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Effects of Vision Umurenge Programme (VUP) Public Works Benefits on Households' Financial Resources Allocations in Rwanda: Application of SUR Models

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Abstract

The analysis of the effects of monetary benefits from the Vision Umurenge Programme (VUP) Public Works on households' financial resource allocations in Rwanda was conducted to assess the statistical significance of this major social safety net programme in poverty reduction among poor households. Specifically, it focused on the contribution to increased aggregate expenditure, food and non-food consumption, savings, and human capital development. The analytical framework utilized data from the latest available Rwanda's Integrated Living Conditions Survey (EICV5) of 2016/17 and published in 2018, and we applied the seemingly unrelated regression model to capture the programme's joint effects on simultaneous financial decision-making by individuals. The results demonstrate a statistically significant and positive effects of VUP Public Works benefits on households' aggregate expenditure, and food and non-food consumption. This effect is even more pronounced among extremely poor households, confirming the achievement of one of the VUP Public Works' policy objective of providing protective support to able-bodied poor individuals in Rwanda. However, the data do not indicate any significant effect of VUP Public Works on individual savings or investment in education, and there is evidence of a significant gender divide in the impact of VUP Public Works. This analysis generates evidence on protective potential of public works programme in Rwanda, however, there is limited evidence on programme

effects on local economies promotion through secondary employments, thus further studies should empirically investigate those effects.

Key words: Public Works, Resources allocations, Regression, VUP, Poverty

1. Introduction

The fight against poverty and the promotion of inclusive development are global endeavors, with varying programmes and interventions implemented by different state governments and other development practitioners. Evidence shows that, over the past half century, countries have pursued diverse strategies to alleviate poverty, accelerate economic growth, and enhance socio-economic resilience. For instance, China's successful anti-poverty programmes combined agricultural and economic reforms in rural areas. In contrast, many Latin American countries have primarily implemented social protection programmes characterized by both conditional and unconditional cash transfers to poor households. Meanwhile, African countries have largely focused on agricultural reforms, which have yielded a slower pace of monetary and no-monetary poverty reduction (Fan & Cho, 2021).

Additionally, throughout the past decades, public works programmes (PWs) have been increasingly taking the centrality in governments' initiatives to respond to household employment needs, income shocks and ultimately to reduce poverty. Also, PWs constitute key component of current social protection provision in many sub-Saharan African countries (McCord, 2012).

The World Bank poverty report of 2018 estimates that 36% of very poor people escaped extreme poverty because of social safety nets worldwide. The safety nets programmes examined include cash and in-kind transfers, social pensions, public works, and school feeding, health insurance premium exemption programmes which targeted poor and vulnerable households. The same report further highlights that the noncontributory social safety nets or social assistance interventions are designed to help individuals and households cope with chronic poverty, destitution, and vulnerability (The World Bank, 2018). Studies suggest that while social safety nets play a significant role in improving individual welfare, their success depends on several factors, including government commitment, efficient targeting of beneficiaries, minimizing leakages, and strengthening monitoring and supervision at various levels of programme governance and delivery (Wetengere & Sabuni, 2015). This suggests that each social protection programme needs to be

critically and empirically evaluated to generate necessary evidence for informing the implementation design and timely programme adjustments to maximize the impact among the beneficiaries.

Additionally, a study on wealth constraints and aggregate consumer behaviour, hypothesizes that not all agents behave rationally, some perform spending out of the current value of discounted future income, while other agents spend out of current and lagged income and wealth (Weale, 1990). Additionally, evidence suggests that individual's financial decisions (spending on consumption, entrepreneurship development, saving behaviour, portfolio investments, transfers among others) are influenced by the level of financial literacy, preferences, risk attitudes, beliefs, expectations, and financial products available including the quality of financial advice that households receive (Loibl, Living in Poverty: Understanding the Financial Behaviour of Vulnerable Groups, 2017; Xu, Yang, Ali, Li, & Cui, 2022).

The Rwanda's National Social Protection Sector Strategy and Social Protection Policy define Social Protection as "a set of public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks and enhance the social status and rights of the marginalized people with the overall objective of reducing the social and economic vulnerability and foster inclusive economic growth" (Ministry of Local Government (MINALOC), 2013).

The Government of Rwanda instituted the Vision Umurenge Programme (VUP) in 2008 with the aim of accelerating poverty reduction through a stronger productive capacity of the poor and extremely poor people and ensuring job and community assets creation. Since its inception, VUP has been implemented through three components, first as direct support (Unconditional cash transfers to needy households), second as public works (paid employment on productive community asset development projects) and third as financial services (access to financial services for the poor and financial literacy). Moreover, VUP public work had two policy objectives on one hand it's meant to release the productive capacity of the poor and extremely poor households, and prevent people from falling in the destitution, deal with socio-economic shocks. On the other side, public works programme was designed to foster the use of community-based participatory approaches to build community assets and create an off-farm employment (MINECOFIN, 2007).

It is believed that VUP Public Works has been given priority in resource allocations among other components. The guiding document of fiscal allocations formula of the public budget on social protection programmes shows that, VUP public works allocation was to set at 50%, the budget for VUP direct support was capped at 20%, while the share of financial services was 30% (Rwanda Local Development Support Fund (LRLDSF, 2011). Additionally, the World Bank (2019) concluded that this distinction aimed at consolidation of efforts to allow physically able adult population from extremely poor households can work in developing and maintaining public infrastructure for a guaranteed wage, offer unconditional cash transfers to extremely poor households without or with physically constrained capacity to work.

Recent studies on social protection programmes effectiveness in poverty reduction, and financial behaviour had focused on cash transfers either conditional or non-conditional programmes (Fiszbein, et al., 2009; Slater, 2011; Nanak Kakwani, 2005; Sabates, Bhutoria, Sabates-Wheeler, & Devereux, 2019), however, public works under social protection programmes remain weakly analysed in the academic sphere which leave limited evidence to accurately inform policy and decision makers. This knowledge gap deepens more in Rwandan context as the analysis VUP Public works programme on improving household welfare through increased household consumption, investment and other expenditure remains limited.

The proponents of Public Works programme believe that beyond the social protection objectives of income provision to poor households, PWs respond to the request for productive safety nets, transformative social protection, and graduation from poverty which further promote labour market participation and ultimately leading to broad and inclusive economic growth (Jacob & Pedersen, 2018).

However, a major criticism of public works, not only in Rwanda but also elsewhere, is that these schemes are implemented on a small scale, transitory and consist of disconnected individual programmes that are too small to make a significant impact on immediate unemployment and poverty situations. Second, there are associated inclusion and exclusion errors in programme participation, leading to ineligible beneficiaries participating in the programme. Finally, there are issues stemming from the design and implementation of public works at the local level, including capital limitations and technical and administrative constraints that affect programme effectiveness and efficiency (Dejardin, 1996; McCord, 2017).

It's against the above background, that this study aims to empirically assess the contribution of VUP public works programme on improving individual aggregate expenditure and household's savings in Rwanda using a nationally representative survey data as collected through the Integrated Household Living Condition Survey in 2016/17, commonly known as *Enquête Intégrale sur les Conditions de Vie de Ménage au Rwanda* (EICV). Specifically, this analysis explored how the VUP public works programme contributes to individual financial decisions amidst constrained income through simultaneous decisions making framework. The analysis further explores how individuals allocate income and benefits from public works to food and non-food expenditure items as well as performing personal savings for future investments or human capital development through education. Therefore, the analysis was guided by three main constructs:

- There is a statistically significant positive relationship between monetary benefits from VUP Public Works and individual aggregate expenditure including food and non-food consumption.
- VUP Public Works benefits contribute positively to increased personal savings, and investment in education for human capital development.
- Influence of VUP Public works benefits on households' financial resources allocation is pronounced when complemented with own food and non-food household production.

2. Literature review

2.1.Overview of Public Works Programme in social protection programming

Data show that there is a triangular relationship between productive employment, income, and poverty reduction. While a country's GDP growth is considered by mainstream economists as a necessary condition, it is not a sufficient condition for broad-based growth and poverty reduction in particular (Islam & Majeres, 2001). Public Works are therefore, meant to provide the basic income to support households' consumption and contribute to enabling access to other services or products, thus prevent the distress selling of households' assets in order to meet subsistence or emergency needs. PWs also are credited to have a community development dimension, as in most of the cases, they enable the creation and/or maintenance of productive infrastructure, such as roads, forestation, soil erosion reduction, community water provision, land terraces, irrigation

systems among others (Dejardin, Public Works Programmes, a Strategy for Poverty Alleviation:The Gender Dimension, 1996).

Public Works programmes have multiple channels through which they impact participants in both the short and medium terms. The main transmission channels are summarized as follows: (i) through a combination of short-term income and substitution effects, income gained by underemployed or non-employed individuals can provide an opportunity to transition away from low-paid farm and off-farm work; (ii) since unemployment and poverty are positively correlated with mental distress, participation in public works can enhance an individual's psychological well-being; (iii) when programmes are designed to encourage the participation of women or marginalized groups in the labor market, earned income has the potential to improve economic empowerment and autonomy; and (iv) in the medium term, once the programmes conclude, they have the potential to increase household income and consumption expenditure through accumulated savings, investment, and acquired skills (Bagga, et al., 2023).

While PWs is a common nomenclature, however, the design structure differs by the delivery, programme governance, and the payment approaches. A study on whether public works for the poor provides more information on PW programme categorization by mode of delivery and the mode of payment; (i) short term employment, (ii) on going and repeated employment with structural change targeting provision of public infrastructure, training, and other political outcomes, and (iii) small, localized employment. The author offered further programme differentiation which is linked with the benefits payment. In this respect, there are two main categories of PWs programme, one is in cash payment, which by principle, should be low to the labour market to avoid disruption and people's preference shift, and the second category relates to in-kind payments which include food payment, agriculture inputs payment such as fertilizers and seeds (McCord, Public works and social protection in sub-Saharan Africa: Do public works work for the poor?, 2012). However, it's worth emphasizing that PWs programmes are currently considered as a means of providing income support to the poor in critical times rather than as a way of getting the unemployed back into the labor market (Subbarao, Systemic Shocks and Social Protection: Role and Effectiveness of Public Works Programs, 2003).

In Rwanda, since the early phase of inception, the VUP public works programme has been linked with the mainstream definition of all other Public Works as discussed in the previous sections of

this research. The ministerial guidelines of VUP implementation highlight two main features, mainly; (i) Productive, this is meant to stopping households from falling below survival levels. Under this model, VUP programme cushion households from economic distress and prevent low income households and individuals from adopting worsening copying mechanisms including distress selling of their productive assets; (ii) Protective which relates to reducing risk, encouraging risks taking behaviour among the programme participants to predictable transfers and wages, creating employment opportunities as a base for savings, taking credit, building community assets, and nurturing entrepreneurial culture (Ministry of Local Government (MINALOC), 2009).

Evidence suggests that for public works to release productive potential of the programme participants, five priority considerations are needed: (i) examining the aggregate supply and elasticity of labour supply of under-employed population, low-cost labor in relation to prevailing labor market conditions; (ii) ensuring alignment of the cost of non-labor resources, such as food, allows programme participants to maintain minimum and protective living expenditures; (iii) ensuring the quality of work to complement labor in achieving high levels of productivity; (iv) assessing the likelihood of reducing poverty through employment support where public works are executed; and (v) evaluating the overall productivity of the works by including non-public works participants (Mellor, 2002).

The ministerial implementation guidelines of VUP public works programme highlights the following eligibility criteria of participation; (i) Community participation through the use of community level (*Ubudehe*) categorization which was implemented through a social map, and the lowest categories were given priority, (ii) complementary measurable indicators such as non-income household characteristics that reliably distinguish the very poor in the community including lack of land ownership and (iii) availability of jobs qualifying for public works.

Over time, VUP public works was reformed with the introduction of the VUP expanded public works (ePWs) programme which is a scheme providing part-time (at least 2 hours per day) multi-year, and year-round employment. With the introduction of ePWs, the initial scheme has been labeled classic public works (cPWs) providing short-term, temporary employment on community infrastructure and environmental projects. (Local Administrative Entities Development Agency (LODA), 2022). This analysis has not, however, made the distinctions of the two PWs schemes.

In this analysis however, because of the sample size limitation, there wasn't a distinction of the two schemes.

Administrative data, from the joint sector reviews report, show that over the past 10 years, VUP Public Works has been expanding in numbers of participants (workers) and benefited on average 123,760 population per year, representing approximately 10.7% of population living in extreme poverty as of 2020. Figure 1 shows a rapid expansion since 2018/2019 fiscal year, and the peak was observed in the 2019/2020 fiscal year. The latter reflects however, the effect of COVID-19, because the government used VUP public works as a mechanism to support households coping with the pandemic negative effects on household welfare.

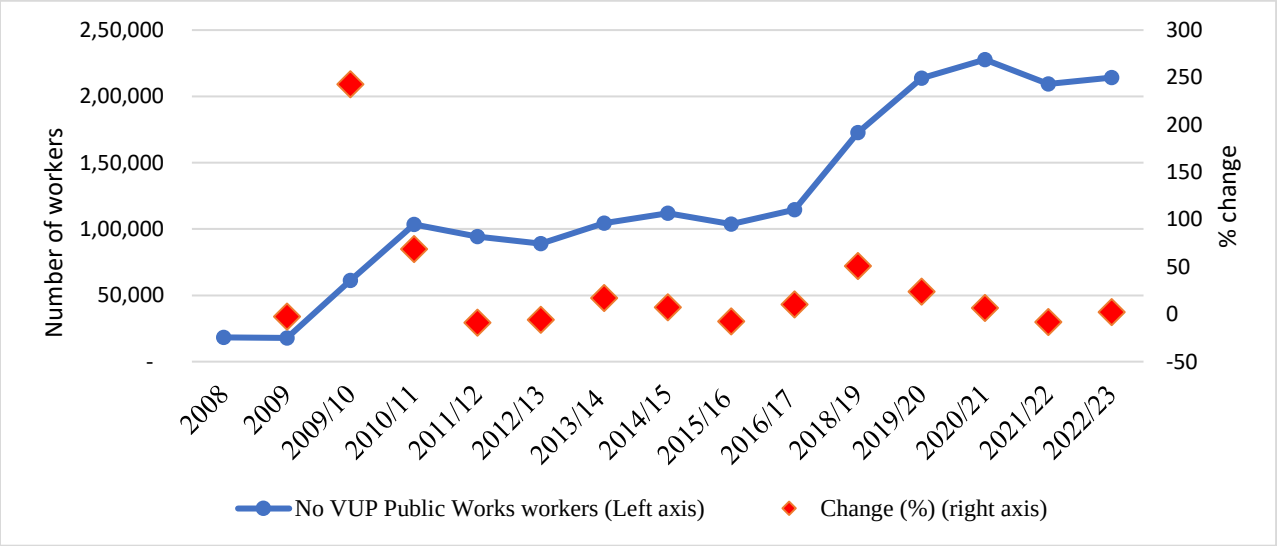

Figure 1: Evolution of PWs participation Rwanda

Source: MINECOFIN, Joint sector reviews reports

Rwanda is not alone in the region to prioritize public works in the social protection programming, across the Eastern and Southern African region, there are similar public works programmes which have been implemented to reduce poverty and strengthen community assets. The **table 1** provides a summary of these programme.

Table 1: Selected countries with public works components in their social protection systems

Country	Per Capita GPD (US$) in 2022	The name of the public works (pw) programme
Botswana	7,738	Public Works programme (*Ipelegeng*).
Burundi	238	Labour intensive public Works (Travaux publics à haute intensité de main d'œuvre)
Ethiopia	1,028	Ethiopia's Productive Safety Net Program (PSNP)
Kenya	2099	Cash and Food for Assets programme (SFA)
Madagascar	505	Labour intensive public Works or commonly known as *Travaux publics à Haute Intensité de Main d'Œuvre (HIMO)*
Malawi	645	Public Works Program (PWP) under Malawi Social Action Fund (MASAF)
Mozambique	541	public works programme: Productive Social Action Programme (PASP)
Rwanda	966	Vision Umurenge Program (VUP) Public works (Classic and Expanded Public Works
Tanzania	1,192	Tanzania Productive Social Safety Net (PSSN)
Uganda	964	Public Works Programmes*
Zambia	1,488	PUSH (Peri-Urban Self-Help) programme
Zimbabwe	1,267	Labor intensive public works program (Pilot)

***** Northern Uganda Social Action Fund (NUSAF), the Karamoja Livelihoods Improvement Programme, Community-Driven Development Programme and Agricultural Livelihoods Recovery Programme.

Source: Authors compilations

2.2.Empirical framework of Public Works on monetary and non-monetary poverty reduction

Recent empirical research on the effect public works programme or labour-intensive programme on poverty reduction is mainly dominated by the work of the World Bank and other researchers

(Subbarao, Ninno, Andrews, & Rodríguez-Alas, 2013). A cross-country study on rural livelihoods and poverty reduction strategies in four African countries (Malawi, Uganda, Kenya, and Tanzania) revealed that better-off households are distinguished by multiple channels, mainly livestock ownership, involvement in non-farm self-employment, diversity of on-farm and non-farm income source. Also, evidence suggests that for the poor to benefit from non-farm growth, there is a need to stimulate buoyant economies, with robust non-farm income growth by not only focusing on low-productivity employment such as those provided under public works schemes (Ellis & Freeman, 2004; Haggblade, Hazell, & Reardon, 2010).

A study conducted in Tigrai National Regional State, Ethiopia, using primary propensity score matching and Foster–Greer–Thorbecke indice found that Productive Safety Net Program (PSNP) on poverty has positive effect on individual consumption, livestock holdings, and productive assets accumulation. The author noted that when comparing with the total per adult equivalent consumption expenditure for program participants and non-participants, it was statistically higher as compared to the matching of the nonparticipants (Gebresilassie, 2014). Additionally, the analysis of Kenya's Hunger Safety Net Programme (HSNP) using yet propensity matching, confirmed that participation in the programme contributed significantly to the reduction of the multidimensional poverty index (MPI). This was mainly driven by the food insecurity dimension, and the poverty decrease was evidence by the fall of both incidence and intensity of poverty (Song & Imai, 2019).

Furthermore, the analysis of the impact of PSNP in Ethiopia shows that, the whole programme has reduced the length of hungry season by 1.29 months among households that received transfers for 5 years, compared to eligible households who did not participate in the programme. The analysis didn't find however, any evidence that the PSNP crowds out private transfers in Ethiopia (Berhane, Gilligan, Hoddinott, Kumar, & Taffesse, 2014). The impact evaluation of the same programme using a probabilistic moment-based approach for measuring resilience and focusing on the role of PSNP transfers and duration of participation on households' resilience, concluded that PSNP transfers below the median value are less likely to provide significant impact in households' resilience and consumption but impact, despite being positive, may be shortly lived by the programme participants, and it is dependent upon the size of transfers for the programme to have a significant and long lasting impact (Abay, Abay, Berhane, & Chamberlin, 2022). This

demonstrates the critical relevance of transfer values, periodic benefits from the productive public works and the consistency of the payment for the programme to have significant impact among the beneficiaries.

However, a study with the randomized control trials to empirically assess the impact of public works programme on household food security, income and fertilizer use among programme participants in Malawi, found no measurable short-term effect on food security in lean season. Moreover, data didn't provide enough evidence to conclude a positive effect of public works programme on increased use of fertilizer or the ownership of durable goods among the participants (Beegle, Galasso, & Goldberg, Direct and indirect effects of Malawi's public works program on food security, 2017). Furthermore, the evaluation of the impact of South Africa's expanded public works on income poverty has shown that, while participation in public works marginally reduce poverty, nearly a half (44%) of the sampled households survived on incomes below the national poverty line and the poverty rate was more felt among female headed household (Sekhampu, 2015).

The above mixed findings from the impact of public works on poverty reduction, and food security, set a strong framework and motivated this analysis to empirically investigate the contribution of VUP public works in Rwanda to generate additional evidence to inform policy makers on the best of course actions along the implementation design of the public works programme, and accelerating poverty reduction in particular.

3. Methods and Data

3.1.Data source and data description

We used data from the Integrated Living Conditions Survey, commonly known in Rwanda as the EICV. The survey contains a nationally representative sample data collected at household level under the stewardship of the Rwanda National Institute of Statistics (NISR). The latest available data are of the EICV 2016/2017 and published in 2018 (National Institute of Statistics of Rwanda (NISR), 2024). We processed the data to ensure that relevant variables are merged together including the dependent and independent variables. This has resulted in 145 individuals aged between 16 and 65 years old who, at some point in time, participated in the VUP public works since its inception in 2008. The minimum cut off age of the VUP participants considered for this

analysis is 15 years old while the maximum age is 64 years old. This age classification was chosen as it represents the working-age population in Rwanda.

3.2.The model framework

While making decisions on resource allocations choice and types of expenditures, individuals don't perform them necessary independently at time *t*. They rather put into context utility maximization on various items of personal and households needs. Modelling of the financing behaviour of households in a limited income setting shows that living in resource scarcity limits self-control, causes stress, fear, and anxiety, which may lead to short-sighted, risk-averse decisions without due consideration of persisting and long-term problems (Loibl, 2017). Furthermore, through standard approach to modelling consumers behaviour, data indicate that households save with the aim of providing for consistent flow of income in their lifetime and enable them to deal with future shocks. Also, income is majorly affected by the preference for expenditure on consumption or leisure. Leisure is also a function of hours foregone to engage in productive work, thus spending earned income (Fitzgerald, Kenny, & Cermeno, 2022).

To analyse various behaviour patterns and decision-making ability of household income from VUP public works, we applied a nonparametric seemingly unrelated regression as adopted by Smith and Kohn (2000). In addition, this paper was inspired by the development of seemingly unrelated model as led by Zellner Arnold (Zellner, 1962). Additionally, we preferred this model over other analytical models, because in a situation of limited sample size, the seemingly system of nonparametric regressions provides reliable function estimates than if multiple models are performed as an individual equation, and the model ignores the correlations of the error terms.

Theoretically, the nonparametric seemingly unrelated regression, follows the following structure with m representing regression equations.

$$y^i = f^i(x^i) + e^i \quad \text{..... (1)}$$

For i = 1, 2, 3… m

ith is the number of i^{th} of m possible regressions, the regression are linked by the possible correlation of the unobserved disturbances, y^i is the dependent variable, $x^i$is a vector of

independent variables, $f^1 \ldots \ldots \cdots f^m$ represent the function that require estimating in non-parametric manner, e^i of all regressions are related and represented as follows.

$e \sim N(0, \Sigma \otimes I_n) \ldots$ ……………………………………………………………...…………..……...

(2)

Where e' = ($e^{1\prime}$, $e^{2\prime}$,…….$e^{m\prime}$), e^i is the vector of error for n observations of the i^{th} regression. While covariance matrix Σ is given by $m * m$ and I_n is the identity matrix of dimension n defined as

$\Sigma \otimes I_n = \begin{matrix} \sigma_{11} In & \sigma_{1m} In \\ \sigma_{m_1} I_n & \sigma_{m_m} I_n \end{matrix}$ …………………………………………………….………..…...

(3)

$f(x) = \sum_{i=1}^{P} B_i b_i(x)$ ……………………………………………………………………....

(4)

B = (b_1,…b_p) and b_i regression parameters, then the i^{th} is estimated as follows

$y_i = x^i \beta_i + ei$……………………………………………………………………….................

(5)

With

$E(U_{ij} U_{ij} | x) = \sigma_j j' \neq 0$…………………………………………………………………..…..

(6)

Where $J \neq j'$

The above illustration shows that, Y_i is the vector of the n observations of the dependent variable and X_i is the matrix containing b_1/b_2, ……. b_p and β is the regression coefficient.

With the aim of maximizing efficiency of regression coefficients, we followed the Generalized Least Squares (GLS) estimator of β. This is because, GLS is robust to heteroscedasticity and autocorrelation of errors, which are common issues in SUR models. Thus,

$\hat{\beta} = (x'\Sigma^{-1})_1^{-1} x'\Sigma^{-1} y$…………………………………………………………….………..…...

(7)

and

$v_{Ar(\beta)} = (x'\Sigma^{-1}x)^{-1})$ …………………………………………….………………………..….

(8)

Zellner (1962) and Haltag (2008) indicated that under GLS estimation in Σ is unknown therefore, the need to perform estimation following the Aitken estimator or the Aitken kernel estimator for estimating the non-conditional mean function.

$$s_{ii} = \frac{\sum_{t=1}^{P} e_{it}^2}{P-k_i} \quad \text{..... (9)}$$

and

$$s_{ij} = \frac{\sum_{t=1}^{P} e_{it}e_{jt}}{(P-k_i)^{\frac{1}{2}}(P-k_j)^{\frac{1}{2}}} \quad \text{..... (10)}$$

For i = 1, 2,… p

e_{it} are the OLS residuals of the i-th equation, an S_{ii} is the S^2 of the regression for the i-th equations.

Against the above background the following are the dependent and independent variables to be tested.

We selected seven dependent variables for the analysis namely, (i) log of aggregate consumption (log(*AgCons*)), (ii) log of income measured by adult equivalent (log(*AE)),* (iii) log of food expenditure (log(*FEXP*)), (iv) log of nonfood expenditure (*Log(NFE)*), (v) log of total savings (log(SAVE)), (vi) log of education expenses (log(*edEXP*)), (vii) log of expenses on utility this combines household expenditure on water and electricity (log(*UEXP*)).

The set of independent variables of interest in this analysis is the monetary annual benefits from VUP public works (log(*IncVUP*)) modelled with control variables mainly, the location (rural - urban) (*RurUrb),* family size (*FmSZ),* receipt of transfers from other sources (log(*InTrans)),* gender (*Sex),* age of the respondents (*AG),* household welfare (*HW) and* education level (*EDUC*).

Model 1: $Log(AgCons) = \beta_{10} + \beta_{11}Log(IncVUP) + \beta_{12}RurUrb + \beta_{13}FmSZ + \beta_{14}Log(InTrans) + \beta_{15}Sex + \beta_{16}AG + \beta_{17}HW + \beta_{18}EDUC + \epsilon_1$ …… (11)

Model 2: $Log(AE) = \beta_{20} + \beta_{21}IncVUP + \beta_{22}Log(AgCons) + \beta_{23}RurUrb + \beta_{24}FmSZ + \beta_{25}InTrans + \beta_{26}Sex + \beta_{27}HW + \beta_{28}EDUC + \epsilon_2$……(12)

Model 3: $Log(FEXP) = \beta_{30} + \beta_{31}IncVUP + \beta_{32}Log(AgCons) + \beta_{33}RurUrb + \beta_{34}FmSZ + \beta_{35}InTrans + \beta_{36}AG + \beta_{37}HW + \beta_{38}EDUC + \epsilon_3$……(13)

Model 4: $Log(NFE) = \beta_{40} + \beta_{41}IncVUP + \beta_{42}Log(AgCons) + \beta_{43}RurUrb + \beta_{44}FmSZ + \beta_{45}InTrans + \beta_{46}Sex + \beta_{47}AG + \beta_{48}EDUC + \epsilon_4$……(14)

Model 5: $edEXP = \beta_{50} + \beta_{51}IncVUP + \beta_{52}Log(AgCons) + \beta_{53}FmSZ + \beta_{54}InTrans + \beta_{55}Sex + \beta_{56}SAVE + \beta_{57}HW + \beta_{58}EDUC + \epsilon_5$……(15)

Model 6: $SAVE = \beta_{60} + \beta_{61}IncVUP + \beta_{62}RurUrb + \beta_{63}Log(NFE) + \beta_{64}Log(AgCons) + \beta_{65}FmSZ + \beta_{66}InTrans + \beta_{67}Sex + \beta_{68}EDUC + \epsilon_6$……(16)

Model 7: $UEXP = \beta_{70} + \beta_{71}IncVUP + \beta_{72}RurUrb + \beta_{73}FmSZ + \beta_{74}InTrans + \beta_{75}SAVE + \beta_{76}Log(NFE) + \beta_{77}HW + \beta_{78}EDUC + \epsilon_7$……(17)

4. Results

4.1.Summary statistics

Table 2 and **Table 3** provide summary statistics of categorical and numerical data to describe the distribution of data by different variables under consideration in the analytical models.

Table 2: Summary of the categorical variables

Variable	**Indicator**	**Yes, VUP Participation**	
		Count	
		(#)	**%**
Gender	Female	71	49.0

Variable	Indicator	Yes, VUP Participation	
		Count (#)	%
	Male	74	51.0
Location	Urban	10	6.9
	Rural	135	93.1
Poverty	Extreme Poor	48	33.1
	Moderately poor	69	47.6
	Non-poor	28	19.3
Participation in Tontine	Yes	26	28.0
	No	67	72.0
Marital Status	Married polygamously	53	36.6
	Married polygamously	8	5.52
	Married polygamously	0	0
	Living together	4	2.76
	Separated/Divorced	11	7.59
	Single	63	43.45
	Widow or widower	18	12.41
Education level	No education	24	16.5
	Primary	106	73.1
	Post Primary training	6	4.1
	Secondary	9	6.2

Source: Data analysed by author

Table 3: Summary of quantitative variables

Variable	Obs.	Mean	Std.dev.	Min	Max
Annual savings (FRW)	48	5,398	3,714.7	-	22,000
Household Size (Persons)	145	5.2	1.8	2	8
Aggregate expenditure (FRW)	145	4.7	1.6	2.0	7.2
Nonfood expenditure (FRW)	145	48,355.5	39,004.9	4,500	126,450
Total consumption (FRW)	145	753,692.0	446,821.2	217,291.2	2,243,084
Food expenditures ((FRW)	145	389,300.6	343,268.7	111,064.3	1,636,243
Food consumption (FRW)	145	529,151.1	346,684.7	168,476.2	1,764,504
Years of schooling	121	15.4	5.3	10	33
Loan amount (FRW)	145	119,086.1	405,194.3	1,000	2,000,000
Years of work experience	99	13	15	-	59
Monthly Net salary (FRW)	53	3,045.3	4,918.2	-	20,000
Number of months participated in VUP PW	145	4.0	2.51	0	10

US$ 1= FRW 838.6; poverty line is defined by Adult Equivalent Consumption amount RWF 159,375 per year and the extreme poverty line is RWF 105,064 per year. Source: Data analysed by authors

4.2.Regression results

Regression findings shows that all models in the seemingly unrelated equations are statistically significant at p-value of 0.05 across all measures mainly root-mean-square deviation (RMSE), and R-squared and F test (**Table 4** and **Table 5**). In addition, **Table 6** provides a detailed presentation of the regression summary with effect of VUP Public works benefits on critical variables of households' financial resources allocations and **Table 7** shows the implication of VUP public works benefits when complemented with households' own production works either for consumption or non-consumption.

Table 4: Seemingly unrelated regression Models summary: VUP Public Works Benefits only

Equation	Obs.	Params	RMSE	R-squared	F	P>F
LogAE	145	7	0.28	0.44	16.79	0.00
LogFEXP	145	7	0.38	0.69	46.58	0.00
LogNFE	145	6	0.66	0.57	31.83	0.00
LogEDUCEXP	145	7	3.15	0.24	6.32	0.00
LogSaving	145	8	3.26	0.10	2.45	0.01
LogUXP	145	7	3.13	0.25	7.44	0.00

Source: EICV-Data analysed

Table 5: Seemingly unrelated regression Models summary: VUP Public Works Benefits with Household Own food and nonfood consumption (F&NF)

Equation	Obs.	Params	RMSE	R-squared	chi2	P>chi2
LogAE	145	6	0.2	0.6	197.7	0.000
LogFEXP	145	7	0.4	0.6	251.3	0.000
LogNFE	145	7	0.7	0.6	171.5	0.000
LogSaving	145	7	3.1	0.1	24.0	0.0012

Source: EICV-Data analysed

Table 6. Seemingly regression models findings from various models: Public works benefits

VARIABLES	(1) LogAE	(2) LogFEXP	(3) LogNFE	(4) LogEDUCEXP	(5) LogSaving	(6) LogUXP
Log (IncVUP)	0.130***	0.105**	0.614***	0.395	0.516	0.308
	(0.0354)	(0.0518)	(0.0903)	(0.403)	(0.501)	(0.442)
InTrans	-0.0233***	-0.0166*		0.0426	0.0873	-0.257***
	(0.00653)	(0.00855)		(0.0737)	(0.0817)	(0.0777)
AGE	0.000988	-0.00350	-0.00196	-0.0318	-0.00706	
	(0.00206)	(0.00280)	(0.00488)	(0.0212)	(0.0240)	
edEXP	0.0210***					
	(0.00707)					
Sex -female	-0.102**	-0.252***	-0.531***	-1.899***	0.424	
	(0.0512)	(0.0668)	(0.116)	(0.508)	(0.605)	
Poverty 1: Severely poor	0.407***	-1.407***	-0.885***	2.432***	-1.648*	-0.0756
	(0.0673)	(0.0997)	(0.173)	(0.749)	(0.934)	(0.871)
Poverty 2: Moderately poor	0.352***	-0.657***	-0.0469	1.091	-0.696	1.765**
	(0.0671)	(0.100)	(0.175)	(0.756)	(0.859)	(0.809)
FmSZ		0.105***	0.144***		0.316	-0.408**
		(0.0221)	(0.0369)		(0.203)	(0.179)
SAVE				0.249***		-0.365***
				(0.0781)		(0.0795)
Log(NFE)					0.474	0.343
					(0.407)	(0.340)
Constant	0.944***	13.17***	9.547***	8.336***	-5.028	0.686
	(0.156)	(0.203)	(0.343)	(1.543)	(4.274)	(3.185)
Observations	145	145	145	145	145	145
R-squared	0.443	0.693	0.573	0.242	0.102	0.253

SURE: performed with small sample properties option, Standard errors in parentheses,
*** p<0.01, ** p<0.05, * p<0.1
Source: Survey data analysed

Table 7. Seemingly regression models findings from various models: VUP Public Works Benefits with Household Own food and nonfood production (F&NF)

VARIABLES	(1) LogAE	(2) LogFEXP	(3) LogNFE	(4) LogSaving
Log (IncVUP)	0.183***	0.215***	0.713***	0.717
	(0.0284)	(0.0501)	(0.0840)	(0.483)
Log of PW and Own F&NF	0.326***	-0.0509	0.220*	1.140**
	(0.0384)	(0.0675)	(0.113)	(0.532)
SAVE	-0.000721	0.00359	0.0343*	
	(0.00632)	(0.0108)	(0.0180)	
InTrans		-0.0325***	-0.0292*	0.0995
		(0.00910)	(0.0155)	(0.0815)
Poverty: Severely poor	0.652***	-1.250***	-0.445**	-0.196
	(0.0610)	(0.105)	(0.175)	(0.847)
Poverty: Moderately poor	0.551***	-0.497***	0.289*	0.350
	(0.0594)	(0.104)	(0.175)	(0.833)
Sex: Female	-0.113***	-0.317***	-0.535***	0.561
	(0.0414)	(0.0710)	(0.119)	(0.597)
Log(NFE)				0.784**
				(0.399)
Constant	-3.312***	13.68***	6.469***	-21.93***
	(0.500)	(0.891)	(1.493)	(7.370)
Observations	145	145	145	145
R-squared	0.589	0.648	0.551	0.128

SURE: performed with small sample properties option, Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Survey data analysed

4.3.Model diagnostics

Prior to performing the regression models, we tested whether data meet the basic assumptions of Seemingly unrelated regression models**.** Since our data are cross sectional, two sufficient conditions were established, (i) Since the SUR model assumes that the errors are correlated across equations, we tested the residuals for contemporaneous correlation and diagonality of Σ using the Breusch-Pagan test for independence of residuals and the hypothesis was specified through the Lagrange multiplier (Halunga, Orme, & Yamagata, 2017).

$$LM = T\sum_{i=2}^{M}\sum_{j=1}^{i-1} r_{ij}^2 \quad (18)$$

When M denotes a number of equations, and $r_{ij}^2 = \frac{s_{ij}}{\left(s_{i_i}s_{jj}\right)^{1/2}}$ and T denotes the number of equations included in the models. The null hypothesis states that the residuals from the different equations are uncorrelated with each other.

$H_0: \sigma_{ij} = 0$ for all $i \neq j$

The Breusch-Pagan test of independence follows a chi-square distribution with 15 degrees of freedom (since there are 15 pairwise combinations of residuals for the test) and the computed statistics of (Pr: 0.000) versus hypothesize value of 0.05 significance levels. This show that, there is strong evidence that the residuals from the different equations are not independent and are likely correlated, thus confirm the SURE model's assumption that the error terms across the equations are correlated is valid. **Table 8** shows the extent of cross-equation corrections.

Table 8: Correlation Matrix of residual

LogAE	LogFEXP	LogNFE	LogEDUCEXP	LogSaving	LogUXP	
LogAE	1					
LogFEXP	0.03	1				
LogNFE	0.11	0.43	1			
LogEDUCEXP	-0.13	-0.11	0.11	1		
LogSaving	-0.06	-0.11	0	-0.01	1	
LogUXP	-0.07	-0.02	-0.08	0.41	0.01	1

Breusch–Pagan test of independence: chi2(15) = 63.010, Pr = 0.000

Small-sample degrees-of-freedom adjustment applied when estimating covariance matrix of residuals

Source: Survey data analysed

Additionally, we tested the nonexistence of multicollinearity among explanatory variables in the models. According to Baltagi (2011) existence of multicollinearity in independent variables implies that the model provides imprecise estimate which cannot separate the influence on Y of the independent variables that are perfectly related, thus contributing to lack of unique solution.

$E\left[\bar{\varepsilon}_{m_t}\varepsilon_{ns}X_1x_2 \ldots x_M\right] = \alpha_{m_{n'}}$ if $t = s \; and \; if \; t \neq s$ ..... (19)

Through ordinary least square (OLS) regression, we performed the Variance Inflation Factor (VIF) as a common measure of the degree of multi-collinearity of the i^{th} independent variable with the other independent variables in a regression model (O'brien, 2007). The decision rule, stipulates that the VIF value greater than 10 is often used as a rule of thumb to indicate significant multicollinearity. **Table 9** shows that across all variables, there is no sign of serious multicollinearity.

Table 9: VIF tables across SUR equations

Variables	LogIncVUP	LogInTrans	AGE	Extreme-Poverty	Relative Poverty	HZSize	Gender	LogSaving	Mean VIF
LogAE	1.58	1.13	1.39	1.99	2.23		1.31		1.55
LogFEXP	1.81	1.26	1.37	2.35	2.66	1.75	1.19		1.77
LogNFE	1.81	1.26	1.37	2.35	2.66	1.75	1.19		1.77
LogEDUCEXP	1.62	1.27		2.35	2.65	1.77	1.11	1.11	1.7
LogSaving	2.31	1.29	1.37	2.82	2.67	1.95	1.33		2.02
LogUXP	2.04	1.29		2.78	2.63	1.96		1.11	1.99

Source: Survey data analysed

5. Discussions

Analytical results indicate that the monetary benefits from both the classical and expanded components of the VUP public works programme have a statistically significant combined impact

on households' aggregate expenditure (13%), food expenditure (10.5%), and non-food consumption (61%). These results confirm what was found as positive impact of Ethiopia Productive Safety Net Program (PSN) for food security of the rural households, which empirical evidence suggests that PSNP has largely helped programme participants for consumption smoothing, asset accumulation, and development of the local community (Welteji, Mohammed, & Hussein, 2017).

However, the results do not provide sufficient evidence to confirm a positive effect of the VUP public works on individual savings, education expenditure, or household expenditure on utilities, specifically, water and electricity. This can be partly explained by limited numbers of days worked which still below global benchmarks of 100 days and relatively low to the market rate daily wage (Ninno, Subbarao, & Milazzo, 2009). Descriptive statistics shows that on average, households spent 69 days per year which large standard deviation (±st 21.17).

Furthermore, across various wealth categories of VUP beneficiaries, cash benefits from the VUP public works influences aggregate expenditure by up to 40.7% among extremely poor households and by 35.2% among moderately poor households (**Table 8 and 9**). These findings are consistent with the result from a study conducted in South Africa to assess the distribution impact of expanded public work programme among poor families. Through application of the income decomposition techniques, the results from the South African study show that social grants have significantly reduced poverty levels in geographical areas with high poverty rates (Takunda, 2016).

Similarly, a recent study on Public Works (PWs) in Tanzania, which investigated the impact of productive social safety nets on households' vulnerability to food insecurity concluded that participation in public works programmes, combined with complementary cash transfers, reduces households' vulnerability to food insecurity among extremely poor households. The findings further suggest that the probability of households remaining food insecure or below the food poverty line in the future is reduced by 27% (Msuha & Kissoly, 2024).

Furthermore, the above findings align with our analysis, which demonstrates that complementing VUP public works benefits with households' own production for consumption yields greater economic benefits for programme participants. The data indicate that participants who supplemented benefits from the Public Works programme with their own production—both food and non-food items—saw an overall increase in aggregate consumption by 18.3%, reflecting a

marginal increase of 5 percentage points. Food expenditure increased by 21.5%, resulting in a doubling of food-related spending, while non-food consumption rose up to 71%. The combination of own production and VUP public works also contributed to increasing individual savings by two folds. Under this scenario, aggregate household expenditure increased by 65.2% among extremely poor individuals and by 55.1% among moderately poor individuals.

These results confirm the results from the cross-country analysis conducted by Rolen, Devereux and Abdulai (2017) to investigate how to make 'Cash Plus' Work. Authors concluded among other things, cash plus interventions which include livelihood support, training and complementary cash support provide linkages that seek to augment income effects and addressing supply side effect thus, accelerate poverty reduction and improve well-being across a range of dimensions, including food security, health, schooling, child protection, productive activities of poor families.

However, a gender-based analysis reveals that female participants do not necessarily experience positive impacts from VUP public work programme participation. The data suggest that participation in VUP public works by women is likely to reduce household consumption by nearly 10%. This holds true whether considering benefits from VUP public works alone or in combination with household own production such as involvement in own agriculture works. This specific pattern is partly explained by the fact female participants in VUP public works spend a very few days at work (19 working days), relative to their men peers (27 days worked).

Our findings, in overall, contradict the results of analytical study that investigated the direct and indirect effects of Malawi's public works program on food security. The authors concluded that the public works program in Malawi was not effective in achieving its primary objective of improving food security during the lean season of 2013, and there was no evidence to confirm its contribution to increased fertilizer use among small holders, household ownership of durable goods, nor indirect positive effects on local economies (Beegle, Galasso, & Goldberg, 2017).

6. Conclusion and recommendations

Unlike other studies that applied OLS methods or other methods which analyzed data by single equations for causal effects, this analysis makes a unique contribution in the academia by employing a novel framework of seemingly unrelated regression (SUR) models. This approach provides more accurate estimates for small samples and accounts for the simultaneous decision-

making of individuals, allowing for a more comprehensive analysis of behavior patterns and decision-making processes among low-income individuals with constrained resources.

The study confirms the statistically significant effect of VUP public works benefits on two specific objectives: aggregate consumption, and food and non-food expenditures under various conditions. The impact of VUP public works benefits is more pronounced among extremely poor individuals and households, highlighting the protective role of public works during difficult situations, especially when other sources of livelihood are not viable.

However, the data did not provide sufficient evidence to confirm that VUP public works benefits alone lead to increased household savings, human capital investments, or certain types of expenditures, particularly on utilities such as water and electricity and effect on income is not evenly distributed by gender.

Based on the above findings, three key policy recommendations emerge from our analysis:

First, the Rwanda should intentionally increase benefits from VUP public works through increasing the number of annual workdays performed in public works programmes. This would have a positive income effect, thereby enhancing household consumption, promoting savings and investment in human capital development, and fostering socio-economic prosperity. These measures could strengthen community resilience to social, economic, and environmental shocks.

Second, Rwanda needs to review and reform the design of the public works programme by including support for households' own production activities as an integral component of public works. Under this framework, VUP participants can engage in household-based work aimed at enhancing both consumption and non-consumption production, such as farming, animal rearing, running small businesses.

Third, there is a need to strengthen national and decentralized efforts to reduce the gender gap by addressing the barriers and challenges that prevent women and girls from regularly participating in the VUP public works programme.

Finally, to achieve a comprehensive understanding of the VUP public works in Rwanda, future academic research should empirically investigate the broader economic benefits on local economies, including secondary employment creation arising from community development projects and infrastructure supported by the public works programme.

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