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Abstract

Households in developing nations are exposed not only to poverty, but also to risks and shocks that are both idiosyncratic and covariate. Several developmental interventions are taken up to eradicate poverty and bridging inequality. While it is widely recognized in theory that such interventions also enhance households' resilience to deal with risks, there has been limited empirical investigation to explore this, particularly in rural India. This paper, therefore, aims to empirically examine the impact of developmental interventions on households' vulnerability. Particularly, the paper looks into the impact the Western Orissa Rural Livelihood Programme launched in the early last decade on aggregate vulnerability as also its different components such as poverty and covariate, idiosyncratic and unexplained risks. The empirical analysis is based on a survey of 800 households in western Odisha, a region that is prone to frequent droughts. Adopting the framework for 'vulnerability as expected utility', this study comes out with three major findings. *First*, both aggregate risk and poverty are the major sources of vulnerability with the former accounting for a major share of the vulnerability. *Second*, households that have benefitted from the rural livelihood programme are less vulnerable. *Third*, vulnerability also depends on factors like education, access to social network, family size and crop-diversification. From a policy perspective, the results support continuation of these programmes, but with renewed focus on targeting risk reduction, a component that has systematically been bypassed by all developmental programmes so far.

Keywords **:** Developmental Interventions, Household Vulnerability, Poverty, Covariate and Idiosyncratic Shocks, Western Odisha, India

JEL classification **:** Q12, D04, D78

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Contents

List of Tables

List of Figures

List of Appendices

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1. Introduction

The past three decades have been witnessed a growing body of literature on measuring vulnerability at household and regional levels to a variety of risks and shocks (Bahinipati, 2011; Patnaik and Narayanan, 2005). Vulnerability, in general, is a multidimensional concept encompassing numerous factors, and hence, different definitions of vulnerability exist across research communities based on the sources of risks or outcomes considered. Although the notion vulnerability is a complex to be described within the economics discipline, it is well documented in the poverty literature where it is generally conceptualized as an outcome of household responses to risks and shocks, assuming a set of underlying conditions (Kanbur and Squire, 1999). Vulnerable households are those that have moved or are likely to move into a state of poverty or destitution as a result of the process of risks as well as shocks and ability to response (Alwang et al., 2001). Risks and shocks encountered by the households affect their wellbeing, particularly for the households with fewer resources to cope (Ligon and Schechter, 2003). The outcome is an ex-post state (poverty status/consumption poor) that is assumed to be the primary concern of policy makers, especially, in the developing nations.

In addition to poverty, households in developing nations are often hit by idiosyncratic and covariate shocks[1], resulting in higher income volatility (Gunther and Harttgen,

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[1] Covariate shock means affecting most of the households in a village and possible nearby villages (e.g. cyclone, flood, drought and epidemics) and idiosyncratic shock restricted to one household and possible some others (e.g., illness or injury of bread winner and other family members, marriage of family members, confiscation of land and theft of property) [Dercon, 2002; Bhattamishra and Barrett,2008].

2009). Specifically, the rural households are highly susceptible to diverse risks and shocks as their main source livelihood is sensitive to climate variability and extremes (Stern, 2007). Given the absence of perfect insurance against income fluctuations, especially, in the developing countries, these risks and shocks foster a state where the households either become poor or remain poor if already so (Bahinipati, 2016). The development economics literature, therefore, has constantly emphasized to go beyond the static measure of poverty to dynamic ex-ante risk assessment, i.e., to identify the potentially exposed entity to future risks and shocks (Gunther and Harttgen, 2009). This has a larger policy relevance in the context of developing nations where it is yet to achieve sustainable development goals and continue to be characterized by soaring population, higher incidence of poverty, large economic inequality and rudimentary state of infrastructure that amplify the outcomes as a result of exposure to risks (Patnaik et al.,2013).

Developing nations tend to address these concerns through various developmental interventions targeting issues like poverty eradication, infant mortality reduction, rural development, provision of access to basic needs, etc. However, it is important to recognize that the impact of these will vary across socioeconomic groups as vulnerability differs amongst the clusters. Addressing this issue, the present paper attempts to contribute to the literature by specifically examining the impact of developmental interventions on vulnerability at a micro level based on large scale primary household surveys. Empirically it tests whether developmental interventions reduce the vulnerability of the beneficiaries vis-a-vis the counterfactual group (i.e., the non-beneficiaries) while also exploring the role of household level socioeconomic characteristics in influencing the outcome. The major advantage is that this looks into the impact on aggregate vulnerability and its' different components as well, e.g., poverty, covariate, idiosyncratic and unexplained risks.

In doing so, this study aimed to assess the impact of a specific developmental intervention undertaken in rural Western Odisha (spelled as Orissa prior to 2011), India, which is one of the poorest regions in India and where human development indicators are very low and comparable with Sub-Saharan Africa. Although it is well documented in the literature that development based activities reduce households' vulnerability across the world, there is hardly any empirical study in the context of Odisha, particularly in the Western region. This region is highly vulnerable to climatic risks like droughts, deficient rainfall spells and flash floods (Panda et al., 2013; Panda, 2016a, b).The intervention in question is the Western Orissa Rural Livelihoods Project (WORLP) funded by the United Kingdom's Department for International Development (DFID) and implemented over a period of ten years (2000-2010) by Odisha Watershed Development Mission (OWDM), an autonomous agency of the Government of Odisha (GoO). The overall goal was to reduce poverty in rain fed areas and promote sustainable livelihoods for the poorest in pre-selected districts (WORLP, 1999). From a policy perspective, the results derived from this analysis provide insights regarding

effective policy designs to alleviate poverty and reduce vulnerability as well, for those households who are not only vulnerable at present but also likely to be susceptible in the foreseeable future. The remainder of this paper is organized as follows. While section two presents the role of developmental interventions in households' vulnerability, section three outlines empirical approach. Fourth section describes the study area, data and empirical specification of model with variables considered for analysis, and fifth section discusses the results. Finally, section six summarizes the concluding observations.

2. Vulnerability: Role of Developmental Interventions

Vulnerability refers to an ex-ante risk (forward looking) that a household's wellbeing fall below some benchmark in future due to risks and shocks (including climatic ones), given the present socio-economic characteristics of the household (Hoddinott and Quisumbing, 2003a). This seems to identify the likelihood of each household to be consumption poor in the next time period. In other words, it is the probability of being poor in the next year, in ten years or in the old age – this could be estimated but cannot observed (Hoddinott and Quisumbing, 2003a). A household's vulnerability depends on the characteristics of the risks and/or shocks to which a household is exposed to and the household's internal ability to mitigate potential impacts (Chambers, 1989). The main onus of doing vulnerability analysis is to identify who is vulnerable and to which risks and shocks while also keying out characteristics that make them susceptible (Kumar et al., 2007). Whereas the poverty status of a household is captured through expected mean consumption, idiosyncratic and covariate shocks and household's coping strategies to insure consumption against these shocks determine variance of consumption. Although voluminous research has been accumulating on vulnerability over the years across the world (Hoddinott and Quisumbing, 2003a, b; Kumar et al., 2007; Patnaik, 2009; Bahinipati, 2011), it has been still a subject of discussion and research in different geographical settings; it is much more relevant in the context of Western Odisha where households often witness climatic shocks such as cyclonic storms, floods and droughts which are likely to increase in the foreseeable future due to climate change (Bahinipati, 2014; Panda, 2016 a,b; IPCC, 2014).

Previous studies pertaining to India assess risks and shocks that affect households' welfare and intensity of these shocks, identify potential group of vulnerable households and determinants and constraints of various coping strategies (Bahinipati, 2016; Patnaik et al., 2016; Pradhan and Mukherjee, 2016; Patnaik and Narayanan, 2015a, b,2010). Responses to risk occur in two ways: (i) ex-ante income smoothening; and (ii) consumption smoothening ex-post (Morduch, 1995). In reference to income and consumption smoothening and its relationship with household vulnerability, a number of studies have emerged over the years with assessing the sources of vulnerability, household's coping strategies and risk attitude behaviour (Binswanger, 1978), effectiveness of coping options (Bahinipati, 2016; Patnaik et al., 2016; Narayanan and

Sahu, 2016; Patnaik and Narayanan, 2015 a,b) and constraints of coping mechanisms (Dercon, 2002). Over the years, in developing economies like India various developmental interventions have been implemented with the main aim to eradicate poverty and enhance living standards of rural households. Therefore, it is imperative to investigate to what extent developmental interventions reduce households' vulnerability, measured in terms of income and consumption expenditure[2]. Since vulnerability has different components like poverty, aggregate, idiosyncratic and unexplained risks, it is necessary to investigate the impact of developmental interventions on these components in addition to aggregate vulnerability.

It is observed that various development based activities undertaken as part of the poverty eradication programme in rural India enhance households' coping capacity, so that they can withstand against various risks and shocks including climatic ones (Bahinipati and Patnaik, 2015; Sharma and Patwardhan, 2008). For instance, it is found that various agricultural based activities undertaken through Mahatma Gandhi National Rural Employment Guarantee Scheme (e.g., water conservation and harvesting, irrigation provisioning and improvement, renovation of traditional water bodies, land development, drought proofing, flood control, etc.) reduce vulnerability of poor households to climatic risks in rural India (Esteves et al., 2013; Tiwari et al., 2011). On the other hand, this also indirectly motivates households to undertake several adaptation option since this enhances overall adaptive capacity (Bahinipati, 2015; Bahinipati and Venkatachalam, 2015). With reference to the study region, OWDM has taken a special initiative to implement WORLP in the four districts of Western Odisha, i.e., Balangir, Nuapada and Bargarh and Kalahandi. The total project outlay was INR (Indian Rupee) 2.3 billion and designed to cover 1,180 villages over 677 watersheds (an area of land drained by a river or a stream) spread across four districts of western Odisha based on a new approach termed as 'watershed plus', i.e., supporting for various other livelihood supports including watershed components. The major interventions are land and water management, economic support to the poorest and capacity building. In doing so, it aims to reduce poverty in rain-fed areas and promote sustainable livelihoods for the poorest households in western Odisha (Sharma et al., 2014). Although identical institutional structure was followed in the implementation across all watersheds and regions, the project impacts varied across different watersheds depending on types of activities chosen, management practices and the vision of PIA (Routray, 2015; ICAI, 2013; CRD, 2010). Overall, it is expected that such interventions could reduce vulnerability of the rural households, and in fact, the end line survey of WORLP report highlights that the incidence of poverty has been come down in the project implementation villages. This study has attempted to do a robust empirical analysis of the hypotheses proposed by end-line survey report.

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[2] The development economics discourse mostly considers average income and consumption expenditure (proxy variable for poverty metrics) as the measure of households' wellbeing (Patnaik et al., 2016; Bahinipati, 2016).

3. Empirical Approach

There are three methods available in the poverty literature to estimate household level vulnerability: (i) vulnerability as expected poverty (VEP),(ii) vulnerability as low expected utility (VEU) and (iii) vulnerability as uninsured risk (VER) (see Hoddinott and Quisumbing, 2003a, b; Bahinipati, 2011). While both VEP and VEU are estimating ex-ante vulnerability of a household, ex-post impact is assessed with adopting VER approach. Both the VEP and VEU follow a common assumption that a households will fall below a threshold level sometime in the future due to the risks and shocks. The present study has been adopted VEU approach to estimate vulnerability of households in Western Odisha.

In the VEU approach, vulnerability is defined with reference to the difference between the 'utility derived' from some level of certainty equivalent consumption, Z_{CE} at and above which the household would not be considered vulnerable, and the 'expected utility' of consumption, $EU_h(C_h)$ (Hoddinott and Quisumbing, 2003a; Ligon and Schechter, 2003). Hence vulnerability is measured as,

$$V_h = U_h(Z_{CE}) - EU_h(C_h) \cdots\cdots (1)$$

Where, C_h is the consumption of a household h and U_h is the utility of a household h, which is weakly concave and strictly increasing function. Equation 1 can be rewritten as (Hoddinott and Quisumbing, 2003a),

$$V_h = \left[U_h(Z_{CE}) - U_h(Ec_h)\right] + \left[U_h(Ec_h) - EU_h(C_h)\right] \cdots\cdots (2)$$

In equation 2, the first square bracket term is the measure of poverty which is the difference of utility at Z_{CE} compared to household $h's$ expected utility at c. The second term measures the risk faced by household h. This can further be decomposed into covariate and idiosyncratic risk. Allowing $E(C_h \mid X_t)$ to represent the expected value of consumption, conditional on a vector of covariant variables X_t, equation 2 can be rewritten as (Hoddinott and Quisumbing,2003a):

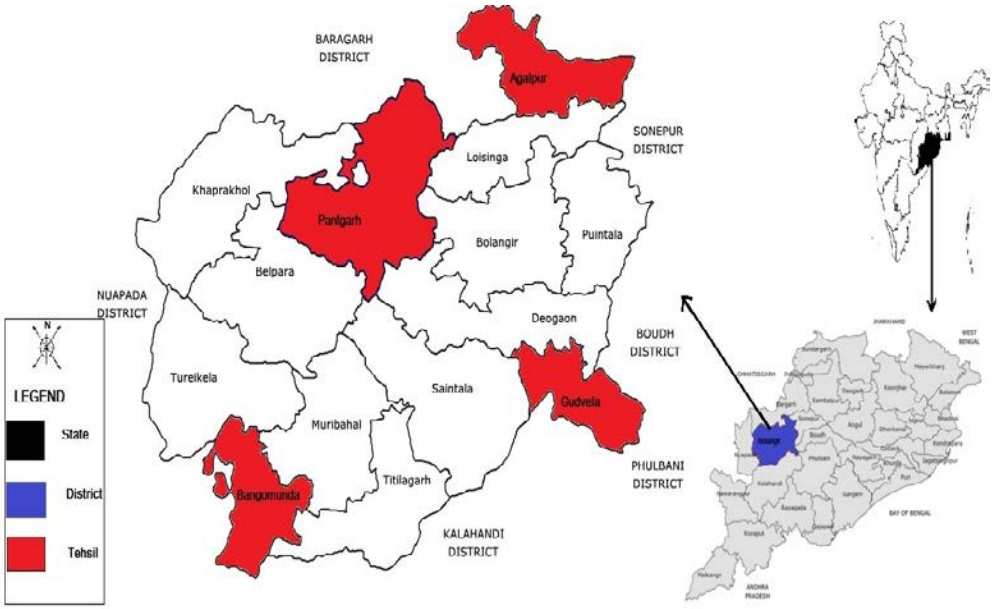
$$\begin{aligned} V_h = &\left[U_h(Z_{CE}) - U_h(Ec_h)\right] \rightarrow (\text{Poverty}) \\ &+ \left\{U_h(Ec_h) - EU_h\left[E(C_h/X_t)\right]\right\} \rightarrow (\text{Covariate Risk}) \\ &+ \left\{EU_h\left[E(C_h/X_t)\right] - EU_h(C_h)\right\} \rightarrow (\text{Idiosyncratic risk}) \cdots\cdots (3) \end{aligned}$$

4. Study Area, Data and Variables

The state of Odisha, geographically situated in eastern part of India, is prone to many disasters including cyclonic storms, floods, and droughts (Bahinipati, 2014; Bahinipati and Patnaik, 2015; Bahinipati and Venkatachalam, 2016). The western part of Odisha state is susceptible to drought and frequent deficient rainfall spells, which affect a majority of rural households (Panda et al., 2013; Panda, 2016 a, b). Further, it is expected that there is a possibility of increasing probability of severe and extreme droughts in the state (Ghosh and Mujumdar, 2007). Among the districts in Western Odisha, Balangir is one of the highly drought prone districts (Swain, 2014; Panda et al., 2013; Pattnaik, 2012; Swain and Swain, 2011; see Figure 1). It is a constituent of the erstwhile KBK (Kalahandi-Balangir-Koraput) region, one of the poorest and underdeveloped regions in entire India. It is located in the West Central table land zone of Odisha and receives a normal annual average rainfall of 1443.5 mm (Panda et al., 2013). While the district experienced severe drought situation in the year 2002 and 2010, moderate drought events were reported in years 1996, 1998 and 2000; the drought occurred in the year 2002 costed INR 1.7 billion (Pattnaik, 2012). In particular, the district experienced drought for 17 years between 1962 and 2002, i.e., at least one drought in three years with the frequency increasing over time (Swain and Swain, 2011). This could have negative impact on agricultural households across the district. The fact that around 75% of total cultivated land is rain-fed could amplify the vulnerability of farm households.

A secondary reason for choosing Balangir district was because WORLP interventions were introduced first in this district and subsequently undertaken in the remaining three. Four blocks (administrative division within a district) - Agalpur, Bongamunda, Gudvela, and Patnagarh (see Figure 1) - were chosen from Balangir district to conduct household survey.

Figure 1: Map of the study area



In these blocks, the WORLP interventions were carried out during the initial phase of implementation. While Agalpur is geographically located on the northern part of the district, Bongamunda is on the southern part. Gudvela and Patnagarh lie in the eastern and western part of the district, respectively. Stratified random sampling method was adopted to select both study villages and households, and the survey was conducted during late 2014. Based on within and outside of the watershed command area, the sample villages were chosen. It is assumed that villages within the command area are WORLP beneficiaries while those outside, non-beneficiaries. In total, 800 households were interviewed, of which 600 households belong to the beneficiary group and the rest 200 are non-beneficiary households. Since the idea of WORLP programme is watershed-plus interventions, both agricultural and non-agricultural households were interviewed. Information was elicited through a structured pre-tested interview schedule that included questions related to household characteristics, land, crop and livestock details, consumption details, health and food security, household assets, loan, credit and savings, impact of climatic aberrations and adaptation measures.

Table 1 presents the variables used in the empirical analysis along with their definitions and descriptive statistics for the sample. Following the development economics literature, per-capita consumption expenditure variable has been considered to capture households' welfare which can measure their relative level of vulnerability (Bahinipati, 2016). Per capita income and land ownership variables are taken to capture household level idiosyncratic shocks. While on an average each household has income of around INR 6,230, the average land holding per household is 0.66 ha. As the main objective is to look into the impact of developmental interventions on

households' vulnerability, this study has considered two variables to capture it such as WORLP beneficiary households (WORLP) and performance of WORLP (PERF). Whereas three-fourth (75%) sample households were the WORLP beneficiaries, the performance of the interventions was better for approximately half of them (37%).

In addition, other covariates which possibly influence the households' vulnerability are also included in the analysis and depict the taste and preference of a household. These variables are age of the household head (AGE), years of education of household head (EDU), family size (SIZE), crop-diversification (CRP_{NO}), number of big and small ruminants owned by the households (RUM_B and RUM_S), access to self-help groups(SHGs) and presence of migrant members in the family (MIG). Previous studies report that combinations of these variables associated with demography, agriculture and economic capacity are the major determinants of vulnerability, and are likely to exhibit either positive or negative relationship with the outcome (Bahinipati, 2016, 2014; Patnaik et al., 2016; Bahinipati and Patnaik, 2015; Christiansen et al., 2007; Dercon et al., 2005; Christiansen and Subbarao, 2004; Datt and Hoogeveen, 2003). It is expected that an inverse relationship exists between household head's educational qualification and vulnerability (Bahinipati, 2016; Patnaik et al., 2016; Sharma et al., 2013; Wamsler et al., 2012; Blankespoor et al., 2010; Dercon et al., 2005). Family size could have either positive or negative relationship with households' vulnerability – it mainly depends upon the composition of the household. Crop diversification will definitely have a negative impact on the households' vulnerability which was reported in the previous studies. The household with higher assets and amenities tends to be richer, and are able to smooth consumption through dissaving and/or depleting the existing assets (Bahinipati, 2016).

However, these households will also have a higher level of exposure and hence the relationship could work either ways (Bahinipati and Venkatachalam, 2016). Households having access to social networks and those with migrant members in the household are likely to exhibit an inverse relationship with vulnerability.

Table 1: Summary and descriptive statistics of the variables used in the model

Variables	Definition of the Variable	Mean	S.D.	Min	Max
Dependent Variables					
PCC	Consumption per capita in Indian Rupees (INR)	5,287	4,654	250	4,239
Idiosyncratic Shock Variables					
PCY	Income per capita in Indian Rupees (INR)	6,230	5,684	250	46,178
LAND	Ownership of Land in Hectares	0.66	0.82	0	7.29
Independent Variables					
Developmental Interventions					
WORLP	Programme Treatment (Dummy equals 1 if the household resides in the Treatment Village, 0 otherwise)	0.75	0.43	0	1
PERF	Interactive Dummy of Treatment and Performance of WORLP (Dummy equals 1 if beneficiary and performance is good, 0 otherwise)	0.37	0.48	0	1
Other Covariates					
AGE	Age of the Head of the Household	51.46	12.15	25	104
SIZE	Number of Members in the Household	5.22	2.76	1	15
EDU	Number of years of Education of the Head of the Household	3.26	3.41	0	15
CRP_{NO}	Number of Crops Cultivated during the previous Agricultural Season	0.92	1.02	0	4
RUM_B	Number of big ruminants owned by the household	1.09	1.38	0	8
RUM_S	Number of small ruminants owned by the household	2.18	4.55	0	40
SHG	Access to Social Networks (Dummy equals 1 if the household has membership in Self Help Groups, else 0)	0.76	0.43	0	1
MIG	Presence of migrant members (Dummy equals 1 if the household has migrant member in the household, else 0)	0.403	0.783	0	1
Decomposition of Vulnerability by Ligon and Schechter (2003) method					
VULN	Vulnerability	0.698	0.76	-0.61	3.13
POV	Poverty	0.231	0.55	-0.68	2.19
$RISK_{AG}$	Aggregate Risk	0.375	0.12	0.11	0.58
$RISK_{ID}$	Idiosyncratic Risk	-0.0004	0.02	-0.06	0.14
$RISK_{UN}$	Unexplained Risk	0.093	0.16	-0. 20	0.78

Note: N = 800 for all variables except those for PCC, PCY and LAND, which were used to calculate vulnerability and its constituents estimated by vulnerability as low expected utility (VEU) method following Ligon and Schechter (2003). Here N = 1600 as PCC, PCY and LAND of the household before the start of WORLP (2000) after the end (2014) were used. The idiosyncratic risk variables considered for VEU formulation were PCY and LAND. SD - Standard deviation.

5. Results and Discussion

Empirical analysis involves the estimation of the model outlined in equation 3. This was done by quantifying vulnerability through the Ligon and Schechter (2003) method and thereby estimating a median quintile regression for vulnerability and its components. The adoption of median quintile regression is necessary due to the presence of high variability in per-capita consumption and income for the sample and the results are presented in Table 2. Similarly, Appendix 1 shows the plots for coefficients of the quintile regression depicting the significant variables obtained in Table 2. The analysis has decomposed vulnerability into four distinct components, i.e., poverty, aggregate risks, idiosyncratic risks and unexplained risks. Appendix 2 shows Ordinary Least Square (OLS) regression for determinants of vulnerability and its components, and Appendix 3 reports the correlation between the components of vulnerability. Household's vulnerability is measured in terms of per-capita consumption expenditure. The goodness-of-fit (R^2) varies between 0.103 and 0.287, i.e., these models explain 10-29% of the total variation in per-capita consumption expenditure. The estimated coefficients of variables taken in the models are consistent with those reported in the earlier literature. The vulnerability of the sample households was reported as 0.698 (Tables 1 and 2); this figure interprets that the utility of the average household in our sample is nearly 70% less than it would be if all the resources are redistributed to eliminate all inequality and risk in consumption (Ligon and Schechter, 2003).

Table 2 also reports the decomposition of vulnerability into poverty, aggregate risk, idiosyncratic risk, and unexplained risk. Both aggregate risk and poverty are the major source of vulnerability (87%). While the aggregate risk component explains half of the vulnerability, (i.e., 54%), poverty accounts for 33%.It seems that aggregate risk is much more important than poverty, idiosyncratic and unexplained risk. This reveals that aggregate risks such as drought and rainfall variability make households, more vulnerable than any other components of vulnerability. In sum, aggregate risk is the first largest component of risk, followed by poverty, unexplained risk and idiosyncratic risk. Moreover, unexplained risk is larger as compared to the idiosyncratic risks. Table 2 also depicts the estimated cross-sectional regressions of each component of vulnerability on a set off fixed covariates and developmental intervention variables.

The analysis also examined the determinants of vulnerability and its' sub- components where each component was regressed with variables related to developmental interventions and a fixed set of other covariates related to household characteristics. WORLP beneficiary households seem to be less vulnerable and a significant negative coefficient value is reported in the case idiosyncratic risk. Moreover, the households living where WORLP performed better are likely to be less vulnerable as compared to the other households. For instance, the former households are around 20% less in terms

of vulnerability compared to non-beneficiary households. Further, these households also face significantly less poverty and aggregate risk; they are 12.6% less vulnerable to poverty, and around 3.2% less vulnerable to aggregate risk. Surprisingly, it is found that these households are marginally more vulnerable to idiosyncratic risks, i.e., 0.7%, which requires a further exploration. The main objective of promoting WORLP was to eradicate poverty in the drought prone regions of Western Odisha, and indeed, findings of this study support this argument.

Table 2: Estimation results for Median Quintile Regression for vulnerability and its components

Variables	(1)	(2)	(3)	(4)	(5)
	VULN	**POV**	**$RISK_{AG}$**	**$RISK_{ID}$**	**$RISK_{UN}$**
	0.698***=	0.231*** +	0.375*** +	-0.001* +	0.093***
	(0.019)	(0.014)	(0.003)	(0.0003)	(0.004)
Developmental Interventions					
WORL	-0.048	-0.002	0.003	-0.005**	-0.024
	(0.080)	(0.051)	(0.013)	(0.002)	(0.016)
PERF	-0.197***	-0.126***	-0.032***	0.007***	-0.001
	(0.058)	(0.037)	(0.010)	(0.002)	(0.013)
Other Covariates					
AGE	-0.009***	-0.006***	-0.002***	0.0002***	-0.0004
	(0.002)	(0.001)	(0.0003)	(0.0001)	(0.001)
SIZE	0.171***	0.136***	0.030***	-0.004***	0.018***
	(0.010)	(0.006)	(0.001)	(0.0002)	(0.003)
EDU	-0.016**	-0.013***	-0.004***	-0.0001	-0.003
	(0.008)	(0.005)	(0.001)	(0.0002)	(0.002)
CRP_{NO}	-0.111***	-0.075***	-0.018***	0.004***	-0.006
	(0.022)	(0.011)	(0.004)	(0.001)	(0.006)
RUM_B	0.003	-0.004	0.0002	0.001	0.008*
	(0.014)	(0.008)	(0.002)	(0.001)	(0.004)
RUM_S	0.006*	0.0000	0.0001	0.0004***	0.003
	(0.003)	(0.002)	(0.001)	(0.0002)	(0.002)
SHG	-0.261***	-0.132***	-0.034***	-0.001	-0.090***
	(0.047)	(0.028)	(0.008)	(0.001)	(0.016)
MIG	-0.057**	-0.060**	-0.016***	0.005***	0.016
	(0.025)	(0.025)	(0.004)	(0.001)	(0.011)
Constant	0.653***	0.067	0.387***	0.002	0.066*
	(0.138)	(0.095)	(0.023)	(0.004)	(0.038)
Pseudo R^2	0.254	0.279	0.287	0.169	0.103
N	800	800	800	800	800

Note: (1) Bootstrapped standard errors for components of vulnerability androbuststandard errors for determinants of vulnerability in parentheses; (2)*** p<0.01, **p<0.05,* p<0.1; (3) Regressions for the median quintile (50).

Among the other covariates, the variables like age of the household head have negative relationship with the level of vulnerability and other components of vulnerability except the idiosyncratic shocks. Households with higher family size are more vulnerable due to non-diversification of income sources. In other words, additional one member in the family increases vulnerability level by 17%; its impact on poverty is higher than that of aggregate risk. This is similar to the result obtained by Christiaensen et al. (2007), Dercon et al. (2005), Christiaensen and Subbarao (2004) and Datt and Hoogeveen (2003). Moreover, it reduces idiosyncratic risks. The years of education of household head variable reduced the probability of vulnerability level. One year more education of the head makes the household on average 2% less vulnerable. The educated household head has higher expected consumption expenditure and also having more knowledge about consumption smoothing; these households, therefore, are less exposed to aggregate and idiosyncratic risks. It is also observed that households who own small ruminants are likely to be more vulnerable. Moreover, households with more diversified crops are less exposed to vulnerability and its' components. It is known that farmers in rural India used to practice crop- diversification to minimize the risk of crop damage due to climate abbreviations. Agriculture being a more risky source of livelihood, the households, which diversify their agricultural crops, are less vulnerable.

As expected, access to SHGs and migration variables also reduce households' vulnerability. While access to SHGs declines vulnerability by 16%, it is reduced by 6% if the household has a migrant member. Appendix 2 looks at how each component of vulnerability is related to each other. The numbers below the diagonals are Pearson correlation coefficients and the number above the diagonal are Spearman rank correlation coefficient. The numbers in the parentheses report 95% confidence intervals. It is found that poverty and aggregate risk have the same rank-order over households, i.e., as decreasing marginal utility implies that the poor will be most affected by aggregate shocks. Similar result also found by Ligon and Schechter (2003). Idiosyncratic risk is negatively correlated with poverty and aggregate risks. This suggests that the households vulnerable to idiosyncratic risks are not vulnerable to poverty and aggregate risks. Moreover, unexplained risk has positive correlation with poverty, aggregate as well as idiosyncratic risks.

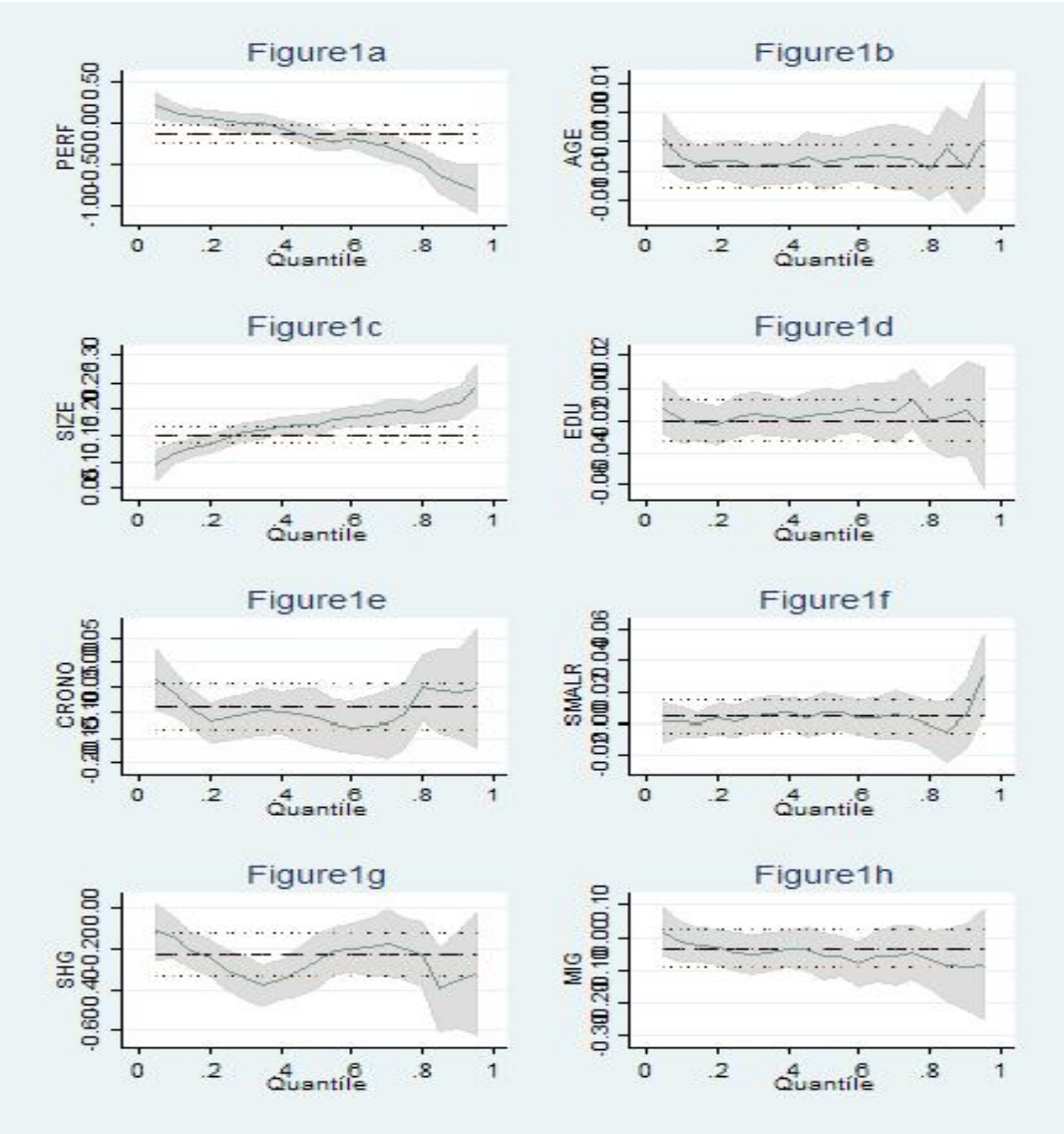
6. Concluding Observations

Households in developing nations are not only exposed to poverty but also to risks and shocks consisting of both idiosyncratic and covariate components. In order to cope with such risks and shocks, households undertake both income and consumption smoothing measures. Various interventions have been taken from time to time by the respective national and state governments for upliftment of the poor households' livelihood. The developmental intervention like WORLP, implemented by the GoO, was based on a different approach, which encompassed the development of sustainable livelihoods

for the rural poor while also addressing poverty reduction. The project targeted development of micro-watersheds in drought prone regions of the state, while it also accommodated mechanisms to provide alternative sources of livelihood, especially, for the non-agricultural households. Given this background, the onus of this study is to investigate the effect of WORLP on households' vulnerability level and its components. In order to do this, around 800 households were surveyed in the four blocks of Balangir district in Western Odisha, a historically drought prone region.

The analysis suggests that utility of the average households in the sample is approximately 70% less than it would be if all the resources are redistributed to eliminate inequality and risk in consumption. While aggregate risk and poverty emerge as the major sources of vulnerability, idiosyncratic and unexplained risks have negligible impact on vulnerability. Hence aggregate risks such as drought and rainfall variability are making the households more vulnerable as compared to poverty and other risks. Importantly, it is observed that beneficiary of the WORLP interventions in general and those particularly living in the better performed regions are less vulnerable as compared to the non-beneficiaries. The major household level characteristics that reduce vulnerability are: age of the household head, education, number of crops cultivated, access to SHGs and presence of migrant members in the family. This study concludes that development interventions promoted by the government agencies to eradicate poverty have also acted as a major determinant in reducing vulnerability and impact on both aggregate and idiosyncratic risks. However, these results need to be interpreted with caution due to certain limitations of the study. Lack of longitudinal data is seen as a major limitation and so also is the non-availability of specific information regarding covariate and idiosyncratic shocks at a micro level. Future studies should aim to overcome these while also deriving results comparing multiple locations within a country which will provide scope for more rigorous inferences on a temporal and spatial scale. Nonetheless, from a policy perspective the findings from this study indicate that the government should promote various developmental interventions in rural India for poverty reduction, which no doubt it has been historically doing. However, there is a need to concurrently re-design these interventions for minimizing the impact of aggregate and idiosyncratic risks.

Appendix 1: Plots for coefficients of the quintile regression depicting the significant variables obtained in Table 2



Notes: Figure 1(a) Interactive dummy of WORLP Beneficiary and Performance and vulnerability showing a negative relationship; Figure 1(b) Age of the head of the household; Figure 1(c) Household size; Figure 1(d) Number of years of education of the head of the household; Figure 1(e) Number of Crops cultivated; Figure 1(f) Number of Small Ruminants; Figure 1(g) Access to Self Help Groups; Figure 1(h) Presence of out-migrant members in the household.

Appendix 2: OLS estimates for determinants of vulnerability and its components

Variables	VULN	POV	$RISK_{AG}$	$RISK_{ID}$	$RISK_{UN}$
(i)	(ii)	(iii)	(iv)	(v)	(vi)
Developmental Interventions					
WORLP	-0.010	0.013	0.007	-0.006***	-0.025
	(0.067)	(0.048)	(0.010)	(0.002)	(0.016)
PERF	-0.129**	-0.095**	-0.023***	0.010***	-0.020
	(0.059)	(0.043)	(0.009)	(0.002)	(0.014)
Other Covariates					
AGE	-0.009***	-0.007***	-0.002***	0.0001	-0.001*
	(0.002)	(0.001)	(0.0003)	(0.0001)	(0.001)
SIZE	0.151***	0.117***	0.025***	-0.004***	0.014***
	(0.009)	(0.007)	(0.002)	(0.0003)	(0.002)
EDU	-0.020***	-0.015***	-0.003***	-0.0000	-0.001
	(0.007)	(0.005)	(0.001)	(0.0002)	(0.002)
CRP_{NO}	-0.089***	-0.068***	-0.015***	0.003***	-0.010
	(0.024)	(0.017)	(0.004)	(0.001)	(0.006)
RUM_B	0.002	-0.002	0.001	0.001**	0.002
	(0.018)	(0.013)	(0.003)	(0.001)	(0.005)
RUM_S	0.004	0.0004	0.0001	0.0002	0.003**
	(0.006)	(0.004)	(0.001)	(0.0002)	(0.002)
SHG	-0.229***	-0.113***	-0.025***	-0.002	-0.089***
	(0.055)	(0.039)	(0.008)	(0.002)	(0.015)
MIG	-0.033	-0.050**	-0.010**	0.006***	0.021**
	(0.035)	(0.024)	(0.005)	(0.001)	(0.009)
Constant	0.754***	0.212**	0.378***	0.012***	0.151***
	(0.139)	(0.099)	(0.020)	(0.004)	(0.035)
N	800	800	800	800	800
R^2	0.366	0.387	0.408	0.275	0.145
F	38.50***	38.11***	44.19***	26.81***	11.82***

Notes: (1) Robust standard errors in parentheses;
(2) *** p<0.01, ** p<0.05, * p<0.1;
(3) Average variance inflation factor (VIF) =1.26.

Appendix 3: Correlation coefficient between elements of vulnerability

	POV	$RISK_{AG}$	$RISK_{ID}$	$RISK_{UN}$
POV	1	1*** (1.00, 1.00)	-0.542*** (-0.575, -0.506)	0.545*** (0.509, 0.578)
$RISK_{AG}$	0.962*** (0.958, 0.965)	1	-0.542*** (-0.575, -0.506)	0.545*** (0.509, 0.578)
$RISK_{ID}$	-0.463*** (-0.5, -0.423)	-0.488*** (-0.525, -0.450)	1	0.008 (-0.041, -0.057)
$RISK_{UN}$	0.525*** (0.488, 0.559)	0.517*** (0.481, 0.552)	0.021 (-0.028, -0.070)	1

Notes: (1) ***p<0.01, **p<0.05, *p<0.1; 95% confidence intervals in parentheses;
(2) Pearson correlation coefficients are given below the diagonal and Spearman rank correlations, above the diagonal.

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