may evolve somewhat independently of other dimensions of empowerment, as such reflecting that corporate glass-ceiling dynamics respond to distinct institutional factors such as firm-level diversity policies, industry composition, or professional credentialing systems rather than broader political or household-level transformations. The moderate positive correlation between managerial representation and female economic resources (0.17) nonetheless indicates some coherence across economic dimensions of empowerment, consistent with the notion that access to high-status positions enhances women's income

and economic agency.

Interestingly, female entrepreneurship displays an essentially zero correlation with female economic resources measured by GNI per capita (−0.00), suggesting that business ownership rates vary independently of women's average income levels. This may reflect the heterogeneous nature of female entrepreneurship across development contexts, e.g. in high-income countries, entrepreneurship may represent a choice-driven pathway to wealth accumulation, whilst in lower-income settings, it often represents necessity-driven self-employment in informal sectors with limited income potential. As such, the aggregate cross-country correlation masks substantial heterogeneity in the quality and returns to female entrepreneurship, further validating the need to disaggregate the analysis by level of development and institutional structure which we do later in this paper.

Collectively, the correlation analysis confirms that the empowerment construct captures multiple dimensions of women's agency across political, economic, and domestic spheres. Political representation and equitable unpaid work distribution emerge as the most strongly correlated indicators, reflecting their central role in the latent empowerment factor. Female economic resources display moderate positive associations with both political representation and time-use equity, reinforcing the complementarity between economic agency and broader empowerment gains. Conversely, the negative correlation between entrepreneurship and unpaid work equity highlights potential trade-offs or contextual constraints that prevent business ownership from translating into reduced domestic burdens. Managerial representation occupies a relatively independent position, suggesting that corporate-level empowerment may require distinct policy interventions beyond those targeting political or household-level agency. These findings validate the use of Dynamic Factor Analysis to extract a unified empowerment factor that synthesises diverse indicators of women's agency whilst respecting their distinct institutional and cultural determinants.

D. Summary and Cross-Construct Correlations

Taken together, the use of Dynamic Factor Analysis (DFA) to construct these latent variables not only consolidates individual indicators into broader, multidimensional constructs but also highlights the interconnectedness of women's outcomes across spheres. The relationships between indicators within each construct demonstrate that improvements in one area, such as education, can often be associated with gains in others, such as health and economic participation.

To assess the empirical coherence and distinctiveness of the three latent constructs, as well as their alignment with established international measures, we examine pairwise correlations among the factor scores for Capabilities, Livelihoods, and Empowerment, alongside their associations with the UNDP Gender Development Index (GDI), the Gender Inequality Index (GII), and measures of social and physical infrastructure expenditure. These correlations, reported in Table 8, provide insight into how the constructs relate to one another and to external benchmarks, as such offering validation evidence and highlighting areas where the constructs capture dimensions not fully reflected in existing indices.

Table 8: Correlation Matrix – Latent Constructs, External Indices, and Infrastructure

Variable	**CAP**	**LIV**	**EMP**	**SINF**	**PINF**	**GDI**	**GII**
CAP	1.00	0.13	0.17	0.18	0.14	0.73	−0.86
LIV		1.00	−0.42	0.05	−0.04	0.25	−0.13
EMP			1.00	−0.09	−0.18	−0.05	−0.08
SINF				1.00	0.74	0.10	−0.14
PINF					1.00	−0.07	−0.03
GDI						1.00	−0.71
GII							1.00

Table 9: Variable Abbreviations – Cross-Construct Analysis

Abbreviation	Description
CAP	Capabilities (latent factor score)
LIV	Livelihoods (latent factor score)
EMP	Empowerment and Agency (latent factor score)
SINF	Social Infrastructure Expenditure
PINF	Physical Infrastructure Expenditure
GDI	UNDP Gender Development Index (higher = better)
GII	UNDP Gender Inequality Index (higher = worse inequality)

The correlations among *the three latent constructs* reveal both expected complementarities and unexpected tensions. Capabilities display moderate positive correlations with both Livelihoods (0.13) and Empowerment (0.17), consistent with the theoretical framing that foundational endowments in health and education enable subsequent economic participation and agency. These associations suggest that improvements in women's capabilities tend to coincide with better labour-market outcomes and enhanced decision-making power, though the moderate magnitudes indicate that capabilities are necessary but not sufficient for livelihoods and empowerment gains, as such implying that institutional, economic, and cultural factors likely mediate the translation of capabilities into realised outcomes.

Most strikingly, Livelihoods and Empowerment exhibit a substantial negative correlation (-0.42), indicating that countries with higher female employment rates and better labour-market integration tend to display lower levels of empowerment as measured by political representation, managerial presence, and time-use equity. This counterintuitive pattern warrants careful interpretation. One plausible explanation is that high female labour-force participation in many contexts occurs not through genuine agency and choice but through economic necessity in low-quality, informal, or precarious employment arrangements that do not confer decision-making power or reduce domestic burdens. In such settings, women may be "doing" more (higher livelihoods) without "deciding" more (lower empowerment) and this may simply be reflecting structural constraints rather than empowerment gains. Alternatively, the negative association may capture heterogeneity across development contexts: middle-income countries undergoing rapid industrialisation may achieve high female employment without corresponding advances in political representation or household equity, whilst high-income countries with lower female participation may exhibit stronger empowerment due to more egalitarian institutions. These interpretations underscore that employment alone is insufficient for gender equality, as the quality, autonomy, and societal recognition of women's economic roles critically shape whether labour-market participation translates into broader agency.

Validation against external indices: The correlations with the UNDP Gender Development Index (GDI) and Gender Inequality Index (GII) provide important validation evidence and reveal the distinct emphases of these established metrics. The GDI, which measures gender disparities in human development dimensions (health, education, and income), exhibits a very strong positive correlation with Capabilities (0.73), a moderate correlation with Livelihoods (0.25), and a weak negative correlation with Empowerment (-0.05). This pattern suggests that the GDI is dominated by capability-related indicators, potentially reflecting that its construction primarily captures health and education outcomes rather than labour-market dynamics or agency dimensions. The near-zero (slightly negative) correlation with Empowerment further indicates that political representation, managerial presence, and time-use equity are not strongly reflected in the GDI framework.

Similarly, the GII, which combines reproductive health, empowerment (parliamentary representation and education), and labour-market participation indicators, displays a very strong negative correlation with Capabilities (-0.86, where negative values indicate that higher capabilities correlate with lower

inequality as measured by the GII), alongside weaker negative correlations with Livelihoods (-0.13) and Empowerment (-0.08). The extremely strong association with Capabilities likely arises because the GII incorporates maternal mortality and secondary education attainment, both of which are central to the Capabilities construct. Interestingly, despite the GII's nominal inclusion of empowerment components (parliamentary seats), its correlation with our Empowerment factor is weak, suggesting that the GII's empowerment dimension is overshadowed by its health and education components.

An intriguing empirical regularity emerges when examining the sum of correlations across constructs. For the GDI, the absolute values of the three construct correlations approximately sum to unity: $|0.73| + |0.25| + |-0.05| \approx 0.93 \approx 1.0$. Similarly, for the GII, the sum of absolute correlations yields: $|-0.86| + |-0.13| + |-0.08| \approx 1.07 \approx 1.0$. This pattern suggests that the GDI and GII, whilst valuable composite measures, allocate their explanatory weight heavily toward capabilities (70–85% of the total), moderately toward livelihoods (13–25%), and minimally toward empowerment (5–8%). As such, these indices may provide incomplete representations of multidimensional gender equality, particularly in domains related to agency, political power, and time-use equity. This finding also motivates my use of separate latent constructs in the present study, as it allows for more granular analysis of how different dimensions of gender equality respond to policy interventions and infrastructure investments.

Structural validation through SEM: To further validate the robustness and coverage of the latent constructs, we re-estimated Capabilities, Livelihoods, and Empowerment jointly using a Structural Equation Modelling (SEM) framework with latent factors. This SEM–DFA hybrid specification integrates the three domains within a unified measurement system, allowing the constructs to borrow strength from one another while retaining their theoretical identities. The results, summarised in Table 10, show exceptionally high correspondence between the SEM-derived factors and both the UNDP Gender Development Index (GDI) and Gender Inequality Index (GII). The correlations between the SEM factors and the GDI range from 0.71 to 0.77, while their correlations with the GII range from -0.85 to -0.86, indicating near one-to-one alignment. This provides strong empirical validation that the latent constructs collectively capture the full spectrum of gender development outcomes embedded in international indices.

That said, the high inter-factor correlations within the SEM (exceeding 0.9 across Capabilities, Livelihoods, and Empowerment) suggest that the model effectively homogenises the three domains into a single overarching "gender development" dimension mirroring the blended structure of the GDI and GII. Consequently, while the SEM results provide excellent external validation of construct coherence, we retain the distinct DFA-FIML-derived factors for subsequent econometric analysis to preserve differentiation across the three conceptual dimensions of gender equality.

Table 10: Correlations between SEM Latent Factors and UNDP Indices

Variable	**GDI**	**GII**	**Inter-factor Correlation**	**Mean**
Capabilities (SEM)	0.77	-0.86	0.93	
Livelihoods (SEM)	0.76	-0.85	0.92	
Empowerment (SEM)	0.71	-0.86	0.91	

This analytical framework from the SEM results also posits a hierarchical structure wherein general gender development manifests through three distinct but interrelated dimensions, each measured by multiple observed indicators. This structure, depicted in Figure 1, reflects the conceptual distinction between latent constructs (Capabilities, Livelihoods, Empowerment) and their observable manifestations, as such providing the foundation for the Structural Equation Modelling approach employed in subsequent analyses.

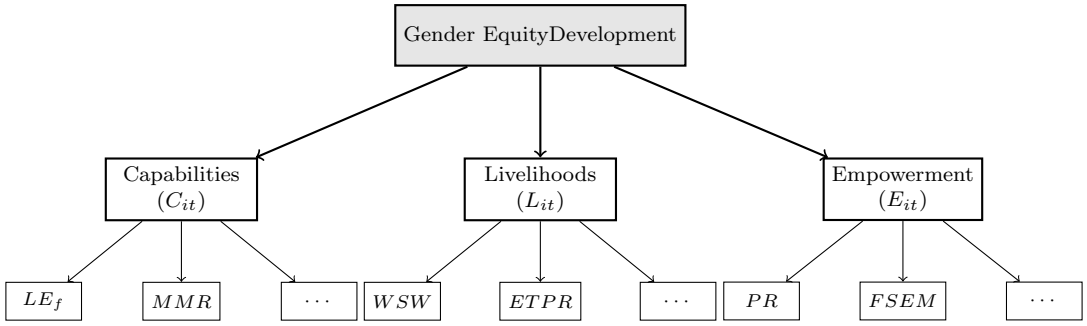

Figure 1: Hierarchical Model for Gender Development Constructs

Modification indices from a confirmatory SEM revealed several theoretically consistent cross-domain relationships, particularly between education (Capabilities) and economic participation (Livelihoods), and between labour-formality indicators (Livelihoods) and agency-related variables (Empowerment). These patterns suggest that women's health, education, and labour outcomes co-move strongly, consistent with cumulative theories of gender development.

Interestingly, the constructed country rankings presented in Appendix Table **??** reveal a set of patterns that both reinforce and refine the insights typically captured by composite measures such as the UNDP Gender Development Index (GDI) and Gender Inequality Index (GII). While countries such as Cyprus, Iceland, and Denmark rank highest in *Capabilities*, reflecting near-parity in female health and educational attainment (consistent with GDI values above 0.93 and GII scores below 0.15), this strength does not consistently translate into comparable outcomes in *Livelihoods* or *Empowerment*.

Southern European and small high-income economies, for instance, display high capabilities but lag in labour participation, wage equality, and representation—mirroring a pattern where women's educational and health gains outpace their economic and institutional inclusion. on the other hand, Nordic countries maintain alignment across all three dimensions, exhibiting the strongest coherence between capability formation, labour-market integration, and agency, while several low to middle-income states achieve moderate livelihood scores without equivalent health or education parity, possibly reflecting necessity-driven participation rather than realised equality. This divergence does highliht the analytical value of separating *potential equality* (Capabilities) from its *realisation* (Livelihoods) and *agency* (Empowerment), in contrast to measures such as the GDI and GII which tend to compress these structural differences into a single measure; as such the disaggregated latent constructs reveal distinct developmental sequencing and expose the institutional bottlenecks, particularly in labour formality and decision-making power, that persist even in otherwise high-achieving contexts.

Moreover, the correlations with social and physical infrastructure expenditure reveal differential associations across the three gender dimensions. Social infrastructure correlations suggests that social infrastructure investments are associated with improvements in health and education outcomes and, to a lesser extent, labour-market participation, but do not systematically coincide with enhanced political representation or reduced domestic care burdens in the cross-sectional data. The negative associations between infrastructure expenditure and empowerment are particularly noteworthy and merit further investigation in the dynamic analyses that follow. One interpretation is that infrastructure spending, whilst beneficial for health and education, may not directly address the institutional, cultural, and political barriers that constrain women's agency and decision-making power. Alternatively, the cross-sectional correlations may mask dynamic or threshold effects wherein infrastructure investments require complementary policy reforms (such as gender quotas, childcare provision, or labour protections) to translate into empowerment gains. These possibilities further support the need to examine temporal dynamics and non-linear relationships in the subsequent econometric analyses.

Overall, these descriptive findings motivate the core hypothesis of this study: that fiscal and government

policy can play a crucial role in strengthening the interconnections between gender dimensions and overall outcomes. Specifically, targeted investments in both social and physical infrastructure may act as channels through which improvements in capabilities translate into better livelihoods and, ultimately, greater empowerment, though the strength and timing of these pathways may vary across contexts and depend on complementary institutional reforms. The moderate positive correlation between Capabilities and both Livelihoods and Empowerment suggests potential for policy-induced amplification effects, whilst the negative Livelihoods-Empowerment correlation highlights the risk that employment gains without corresponding agency enhancements may not constitute genuine progress toward gender equality.

In the sections that follow, we employ dynamic panel econometric methods, including Common Correlated Effects Mean Group Autoregressive Distributed Lag (CCE-MG-ARDL) models with threshold analysis and Structural Equation Modelling (SEM), to investigate these relationships more rigorously. These methods allow us to disentangle short-run and long-run effects, assess potential non-linearities and threshold effects in infrastructure-gender linkages, and evaluate the extent to which capabilities, livelihoods, and empowerment mediate one another's responses to infrastructure investments. As such, the descriptive correlations reported here serve as a foundation for more causal and dynamic inference in the subsequent analytical stages.

4 EMPIRICAL FINDINGS

In this section, we present the results of our empirical analysis, utilising a combination of methodologies including the Common Correlated Effects Mean Group (CCEMG) ARDL model, threshold analysis, and Structural Equation Modelling (SEM). Prior to the main analysis, we conducted preliminary tests to ensure the robustness of our approach. Specifically, unit root tests were performed to determine the stationarity of the variables, revealing that while some variables are stationary in levels, others are integrated of order one. Additionally, cross-sectional dependence tests indicated significant interdependencies across countries in our panel data. These findings necessitate the use of methodologies that account for both non-stationarity and cross-sectional dependence, thereby justifying the application of the CCEMG-ARDL approach in our analysis.

Table 11: Summary of Unit Root and Cross-Sectional Dependence Test Results

Variable	**Unit Root Test**	**CD-test**	**Variable**	**Unit Root Test**	**CD-test**
lnpinf	I(0)	115.80	lnsinf	I(0)	121.64
lnlfpr	I(1)	57.23	lnurbp	I(1)	-
lngdppc	I(1)	142.76	liv	I(1)	23.07
emp	I(1)	114.06	cap	I(1)	93.00

4.1 CCE-MG ARDL Results

CAPABILITIES

Table 12 summarises the empirical findings for our capabilities analysis and allows us to draw some conclusions from the data. First, the signifiant and positive long-term effect of social infrastructure spending on women's capabilities is aligned with the broader literature, which emphasises the importance of investments in education, healthcare, and social services. Several studies, including King and Mason, 2001; Duflo, 2012; Psacharopoulos and Patrinos, 2004; Unterhalter, 2005; Sen 1999; and Kabeer, 2005, have argued that targeted investments in social infrastructure — specifically in education, healthcare, and similar social services — are vital for building human capital, particularly for women who face disproportionate barriers in accessing these resources. The observed positive long-term impact therefore

suggests that sustained investments in social infrastructure are essential for improving key indicators such as literacy rates, maternal health, and educational attainment among women, thus contributing to their overall capabilities.

However, the relatively modest magnitude of this effect, despite its significance, warrants further consideration. It is possible that the benefits of social infrastructure spending take time to materialise, as suggested by Schultz (2002), who notes that improvements in education and health systems are often gradual. Similarly, Gakidou et al. (2010) highlight that while these investments are essential, their impact may be diluted if not accompanied by targeted policies that address gender-specific barriers. This may explain why the long-term effects, although positive, are not as large as one might expect. The delayed impact reflects the time it takes for improvements in social services to translate into measurable outcomes such as higher female labour force (LF) participation or better health outcomes.

Interestingly, the results for physical infrastructure spending show a positive long-term effect on capabilities, though this effect is not statistically significant. This finding is not surprising given the literature that associates infrastructure improvements with enhanced access to markets, schools, and healthcare facilities, which should theoretically contribute to women's capabilities in the long term (e.g. see Calderón and Servén, 2004; Duflo, 2012). The lack of significance in the long run, however, suggests that the benefits of physical infrastructure may be more indirect, potentially requiring a combination of complementary social services and policy interventions to be fully realised. For instance, Moser (1993) and World Bank Report (2012) note that while infrastructure development can improve access to essential services, the actual benefits for women depend on whether these services are accessible, affordable, and culturally appropriate.

In the short run, although these effects are not statistically significant, we see that both physical and social infrastructure spending exhibit negative effects on capabilities. This could be indicative of the immediate disruptions caused by large infrastructure projects, which might temporarily divert resources away from critical social services or even displace communities (Mitchell, 1995; Razavi, 2007). Such disruptions could hinder women's access to healthcare, education, or employment opportunities in the short term, thereby negatively impacting their capabilities. Another possibility that comes to mind is that social infrastructure spending, while crucial, is not often targeted towards women specifically. It is possible that these investments are broadly beneficial but not necessarily focused on the areas that would most significantly enhance women's capabilities in the short term. For example, if the spending is spread across various demographics and needs, women might not be the primary beneficiaries, or the impact on them might be diluted. Although these effects are not significant, they highlight the importance of careful planning and gender-sensitive implementation of infrastructure projects to mitigate potential negative short-term impacts.

The role of female labour force (LF) participation in enhancing capabilities also presents an intriguing aspect of the analysis. While the coefficients for female labour force (LF) participation are positive in the long run, they are not statistically significant. This suggests that simply increasing female participation in the labour market may not be sufficient to significantly enhance capabilities without addressing other structural barriers. Studies by Heintz (2006) and Kabeer (2008) suggest that the quality of employment, access to childcare, and the distribution of unpaid domestic work are critical factors that influence how labour force (LF) participation translates into broader capability outcomes. The insignificant results in this study might reflect the complexity of translating economic participation into tangible improvements in women's capabilities, particularly when women are concentrated in low-paying or precarious jobs.

The absence of significant effects for GDP per capita further complicates the picture. While GDP growth is often associated with improvements in overall economic conditions, it does not necessarily translate into enhanced capabilities for women, especially if the growth is not inclusive (Stotsky, 2006; Klasen and Lamanna, 2009). This aligns with findings by Seguino (2000) who argued that economic growth without gender-sensitive policies often fails to benefit women equally, particularly in terms of capabilities such

as health, education, and economic security.

These findings collectively suggest that while social infrastructure spending is critical for enhancing women's capabilities, the impact of physical infrastructure and female labour force (LF) participation is more complex and context-dependent. The results indicate that infrastructure investments, though necessary, need to be carefully targeted and integrated with complementary policies to ensure they effectively address the specific needs of women economic outcomes. This is consistent with the broader literature, which emphasises the need for gender-sensitive approaches to public investment to ensure that the benefits of such spending are equitably distributed and that they effectively address the barriers women face (Razavi, 2007; Grown et al., 2006).

Finally, the significant and negative error correction term as summarised in Table 12suggests a strong long-term relationship between the independent variables and capabilities, with about 53% of deviations from the long-term equilibrium being corrected annually. This indicates that while short-term disruptions might occur, the system tends to revert to a long-term equilibrium where social infrastructure investments positively impact women's capabilities. The speed of adjustment highlighted by this term suggests that policies targeting these areas can have a relatively quicker long-term impact, which is encouraging for policymakers aiming to improve gender equality through strategic investments in infrastructure.

As argued by İlkkaracan (2013), care-related employment, often referred to as "purple jobs," lies at the heart of sustainable development, challenging traditional hierarchies that privilege physical infrastructure over social investment. Similarly, Ghani et al. (2013) demonstrate that the impact of expansionary fiscal shocks on the gender composition of employment is far from uniform. In contexts such as India, where women constitute a large share of public employment, fiscal expansion focused on physical infrastructure may inadvertently reinforce gendered employment disparities. These findings highlight the importance of structural context: fiscal policy cannot be homogenised

LIVELIHOODS

The results from the CCE-MG ARDL ECM regression analysis on the livelihoods dimension offer some understanding of the economic opportunities and security available to women in different macroeconomic contexts. When we refer to livelihoods, we consider critical aspects such as women's participation in the labour force (LF), access to wage employment, and their share in the economic benefits within the broader market. These indicators are vital for gauging whether women can effectively utilise their capabilities in the economic arena.

Surprisingly, in the short run, neither physical nor social infrastructure spending shows a statistically significant effect on women's livelihoods. The coefficients for both are positive, suggesting that these forms of expenditure might move livelihoods in the right direction, but the lack of statistical significance indicates that these effects are not immediate or perhaps are counterbalanced by other short-term challenges. This aligns with findings from Duflo (2012) and Psacharopoulos and Patrinos (2004), who argue that the benefits of infrastructure spending, particularly on women's economic outcomes, often require a longer gestation period before they become evident. That said, the coefficients are all positive, so there's a likelihood that these factors might be moving in the right direction, just not in a way that's immediately measurable or impactful in the short term. The same goes for GDP per capita and the labour force (LF) participation rate — both of which also have positive coefficients but are not statistically significant.

Traditionally, we might expect that as an economy grows and more women join the workforce, their economic security and opportunities would improve correspondingly. However, the lack of significance in the short term might reflect the complexity of how these factors interact with women's livelihoods. Economic growth, as measured by GDP, does not necessarily translate into immediate gains for women, particularly if the growth is concentrated in sectors that do not predominantly employ women or if the benefits of growth are not equitably distributed (Seguino, 2000; Psacharopoulos and Patrinos, 2004).

In the long run, however, the analysis reveals some stark contrasts. Social infrastructure spending,

despite its positive coefficient, remains statistically insignificant. This suggests that while investments in education, healthcare, and social services are crucial, they may not have a robust or transformative impact on women's economic opportunities over time without complementary policies or more targeted interventions (King and Mason, 2001). This also aligns with Unterhalter (2005), who points out that social investments alone may not suffice to break down the barriers women face in the labour market and may require a more holistic approach that includes gender-sensitive economic policies.

The most striking finding is the significant negative long-term effect of physical infrastructure spending on women's livelihoods. The coefficient, at approximately -0.347, suggests that these investments may, in fact, erode women's economic security over time. This could be indicative of infrastructure projects that are not inclusive enough or that primarily benefit male-dominated sectors, thereby widening existing gender disparities. Razavi (2007) and Moser (1993) have similarly highlighted that without gender-sensitive planning, large infrastructure projects can often displace communities or divert resources from services that directly benefit women, thereby undermining their economic status.

The negative and significant relationship between GDP per capita and women's livelihoods in the long run further complicates the narrative. This suggests that economic growth, in its conventional sense, may not be benefiting women as much as it does men, or it could be exacerbating inequalities that disproportionately disadvantage women. This finding echoes the work of Klasen and Lamanna (2009), who argue that economic growth can sometimes entrench gender inequalities if the gains are not equitably distributed or if women continue to face barriers to accessing the benefits of growth.

In contrast, however, the significant and positive impact of female labour force (LF) participation on livelihoods highlights the important role of women's economic engagement. The coefficient suggests that as more women enter the labour force (LF), their economic opportunities and security improve significantly, reinforcing the importance of policies that promote female employment (Heintz, 2006; Braunstein, 2008). This finding also buttresses the livelihoods indicator as a suitable indicator of women's economic participation.

EMPOWERMENT AND AGENCY

The results from the CCE-MG ARDL ECM regression analysis provide insightful indications regarding the relationship between gender empowerment and various macroeconomic factors, including GDP per capita, physical infrastructure spending, social infrastructure spending, and the ratio of female to male labour force (LF) participation. The empirical results, as summarised in Table 12, show that the error correction term is negative and highly significant, suggesting a strong long-term relationship between the independent variables and gender empowerment, with about 52% of deviations from the long-term equilibrium being corrected annually.

The analysis reveals that social infrastructure spending has a significant negative effect on empowerment in the long run, which could suggest that while such investments are critical, they might not translate into long-term empowerment outcomes, or they might even face diminishing returns over time. This finding is consistent with some of the mixed results in the literature, where the effectiveness of social spending on gender outcomes can vary depending on the context (Braunstein and Heintz, 2008). In the short run, however, social infrastructure spending shows a positive effect, although significant at the 10% level, indicating that these investments might provide some immediate benefits to empowerment but may not sustain their impact in the long term.

These constrasting long- and short-run resulys may indicate that in the long run, there might be a scenario where continuous social spending leads to dependency without corresponding improvements in underlying structural factors, such as labour market conditions or entrenched social norms and discriminatory practices. As the initial benefits of social infrastructure investments saturate, the marginal gains might decrease, and the long-term empowerment effects could taper off or even become negative as we see from our findings. As such this might be in cotrast to the short-term positive effects of social infrastructure

spending might reflect the immediate benefits of services that support women's empowerment.

On the other hand, female labour force (LF) participation demonstrates a robust and highly significant positive impact on empowerment, both in the long run and the short run. A 1% increase in female labour force (LF) participation is associated with a substantial increase in the empowerment index, reinforcing the critical role of economic participation in enhancing women's agency and decision-making power, as highlighted by previous studies (Kabeer, 1999; Duflo, 2012).

The coefficients for GDP per capita and physical infrastructure spending, however, do not show significant effects in either the short or long run, suggesting that their impacts on empowerment may be more indirect or context-specific. That said, it is likely that physical infrastructure spending may have more indirect or lagged effects, which might not be immediately visible in our empowerment indicator. Moreover, while the physical infrastructure coeficnts are not significant in both period, they are negative - this could potentially indicate that such projects, which often create jobs and opportunities in sectors traditionally dominated by men like construction and engineering, might not directly empower women or improve their representation in decision-making roles.

Table 12: CCE-MG ARDL Estimation Results: Long-Run and Short-Run

Variable	**Livelihoods**	**Capabilities**	**Empowerment**
Long-Run Results			
GDP per Capita (Current US$)	-0.3491***	-0.1996	-0.0864
	(0.0747)	(1.0261)	(0.0968)
Physical Infrastructure Spending	-0.3469***	18.1593	-0.0147
	(0.0621)	(12.5367)	(0.0559)
Social Infrastructure Spending	0.0244	2.4173***	-0.1516***
	(0.0355)	(7.1010)	(0.0456)
Female to Male labour force (LF) Participation Rate	2.0617***	80.5060	2.9854***
	(0.4665)	(71.5542)	(0.2991)
Error Correction Coefficients			
ECT	-0.4766***	-0.5315***	-0.5177***
	(0.0482)	(0.1097)	(0.0524)
Short-Run Results			
GDP per Capita (Current US$)	0.0379	1.7464	-0.0388
	(0.2066)	(2.0785)	(0.1301)
Physical Infrastructure Spending	0.0099	-9.1163	-0.1924
	(0.1480)	(8.2224)	(0.1293)
Social Infrastructure Spending	0.0915	-28.1769	0.0869*
	(0.1150)	(21.2114)	(0.0498)
Female to Male labour force (LF) Participation Rate	0.7979	-3.7111	4.7065
	(0.6246)	(4.8406)	(5.2374)

Note: *, ** and *** represents 10%, 5% and 1% significance levels respectively. Standard errors are in parentheses. The coefficients are interpreted as the percentage change in the empowerment index for a 1% change in the independent variables.

The analysis of infrastructure spending on women's livelihoods, capabilities, and empowerment presents us with some findings which suggest that while social infrastructure spending generally contributes positively to women's outcomes, the magnitude of these effects is often modest and, in some cases, not statistically significant. This indicates that while investments in education, healthcare, and welfare services are essential, their impacts on improving women's economic opportunities, health, and social participation may be constrained by factors such as the broad allocation of resources, the implementation process, or the time required for these investments to translate into tangible benefits. Physical infrastructure spending, on the other hand, yields mixed results. In the short term, the disruptive effects or unequal distribution of benefits associated with these projects may hinder progress in women's livelihoods and capabilities. Even over the long term, the benefits of physical infrastructure spending for

women appear limited and statistically insignificant, highlighting potential gaps in how these investments are designed or executed with regard to gender inclusively.

One of the most consistent and significant findings across all dimensions is the critical role of women's labour force (LF) participation in the long run. This variable emerges as a robust driver of positive outcomes in economic security, capabilities, and participation, particularly in the long run. This underscores the importance of policies that actively promote and support women's engagement in the labour market. The strong positive impact of female labour force (LF) participation suggests that, beyond infrastructure investments, direct interventions to enhance women's economic participation are crucial for advancing gender equality. These results may suggest that while infrastructure spending is a key component of development, without gender-sensitive approaches and targeted policies, the benefits for women may be limited, and existing gender disparities could persist or even widen.

Given these findings, the next phase of our analysis will involve more detailed investigations through threshold-based analyses and structural equation modelling (SEM). The threshold analysis will help us explore whether the magnitude of physical versus social infrastructure spending affects gendered outcomes differently across various income levels—high, middle, and low to lower-middle-income countries. This approach will provide insights into whether there are critical levels of investment necessary to trigger significant improvements in gender outcomes. Additionally, SEM will allow us to examine the pathways through which fiscal expenditures influence gendered outcomes, identifying whether the effects of spending are mediated by factors such as labour market conditions or social norms. This further analysis may aid int understanding the indirect effects and potential causal mechanisms that drive the observed relationships, helping to refine our hypotheses and inform more effective, gender-responsive policy recommendations.

4.2 CCE-MG-ARDL: Threshold Analyses By Country Income level and Magnitude of Fiscal Expenditure

CAPABILITIES

The threshold analysis of the capabilities variable across different income groups (high-income, middle-income, and low-to-lower-middle-income countries), summarised in Table 13 reveal both expected and surprising patterns.

In **high-income countries**, the results indicate that social infrastructure spending tends to have positive effects on women's capabilities in high-income countries, particularly at the 25th and 50th percentiles. This suggests that in countries with already established infrastructure and institutional frameworks, additional spending on social services like education and healthcare continues to enhance women's capabilities. This aligns with findings from Morrissey (2012), who noted that in more developed contexts, the marginal returns on social infrastructure spending are generally positive as these investments build on an already solid foundation. However, the lack of significant effects at the 75th percentile may indicate diminishing returns, where further investments do not lead to substantial additional improvements,potentially due to inefficiencies or saturation in the impact of such spending, as Gupta et al. (2002) suggested in their work on fiscal policy and human development.

However, the results for **middle-income countries** present a stark contrast. Here, none of the fiscal variables show statistically significant impacts on capabilities, which might reflect the complex economic environments in these emerging economies. Such countries, often characterised by emerging markets and transitional economies, may be in a phase where the benefits of such spending are not immediately realised, or where investments are not sufficiently targeted to overcome existing structural challenges. This could be linked to the findings of Dollar and Gatti (1999), who argued that the effectiveness of social spending in promoting gender equality can vary significantly depending on a country's economic

Table 13: CCE-MG-ARDL Estimation Results for **Capabilities** (CAP) Based Country Income Groups

Variable	High-Income	Middle-Income	Low-to-Lower-Middle-Income
Long-Run Results			
GDP per Capita (Current US$)	-6.1885	2.1651	0.9220
	(6.6859)	(2.6573)	(3.3066)
Physical Infrastructure Spending (25th pct)	-0.5431	21.9635	-2.1349
	(0.3376)	(22.3390)	(1.7035)
Physical Infrastructure Spending (50th pct)	0.6900	0.8726	-0.0112
	(1.0712)	(1.0698)	(0.0116)
Physical Infrastructure Spending (75th pct)	0.1114	0.3332	1.9848
	(0.6620)	(0.9784)	(2.4048)
Social Infrastructure Spending (25th pct)	1.0900*	31.0867	2.4599
	(0.6300)	(30.6407)	(1.5951)
Social Infrastructure Spending (50th pct)	1.0041**	1.1642	0.0282
	(0.5187)	(0.9389)	(0.6325)
Social Infrastructure Spending (75th pct)	0.5642	0.4934	1.0470**
	(0.7337)	(0.3758)	(0.6329)
Error Correction Term			
ECT	-0.4615***	-0.3167***	-0.6612**
	(0.1031)	(0.0664)	(0.4845)
Short-Run Results			
GDP per Capita (Current US$)	0.9467	2.5020	0.1510
	(0.7624)	(3.8479)	(0.2954)
Physical Infrastructure Spending (25th pct)	0.3650	-2.0337	-0.0155
	(0.2262)	(1.8900)	(0.0103)
Physical Infrastructure Spending (50th pct)	0.5528	-0.2557	-0.0035
	(0.4623)	(0.1574)	(0.0032)
Physical Infrastructure Spending (75th pct)	0.1391	-0.1652	1.0233
	(0.5802)	(0.1692)	(1.0511)
Social Infrastructure Spending (25th pct)	-0.1659	-19.2221	-0.0128
	(0.3361)	(19.2104)	(0.0202)
Social Infrastructure Spending (50th pct)	0.1276	0.0643	-0.0830**
	(0.1202)	(0.1791)	(0.0441)
Social Infrastructure Spending (75th pct)	0.9774	-0.0957	1.5637
	(1.0235)	(0.1699)	(1.6524)

Note: *, ** and *** represent 10%, 5%, and 1% significance levels, respectively. Standard errors are in parentheses.

and institutional context.

In these settings, it might be that the returns on social infrastructure are more contingent on addressing deeper institutional barriers, such as entrenched gender norms or unequal access to resources, rather than simply increasing spending. Also, this may imply that other factors such as private sector dynamics, market-driven opportunities, and institutional frameworks may play a more critical role in shaping women's outcomes than direct government spending. This is consistent with the findings of Braunstein and Heintz (2008), who argue that in such emerging economies, economic growth and gender equality are often driven more by market forces than by state intervention.

The results in **low-to-lower-middle-income countries** provide a particularly intriguing narrative. While higher levels of social infrastructure spending seem to improve women's capabilities in the long run, a negative effect is observed in the short term at the 50th percentile. This might reflect the initial disruption caused by new infrastructure projects, as suggested by Bradshaw and Linneker (2003), who highlighted how large-scale infrastructure initiatives can temporarily displace local economic activities or create shifts in traditional roles, particularly in contexts where women's livelihoods are closely tied to local economies and informal work. This disruption might initially disadvantage women before the long-term benefits of improved social services begin to materialise.

The results for physical infrastructure spending are equally complex. Across all income groups, physical infrastructure spending does not have a statistically significant effect on women's capabilities in either the short or long run. This is counterintuitive, given that infrastructure improvements are typically seen as drivers of economic growth and opportunity. One possible explanation is that physical infrastructure projects, while beneficial for overall economic development, may not directly benefit women if these projects are not designed with a gender-sensitive approach. Even in high-income countries, where infrastructure is already more developed, new projects might primarily enhance sectors or regions that are male-dominated, thereby failing to address or even exacerbating existing gender disparities. As Es-

candón (2019) discusses, infrastructure projects often overlook gendered impacts, which could explain why physical infrastructure spending does not significantly improve women's capabilities, even in varied developmental contexts.

LIVELIHOODS

The results from the CCE-MG-ARDL estimation for livelihoods presented in Table 14 reveal some nuanced insights into how infrastructure spending impacts women's economic opportunities across different income groups.

Table 14: CCE-MG-ARDL Estimation Results for Livelihoods (LIV) Based on Country Income Groups

Variable	High-Income	Middle-Income	Low-to-Lower-Middle-Income
Long-Run Results			
GDP per Capita (Current US$)	0.4574	-0.4327	-0.3284
	(0.6154)	(0.6790)	(0.4829)
Physical Infrastructure Spending (25th pct)	-0.7038	1.6022	0.2685
	(0.5876)	(1.4309)	(0.1866)
Physical Infrastructure Spending (50th pct)	-0.3177	1.6508	0.6201
	(0.7235)	(1.1724)	(0.4971)
Physical Infrastructure Spending (75th pct)	0.5333	1.6666	0.4168
	(0.3907)	(1.1544)	(0.5522)
Social Infrastructure Spending (25th pct)	1.1437**	-0.5610	-0.4766**
	(0.5216)	(0.7181)	(0.2488)
Social Infrastructure Spending (50th pct)	1.5636***	-0.3319	-0.5949
	(0.6031)	(0.6979)	(0.3752)
Social Infrastructure Spending (75th pct)	0.8345	-0.6436	0.4500
	(0.5970)	(0.5268)	(0.3613)
Error Correction Term			
ECT	-0.3915***	-0.3068***	-0.4923***
	(0.0515)	(0.0541)	(0.1172)
Short-Run Results			
GDP per Capita (Current US$)	0.3452	0.0208	0.0415
	(0.4424)	(0.3107)	(0.2133)
Physical Infrastructure Spending (25th pct)	0.3733	-0.0281	-0.0811
	(0.2470)	(0.0286)	(0.0583)
Physical Infrastructure Spending (50th pct)	0.2268	-0.1338**	0.3382
	(0.3093)	(0.0650)	(0.3288)
Physical Infrastructure Spending (75th pct)	-0.2081	-0.2671	0.3229
	(0.1451)	(0.1706)	(0.3316)
Social Infrastructure Spending (25th pct)	-0.3893	-0.0067	-0.1451
	(0.4380)	(0.0483)	(0.2342)
Social Infrastructure Spending (50th pct)	-0.1221	0.0849	-0.1370
	(0.2256)	(0.0686)	(0.2350)
Social Infrastructure Spending (75th pct)	0.0249	0.1875	-0.1337
	(0.1645)	(0.1658)	(0.2327)

Note: *, ** and *** represent 10%, 5%, and 1% significance levels, respectively. Standard errors are in parentheses.

In **high-income countries**, the significant positive effects of social infrastructure spending at the 25th and 50th percentiles on women's livelihoods highlight the effectiveness of moderate investments in sectors like healthcare, education, and social services. These investments are crucial for enabling women to participate in the labour market, balance work and family responsibilities, and access better job opportunities. For instance, affordable childcare can increase female labour force participation by freeing up time for paid employment, while improvements in healthcare reduce the time women spend on unpaid caregiving, further supporting their economic activities.

This finding is consistent with earlier studies, such as those by Kabeer (1999) and Esping-Andersen (2002), which emphasise that social investments play a critical role in enhancing women's economic participation and capabilities by addressing specific needs like care work and education. These studies, like our findings, suggest that social infrastructure is a vital component of supporting women's entry and retention in the labour market. This finding is also consistent with the capabilities results, where social infrastructure spending also showed positive long-term impacts, suggesting that targeted investments in education, healthcare, and social services contribute to both enhancing women's economic participation and their broader capabilities.

However, the smaller, non-significant effect at the 75th percentile suggests diminishing returns on social

infrastructure spending as investment levels increase. While it is true that foundational infrastructure is likely already well-developed in high-income contexts, leading to fewer gains from additional investments, there may be other factors at play as well. One possible explanation is that as social infrastructure spending grows beyond a certain point, it could create unintended trade-offs. For example, extensive public investment might inadvertently encourage over-reliance on government-provided services, reducing incentives for private sector engagement or individual labour force participation. This aligns with arguments presented by scholars such as Ostry et al. (2018), who note that excessive social spending in already well-serviced areas may lead to inefficiencies. The smaller positive coefficient at the 75th percentile, though not statistically significant, might reflect these complexities where increased public investment could inadvertently dampen the potential for private initiatives or create dependencies that do not necessarily translate into higher economic participation for women.

The lack of significant effects from physical infrastructure spending in high-income countries also supports the idea that these investments may have limited marginal utility where existing infrastructure is robust. Calderón and Servén (2010) suggest that once a basic infrastructure base is well-established, further investments in physical infrastructure might not significantly enhance women's economic opportunities. In these contexts, women might benefit more from targeted social infrastructure that directly addresses gender-specific barriers, rather than from broad physical infrastructure projects that do not specifically cater to the needs of women in the workforce.

In **middle-income countries**, the situation is more complex. The negative short-term impact of physical infrastructure spending at the 50th percentile is particularly striking and suggests that these investments might reinforce existing gender inequalities rather than alleviate them. Physical infrastructure projects, often concentrated in male-dominated sectors like construction and transportation, may disproportionately benefit men, widening the gender wage gap and failing to create new opportunities for women. The increasing negative coefficients as spending moves from the 25th to the 75th percentile further indicate that larger projects may be more disruptive or may entrench existing economic structures that marginalise women. For example, large infrastructure projects often involve significant private sector investment, which might prioritise profitability over inclusivity, leading to outcomes that do not favour women. These findings align with Grown et al. (2006), who emphasise that infrastructure projects focused on economic growth frequently overlook women's needs unless gender considerations are explicitly integrated.

In **low-to-lower-middle-income countries**, the negative long-term effects of social infrastructure spending on women's livelihoods are particularly concerning. After adjusting the latent variable to account for the directionality of the indicators (inverting self-employment and unemployment rates), we see that these negative effects persist, which suggests deep structural issues. The non-inverted model, which showed a significant negative impact at the 25th percentile, suggests that minimal investments in social infrastructure may not only be insufficient but could also have unintended consequences. These could include increased dependency on under-resourced services or the disruption of informal economies that women rely on.

Another possible explanation is that in these countries, social infrastructure spending—such as on healthcare and education—may not be reaching the most vulnerable populations or may be poorly implemented. If these investments are not complemented by efforts to improve access for women or to address cultural and economic barriers, they might not translate into better livelihoods. For instance, if new schools are built but girls are still unable to attend due to cultural norms or safety concerns, the investment won't improve women's economic opportunities. Similarly, Chant (2010) discusses how in low-income contexts, socio-economic barriers can significantly blunt the impact of even well-intentioned policies and investments. It is also worth noting that as social spending increases to the 75th percentiles in these lower income economies, the livelihoods coefficients become positive, though not statistically significant. This shift hints at a potential threshold effect, implying that while smaller investments fail to overcome the substantial barriers women face in these economies, larger investments may start to address these

challenges more effectively.

However, when we inverted the livelihoods variable to better reflect the expected direction of economic outcomes, the negative effects persisted but were not statistically significant. This lack of significance in the inverted model, combined with a higher log-likelihood in the non-inverted format, indicates that while the initial negative impact observed at low levels of spending might be relevant, the overall picture is potentially one of inadequately implemented investments that fail to fully address women's needs.

To provide further insight into the patterns observed in livelihoods, we also examined the granular effects of public spending by looking at the individual indicators that make up the livelihoods variable—such as the ratio of female to male wages, labour force participation, part-time employment, and self-employment to gain a deeper understanding of how social and physical infrastructure spending affects women's economic outcomes across high-, middle-, and low-income countries. This granular analysis of the individual livelihoods indicators further illuminates these challenges above.

In high-income countries, social infrastructure spending at the 25th and 50th percentiles significantly boosts labour force participation and moderately improves wage equality in the short term, though the latter effect diminishes over time, suggesting that sustaining wage equality may require additional targeted policies. In middle-income countries, physical infrastructure spending at the 50th percentile appears to exacerbate gender disparities, particularly in wage equality, likely due to investments favouring male-dominated sectors like construction, while also failing to enhance women's labour force participation or self-employment opportunities.

In low- to lower-middle-income countries, the initial negative effects of lower levels of social infrastructure spending highlight the inadequate reach and implementation of these investments, which may displace women from informal sectors without providing adequate formal employment opportunities. Although higher levels of investment show some potential for positive impact, their lack of statistical significance highlight the need for complementary policies that directly address the structural barriers women face in these economies. More so, in low- to lower-middle-income countries, the lack of significant improvements in labour force participation and wage equality suggests that social infrastructure spending may not be overcoming the deep-rooted socio-economic barriers that women face, such as limited access to education, healthcare, and formal employment. The potential displacement of women from informal sectors, without sufficient formal job opportunities being created, could explain the observed negative impact on self-employment rates at higher levels of social infrastructure spending.

These findings indicate that while infrastructure spending has the potential to improve women's livelihoods, its effectiveness depends heavily on the scale, design, and targeting of the investments. Smaller investments might not only be insufficient but could also exacerbate existing inequalities if they fail to address the specific challenges women face in these economies. Therefore, a more nuanced and targeted approach to social infrastructure spending is necessary to ensure that these investments truly benefit women across different income contexts.

EMPOWERMENT

The analysis of the empowerment dimension across different country income groups reveals some intriguing and, in some cases, counterintuitive results that merit deeper consideration, and is presented in Table 15. Recall that, Empowerment, as defined in this study, encompasses the collective ability of women to shape decision-making in productive roles, political spaces, and within households, as framed by Eyben et al. (2008).

For our **high-income countries**, we find a lack of significant long-term effects from GDP per capita and infrastructure spending — whether physical or social — on women's empowerment. These results suggest that in countries with already established economic and institutional structures, additional fiscal

Table 15: CCE-MG-ARDL Estimation Results for Empowerment (EMP) Based on Country Income Groups

Variable	High-Income	Middle-Income	Low-to-Lower-Middle-Income
Long-Run Results			
GDP per Capita (Current US$)	0.6613	1.0789***	-38.1556
	(0.5587)	(0.3852)	(40.4149)
Physical Infrastructure Spending (25th pct)	0.2416	0.5003**	-0.2381
	(1.0770)	(0.2561)	(0.2359)
Physical Infrastructure Spending (50th pct)	-1.1660	1.5130	-0.6150
	(0.9481)	(0.9462)	(0.6272)
Physical Infrastructure Spending (75th pct)	-0.7368	1.3814	-64.5904
	(0.7175)	(0.9488)	(63.6601)
Social Infrastructure Spending (25th pct)	1.7693	0.1485	0.4066
	(1.6001)	(0.4456)	(0.2999)
Social Infrastructure Spending (50th pct)	1.9412	0.5584	82.3731
	(1.5574)	(0.5631)	(82.2712)
Social Infrastructure Spending (75th pct)	0.6843	0.5384	81.9575
	(0.6158)	(0.3361)	(81.6279)
Error Correction Term (ECT)			
ECT	-0.4003***	-0.3714***	-0.2758**
	(0.0759)	(0.0459)	(0.1251)
Short-Run Results			
GDP per Capita (Current US$)	0.0717	-0.3947	-0.3588
	(0.2343)	(0.5934)	(0.2441)
Physical Infrastructure Spending (25th pct)	-0.1376*	-0.1379*	-0.0010
	(0.0822)	(0.0813)	(0.0026)
Physical Infrastructure Spending (50th pct)	-0.0605	-0.4623	-0.7982
	(0.1826)	(0.3078)	(0.7954)
Physical Infrastructure Spending (75th pct)	0.0363	-0.4404	-0.4509
	(0.0744)	(0.3202)	(0.8740)
Social Infrastructure Spending (25th pct)	-0.0831	0.0038	0.4589
	(0.4231)	(0.0779)	(0.4284)
Social Infrastructure Spending (50th pct)	0.0829	-0.2752**	0.5937
	(0.3608)	(0.1258)	(0.4232)
Social Infrastructure Spending (75th pct)	-0.1929*	-0.3121**	0.5960
	(0.1032)	(0.1495)	(0.4277)

Note: *, ** and *** represent 10%, 5%, and 1% significance levels, respectively. Standard errors are in parentheses.

investments may not be the primary drivers of women's empowerment. This aligns with studies like those by Duflo (2012), which suggest that beyond a certain point, empowerment is less about resource availability and more about how effectively women can leverage existing structures and opportunities. In such contexts, empowerment might be more influenced by cultural and social norms or by legal frameworks that ensure women's participation in political and economic decision-making. Therefore, the results could be highlighting the limitations of fiscal policy in further advancing gender equality in highly developed economies, where the onus may shift towards addressing more subtle, ingrained societal barriers rather than increasing spending (e.g. see Alesina and La Ferrara, 2005).

The short-run results reveal a complex picture for high income countries, particularly regarding the negative and statistically significant effects of physical infrastructure spending at the 25th percentile and social infrastructure spending at the 75th percentile. The negative impact of physical infrastructure spending at the 25th percentile may reflect its maintenance-focused nature, common in high-income countries, which typically involves routine upkeep or updating of infrastructure dominated by male workers. This type of spending may inadvertently reinforce existing gender disparities by failing to create new opportunities for women in the workforce or leadership roles. Additionally, the small-scale nature of this spending might not be sufficient to drive the structural changes necessary for women's empowerment, highlighting the need for targeted policies that actively promote women's participation and leadership.

The negative effect of social infrastructure spending at the 75th percentile is particularly intriguing, as it suggests that while high levels of social spending may stabilise women's well-being by meeting immediate needs and being crusial for huan capital development, they might not necessarily empower women to take on more influential roles in society. This paradox could arise because extensive social safety nets reduce the pressure for women to engage actively in economic or political life. Furthermore, in high-income countries, substantial investments in education, healthcare, or welfare might not yield immediate

benefits in terms of empowerment, as these effects may take longer to materialise. This emphasises the idea that empowerment, particularly in political and economic leadership, is a long-term process that requires sustained efforts and targeted interventions.

In **middle-income countries**, the results suggest a somewhat different dynamic. Here, we observe a significant positive long-term effect of physical infrastructure spending at the 25th percentile on women's empowerment. This finding might indicate that in these economies, which are often in transition and still developing their infrastructure, even modest investments can have substantial impacts. Improved infrastructure such as transportation and energy networks may enhance women's mobility, access to markets, and economic opportunities, thereby contributing to their empowerment. However, the lack of significant effects from higher levels of physical infrastructure spending might reflect the limitations of such investments when not accompanied by targeted policies that ensure women benefit equally. In these contexts, infrastructure projects might still be male-dominated or might fail to address specific barriers that women face in accessing economic and political opportunities.

Moreover, the significant positive effect of GDP per capita on empowerment in middle-income countries may aslo buttress the conclusion above by showcasing the importance of economic growth as a driver of women's agency in these contexts. These findings suggest that as these countries experience economic expansion, opportunities for women to participate in economic and political life also expand. This could be due to improvements in education, healthcare, and general labour market conditions that often accompany economic growth, as posited by studies such as Seguino (2016), even when these may not be specifically targetted at women or yield similar short-run results, as we find here too. Interestingly, the middle-income group also exhibits a negative and statistically significant short-term effect of physical infrastructure spending at the 50th percentile. This suggests that while social infrastructure is essential for long-term development, its immediate impact on women's empowerment may be limited, possibly because such spending does not directly address the entrenched societal norms or systemic barriers that hinder women's participation in leadership and decision-making roles.

In low-to-lower-middle-income countries, the results are marked by high variability in coefficients and large standard errors, indicating a lack of statistically significant effects from both physical and social infrastructure spending on women's empowerment. This suggests that in these contexts, fiscal spending on infrastructure does not have a clear or consistent impact on empowerment outcomes. The variability in results could reflect the complexities and challenges of implementing effective infrastructure projects in these settings, where socio-economic barriers are deeply entrenched and where the benefits of such investments are not easily realised. It may also suggest that in these contexts, the infrastructure is either too underdeveloped for fiscal spending to have an immediate impact, or the spending is not effectively reaching the most vulnerable populations, including women. These findings highlight the need for more targeted and nuanced approaches to infrastructure spending in low-income countries, recognising that simply increasing fiscal expenditure may not be sufficient to overcome the significant barriers to women's empowerment.

Overall, these findings suggest that while fiscal spending on infrastructure can support women's empowerment, its effectiveness is highly contingent on the context, the type of infrastructure, and the specific design and implementation of these investments. In high-income countries, where basic infrastructure is already well-developed, the returns on additional spending may be limited, particularly in the short run. In middle-income countries, the benefits of infrastructure spending are more evident in the long run but may be offset by short-run disruptions or dependencies that undermine empowerment. In low-to-lower-middle-income countries, the lack of significant results underscores the challenges these countries face in using fiscal spending to promote empowerment, suggesting that more comprehensive and integrated strategies are needed to achieve meaningful progress in this area.

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4.2.1 APPENDIX 1

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Table 16: Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Physical Infrastructure Spending (*lnpinf*)	24.25	2.70	6.86	30.53
Social Infrastructure Spending (*lnsinf*)	24.71	2.90	7.03	31.70
GDP per capita (*lngdppc*)	9.39	1.47	5.22	11.80
Ratio of Female to Male Labor Force Participation (*lnlfpr*)	4.28	0.29	2.59	4.69
Urban Population (% of total) (*lnurbp*)	4.17	0.38	2.18	4.61
Livelihood Index (*liv*)	-1.34e-10	0.99	-2.94	2.42
Empowerment Index (*emp*)	3.10	30.26	-62.95	192.86
Capabilities Index (*cap*)	20.99	128.17	-39.63	1180.14

4.2.2 APPENDIX 2

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Table 17: Appendix: Country rankings by construct (2023)

Capabilities		Livelihoods		Empowerment	
Rank	**Country**	**Rank**	**Country**	**Rank**	**Country**
1	Cyprus	1	Madagascar	1	Norway
2	Hungary	2	Iceland	2	Sweden
3	Netherlands	3	Moldova	3	Finland
4	Costa Rica	4	Netherlands	4	Denmark
5	United Kingdom	5	Norway	5	Spain
6	Denmark	6	Israel	6	Estonia
7	Switzerland	7	Australia	7	Costa Rica
8	Poland	8	Germany	8	Switzerland
9	France	9	Switzerland	9	Belgium
10	Belgium	10	Ireland	10	Netherlands
11	Chile	11	Denmark	11	Germany
12	Greece	12	United Kingdom	12	Iceland
13	Sweden	13	China	13	Lithuania
14	Luxembourg	14	Sweden	14	Belarus
15	Croatia	15	Malta	15	France
16	Ukraine	16	Austria	16	Portugal
17	Austria	17	Belarus	17	Austria
18	Kazakhstan	18	Luxembourg	18	Poland
19	Latvia	19	Finland	19	Luxembourg
20	Finland	20	Cyprus	20	Moldova
21	Guatemala	21	Estonia	21	Latvia
22	Portugal	22	Slovenia	22	Slovenia
23	Romania	23	Kazakhstan	23	Australia
24	Estonia	24	Belgium	24	Croatia
25	Lithuania	25	Hungary	25	United Kingdom
26	Belarus	26	Portugal	26	Cyprus
27	Italy	27	Poland	27	Israel
28	Iceland	28	Lithuania	28	Romania
29	Kuwait	29	Latvia	29	Chile
30	Israel	30	France	30	Greece
31	Germany	31	Bulgaria	31	Nepal
32	China	32	Kuwait	32	Ireland
33	Mauritius	33	Chile	33	Malta
34	Slovenia	34	Croatia	34	Ukraine
35	South Africa	35	Romania	35	Italy
36	Moldova	36	Spain	36	South Africa
37	Bulgaria	37	Italy	37	Mauritius
38	Spain	38	Guatemala	38	Bulgaria
39	Nepal	39	Mauritius	39	Madagascar
40	Malta	40	Ukraine	40	Pakistan
41	Australia	41	Costa Rica	41	China
42	Ireland	42	Greece	42	Kuwait
43	Madagascar	43	Pakistan	43	Hungary
44	Norway	44	Nepal	44	Guatemala
45	Pakistan	45	South Africa	45	Kazakhstan