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A Novel Analysis of Risk Sharing Effects on Income Inequality in Informal Insurances

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Abstract

This study aims to demonstrate that joining in risk sharing network leads to the reduction in incomes volatility. In this respect, income variance for a group of members in an informal insurance is modelled in which income variance prior to joining risk sharing network and after joining is analyzed statistically. A Monte Carlo simulation technique is used to prove the result. To extend and analyze the sensitivity, a simulation is performed on either small size population or large size population, the probability of occurrence and the amount of loss are also repeated in all levels. The result of study shows that joining to risk sharing network significantly decreases the income volatility. It is also proved that the probability of occurrence and the amount of loss positively affect the intensity of income volatility.

Keywords: Risk Sharing, Income Inequality, Informal Insurance.
JEL Classification: G29, D33, G32.

1. Introduction

Risk sharing is one of the risk management approaches by which the possible losses arising from a risk would be shared based on a specified rule. The advanced form of risk sharing is used as a critical process in the commercial businesses. Due to existing morale hazards, adverse selection and financial cycle assurance related to the insured people, insurance agencies have to comply with some special regulations and methods. As a way, they would screen customers that the result of screening is to exclude the rural people, especially in a developing country. In this way, various types of informal insurance are generated in which the risk sharing of revenue shocks is the major task among members.

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This paper aims to reveal how income inequality would be affected in special type of informal insurances by risk sharing, so a special type of informal insurance is modeled. Several studies have shown that it is inevitable for poor people in underdeveloped countries to join informal risk sharing in order to control the possible losses happening in their everyday life. There are some reasons which can explain why the poor people are forced to join informal insurance, such as: their illiteracy and irregular income which cause commercial insurance companies not to have tendency to cover their risk.

Many studies have been carried out on the informal insurances, their performance and that how these insurances are generated in [1-10]. The way a risk sharing network is generated among urban people, the motivation for joining into this kind of insurance and the performance of this network in member risks are the major directions of studies in this area of risk sharing.

In recent years, other studies are carried out on the informal networks of risk sharing facing with poverty. Dercon (2005) presented that insurance mechanism for risk-sharing could be used to fight poverty. Caribbean Area and Latin America, as a case study, indicated that rural households face with much more risks than what have been resulted by simple surveys. Dercon (2005) presented that how to establish free market insurance in these areas has led to market failure due to information asymmetry. Also, there is not any social security system for the poor in all of these countries due to government budget issues and prevailing corruption. In spite of the lack of public and private insurance, risk management activities have not been prevented in these areas. People in these areas create communities acting as a kind of informal insurance among them by some tools such as gift.

Habtom & Ruys (2007) revealed that in Eritrea neither the state nor the market is effective to provide health insurance for low-income people. One of the main reasons of this issue is the lack of regular income of the poor people. As they do not have a certain monthly income, they would not be able to pay the premium in installment. *Mahber* is an informal community among poor people with common neighborhood, ethnic, religious or family ties. Each member of the *Mahber* makes a periodic contribution to the community through a specific amount of money and benefits are paid out to members in

kind or money in case of an accident, illness or death. Habtom & Ruys (2007) concluded that development of a traditional and informal insurance like *Mahber* is effective in poverty fighting.

Kurosaki & Fafchamps (2002), Dercon & Christiaensen (2011) and Jalalan & Ravalion (1999) showed that how a risk sharing network can improve the income of poor people in particular. Without risk sharing network, there are fears of possible shocks among low-income people, thus they tend to invest in low-risk activities with low returns. However low-income people take the relative risk more than rich people. Kurosaki & Fafchamps (2002), Dercon & Christiaensen (2011), and Jalalan & Ravalion (1999) concluded that a risk sharing system can reduce the gap between the poor-income people and the rich ones and can be relatively efficient in risk reduction of the poor-income people.

The above mentioned result would be generally studied in other types insurances. Bonfiglioli (2012) studied on risk sharing effects among investors. Investors can take more risk depending on their capability; hence benefits are not equally shared. However, due to risk sharing, there is an opportunity to invest for all people.

Bonfiglioli (2012) proposed a model with risk adverse investor and heterogeneous ability presumption that shows investor protection performs as a risk sharing which decrease investor's income volatility. On the other hand, Investors will be able to take more risks and they earn different income with regard to their different potentiality for taking risks. Although the purpose of this paper is to examine the relationship between protection of investors and the Income distribution, however, the relation between risk sharing and income inequality for the Investors will be proved.

Fischer (2013) studied on the benefit of inequality through risk sharing from the perspective of morale hazards[1]. The most important issue is that the possibility of reneging by the poor is more than the rich ones in informal insurance. Since, the rich would take part in risk sharing system and also have more capability to earn the investment advantage of risky activities. Consequently, Fischer (2013) concluded that morale

1. Moral hazard occurs under a type of information asymmetry where the risk-taking party to a transaction knows more about its intentions than the party paying the consequences of the risk.

hazard leads to reduction in accepting risk sharing by the poor, hence they miss the benefits of risky investment, in other words, income gap can be increased without risk sharing network. Delpierre et al. (2016) also concluded like Fischer's study. Considering homogenous groups, the result shows that there is a more tendency to risk sharing in the poor than in the rich. In heterogeneous groups, due to existing discrepancy, the rich would not be the members of the group.

Ogunmefun & Achike (2015) analyzed informal insurance practices in low income farmer communities. In their study, eighty farmers were randomly sampled and data collected through structured questionnaires and interview schedules were analyzed using frequency distribution and Pearson correlation techniques. Results showed a positive correlation between number of sources of risks and uncertainties perceived by farmers and strategies employed to prevent their effects. This research work also showed that rural farmers used different informal insurance measures like contract farming, savings, land fragmentation and others to manage various risks that they routinely face.

Because of benefits from investment along with risk, all above-mentioned studies most focus on commercial risk. In this paper, we study more on pure risk. This study demonstrates that the income shock generated from the pure risk leads to lower income inequality in spite of a risk sharing network. Two levels of society, i.e., small and large, are analyzed through Monte Carlo simulation.

The main contribution of this study is to decrease income inequality in risk sharing network such as informal insurance through an analytical method, this study efficiently shows that the probability of occurrence and the measure of loss in income volatility.

2. Model

Although Informal Insurances have different structures depending the customs, cultural and geographical conditions of each region, most of these informal and generally rural Insurances have common characteristics. These Insurances are conducted generally in the form of cooperatives and no administrative cost required due to limited number of people. There is no expectation to make a profit. Because of consistent social relationships among the participators of these insurances, there are not so much concerns about Hazards and that is

why no parameters such as franchise could be founded. Potentially, there exists a type of morale hazards among people who know each other and there is a minimum social communication. Hence, these people do not concentrate on morale hazards.

Because there is no systematic approach to forecast the amount of loss for this kind of insurance in practice premium is not taken upon joining to this insurance and the amount of loss related to the insurance is only paid among members after occurrence. This kind of sharing is common against pure risk of occurrence relevant to agriculture crops in some rural areas in Middle East that this kind of insurance is so called Takaful.

An Informal insurance system with N member is contemplated. Each member's income is denoted by x_i. μ_x and v_x denotes the mean income of the group and income volatility of the group, respectively. As per the above-mentioned discussion, income volatility of the group per any number of occurrences and any loss does not change after occurrence because a same amount is taken from each member. Against, if these people did not joint to the insurance, then their income and variance would be changed to their mean income and their…., respectively.

If the number of incidents would be equal to constant value b for a subset with n members, each member's Income after the incident ${x_i}^*$ will be obtained by equation 1.

$$ {x_i}^* = x_i - hb \quad \forall\, h(0.1) \tag{1} $$

If p is the probability of incident occurrence, equivalent expenses will equally be imposed to all the members. This expense is denoted by C which is equal to. Provided that no risk sharing would be available and the injured members provide the cost out of their earning, income variance of the society will be changed.

$$ \vartheta_{(x^*:h)} = \frac{1}{N}\left[\sum_{i=1}^{N}\left({x_i^*}^2\right) - \mu_{x^*}^2\right. = \left.\frac{1}{N}\left[\sum_{i=1}^{N-n} x_i^2 + \sum_{N-n}^{N} {x_i^*}^2 - \mu_{x^*}^2\right.\right] \tag{2} $$

In this case, volatility of people income in no risk sharing conditions could be formulated as below:

$$ \mu_{x^*}^2 = \left(\frac{1}{N}\left[\sum_{i=1}^{N} x_i - \sum_{i=1}^{n} b\right]\right)^2 = \mu_x^2 - 2\mu_x c + c^2 \tag{3} $$

$\frac{1}{N}\sum_{i=1}^{n} x_i^{*2} = \frac{1}{N}\sum_{i=1}^{n}(x_i - b) \Longrightarrow \frac{1}{N}\sum_{i=n}^{N} x_i^2 + \frac{1}{N}\sum_{i=1}^{n} x_i^{*2} = \frac{1}{N}\sum_{i=1}^{N} x_i^2 + \frac{1}{N}\sum_{i=1}^{n}(b^2 - 2bx_i)$ (4)

$\vartheta_{x^*} = \frac{1}{N}\sum_{i=1}^{N} x_i^2 + \frac{1}{N}\sum_{i=1}^{n}(b^2 - 2bx_i) - \mu^2 - c^2 + 2\mu c$ (5)

$\vartheta_{x^*} = \left[\frac{1}{N}\sum_{i=1}^{N} x_i^2 - \mu^2\right] + \frac{1}{N}\sum_{i=1}^{n}(b^2 - 2bx_i) - c^2 + 2\mu c = v_x + \frac{n}{N}b^2 - \frac{2b}{N}\sum_{i=1}^{n} x_i - c^2 + 2\mu c$ (6)

$\left[\frac{1}{N}\sum_{i=1}^{N} x_i^2 - \mu^2\right] = v_x \Rightarrow \quad \frac{1}{N}\sum_{i=1}^{n}(b^2 - 2bx_i) = \frac{n}{N}b^2 - \frac{2b}{N}\sum_{i=1}^{n} x_i$ (7)

$\vartheta_{x^*} = v_x + pb^2 - 2\frac{n}{N}b\frac{\sum_{i=1}^{n} x_i}{n} - c^2 + 2\mu c$ (8)

$\vartheta_{x^*} = v_x + pb^2 - 2pb\bar{X} - c^2 + 2\mu c$ (9)

If $\theta = pb^2 - c^2$ and $\varphi = 2c(\mu - \bar{X})$, we have the following result:

$\vartheta_{x^*} = v_x + \varphi + \theta$ (10)

In the other words, income variance in no risk sharing will be equal to income variance in risk sharing condition plus φ and θ. It is clear that θ is always positive.

$\theta = b^2pq > 0)$ (11)

θ is size of the risk effect on the income distribution. Sign of φ is not defined in the limited societies and widely depends on income distribution and skewness. However, in an unlimited scale and based on law of the large number, income average could be considered equal to society income average and therefore φ will be equal to zero. On the other hand, in small society with negative skewness, φ might be minus. Considering, general shape of income distribution, it can be expected φ, will be tended to zero and positive value. Thus, society variance in no risk sharing condition is always higher than the variance in risk sharing conditions.

$\vartheta_{x^*} = v_x + \theta$ (12)

If b is defined as a fraction of the initial income of members, equation 13 would be obtained. Based on the equation 13, it can be affected by the amount of loss and the probability of incident occurrence. In other words, higher probability of incident occurrence

and higher loss lead to a higher distance between incomes in risk sharing circumstance rather than others.

$$\vartheta_{x^*} = v_x + \tau^2 x^2 p - p^2 \quad (13)$$

Where $\tau = \frac{b}{x}$.

3. Numerical Instance

In this section, we present an instance for a small community through simulation. The initial income value of group members has been generated randomly and the generation has been replicated 25000 times. The accident occurrence for members has been also determined randomly in each time, thus the income after occurrence per a member is calculated based on two scenarios as follows: all members are joined to informal insurance mentioned in section 2 and the members are not joined to any risk sharing network.

Table 1: The Effect of "P" on Income Variance of the Group Members before and After Joining

P	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
With Risk Sharing	287.9	288.4	287.7	287.6	288.1	288	288.2	287.9	288.1	287.8
Without Risk Sharing	292.2	296.9	300	303.9	296.5	311.5	315.2	318.3	321.6	324.5
t	<-15	<-15	<-15	<-15	<-15	<-15	<-15	<-15	<-15	<-15
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: A 200-member group is contemplated in the simulation. The amount of occurring is equal to the 50 percent of the group members on average. The simulation is replicated 25000 times. The zero assumption is that the income variance of the group before joining and after that is equal in a risk-sharing network related to an informal insurance.

Table 2: The Effect of "τ " on Income Variance of the Group Members before and After Joining

τ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
With Risk Sharing	288	287.9	288.1	287.9	288.1	287.6	288.2	287.9	288	287.7
Without Risk Sharing	288.3	289.2	291.2	293.2	296.4	299.6	304.4	308.9	314.2	320
t	-0.81	-5.05	-11.52	<-15	<-15	<-15	<-15	<-15	<-15	<-15
P-value	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: A 200-member group is contemplated in the simulation. The probability of incident occurrence is equal to the 5 percent. The simulation is replicated 25000 times. The zero assumption is that the income variance of the group before joining and after that is equal in a risk-sharing network related to an informal insurance.

In Table 1, at first, the difference between risk sharing and others is

measured based on the probability of incident occurrence into 10 same categories. As seen, increasing in the probability of incident occurrence leads to a more distance between the inequality income of insured people and uninsured ones.

In Table 2, the ratio of the amount of loss to the mean income is changeable and the probability level of incident occurrence is considered a fixed value. As seen, in this level of the probability, if the ratio of the amount of loss to the mean income of members exceeds 10 percent, the membership can leads to a reduction in the income variance.

Also, increasing in the fraction of cost of loss from the mean income leads to more difference between the inequality income of insured people and uninsured ones.

However, the results is obtained based on the study on a simple informal insurance, but it can be generalized to all conditions relevant to the pure risk. Indeed, the value of loss and the probability of incident occurrence directly affect the intensity of income fluctuations. This case is shown for a range of probability in Fig (1).

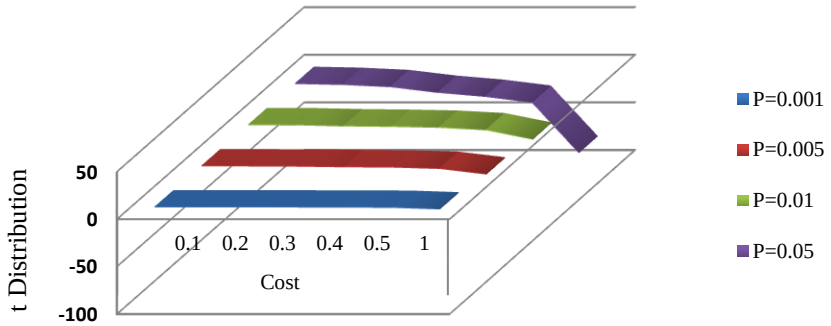

Figure 1: The Result of Simulation

As seen in Fig (1), the standardized statistics by t-distribution is used to represent the difference between the income variance of the 20000-member group considering the ratio of loss to the probability of incident occurrence. For more details, vertical axis indicates the value of t distribution, the horizontal axis, p, indicates the probability level of incident occurrence and the third axis, C, indicates the expense. Increasing in P and C together leads to a more negative value of t expressing a significant difference between the inequality income of

insured people and uninsured ones. Fig (1) would be summarized in Table 3 through point by point as sequence below.

Table 3: The Result Shown Point by Point

		C					
		0.1	**0.2**	**0.3**	**0.4**	**0.5**	**1**
P	0.001	-0.0211	-0.06876	-0.17653	-0.24114	-0.50632	-2.11501
	0.005	-0.09403	-0.2981	-0.96888	-1.26004	-2.68634	-8.55137
	0.01	-0.184	-1.23738	-1.75569	-2.6852	-5.32107	-15.09
	0.05	-0.97	-3.2586	-9.25283	-13.474	-19.6264	-72.7886

4. Conclusion

In this study, we tried to find the relation between risk sharing and income inequality. For this purpose, an informal insurance company with the specified number of members has been modelled. The difference of income variance before and after risk sharing has been compared. The result shows that income variance will be decreased by creating risk sharing mechanisms.

This study implies that the income variance of a group exposing to the net risk may increases. This increasing has a direct relation to the probability of incident occurrence and the ratio of the amount of loss to the amount of income. The more probability in incident occurrence and consequently the more loss can lead to the increasing in income variance of the group, while the membership in a risk-sharing group sharing the loss equally can decrease the income variance. A simple informal insurance was modelled to prove this case. In this type of insurance, there is not the usual complexity in the contract of commercial insurance that is generally resulted from moral hazards and the wrong selection. By the way, the amount of loss is equally shared between the members, so if a bad event occurs, the amount of the given loss for each member is equal, then the income variance of each member does not change. Therefore if a person was not a member of this group, the income variance would increase.

The above-mentioned model was discussed more through Monte-Carlo simulation method in a 200-member group. The study shows that if the amount of loss exceeds or equals to the 50 percent of the income on average, the difference between the income variance of people before

joining the group and after joining it is significant. Next, the simulation would be done on a 20000-member group in the crossing way. The result represents that the threshold value of sensitivity for a significant difference between the variance and the loss gets 50 percent. It is evident that if the amount of probability becomes more, the significant difference between the income variance before joining the group and after joining it can be obtained through the less loss. It is also shown that in the fixed loss ratio 30 percent, the sensitivity of the model for the significant difference between the income variance before joining the group and after joining it can reaches to 1 percent. In other words, the amount of loss resulted from occurrence exceeds 30 percent, the risk that would happen with the probability less than 1 percent can also leads to a significant difference between the income variance before joining the group and after joining it.

The result can be an efficient theoretical base through practical observations in which the role of informal insurance in the reduction of income variance and in particular, in risky circumstances for people who do not have access to the restricted commercial insurance. However, the model studied here was constructed based on a simple and elementary risk sharing that would be extended in future research.

References

Ahmed-Mushfiq, M., & Rosenzweig, M. R. (2013). Informal Risk Sharing, Index Insurance, and Risk Taking in Developing Countries. *The American Economic Review*, *103*(3), 375-380.

Ambrus, A., Chandrasekhar, A., & Elliott, M. (2015). Social Investment, Informal Risk Sharing and Inequality. *Duke Working Paper Series, ERID-178*, Retrieved from http://EconPapers.repec.org/RePEc:red:sed015:189.

Amiel, Y., Cowell, F. A. & Polovin, A. (2001). Risk Perceptions, Income Transformations and Inequality. *European Economic Review*, *45*(4-6), 964-976.

Arnott, R., & Stiglitz, J. (1991). Moral Hazard and Nonmarket Institutions: Dysfunctional Crowding Out or Peer Monitoring? *American Economic Review, 81*(1), 179-190.

Attanasio, O., Barr, A., Cardenas, J. C., Genicot, G., & Meghir, C. (2012). Risk Pooling, Risk Preferences and Social Networks. *American Economic Journal, 4*, 134-167.

Besley, T. (1995). Nonmarket Institutions for Credit and Risk Sharing in Low-Income Countries. *The Journal of Economic Perspectives, 9*(3), 115-127.

Bloch, F., Genicot, G., & Ray, D. (2008). Informal Insurance in Social Networks. *Journal of Economic Theory, 143*, 36-58.

Bonfiglioli, A. (2012). Investor Protection and Income Inequality: Risk Sharing vs. Risk Taking. *Journal of Development Economics, 99*, 92-104.

Delpierre, M., Verheyden, B., & Weynants, S. (2016). Is Informal Risk-Sharing Less Effective for the Poor? Risk Externalities and Moral Hazard in Mutual Insurance. *Journal of Development Economics*, *118*, 282-297.

Dercon, S., & Christiaensen, L. (2011). Consumption Risk, Technology Adoption, and Poverty Traps: Evidence from Ethiopia. *Journal of Development Economics*, *94*(1), 141-166.

Dercon, S. (2005). *Risk, Insurance, and Poverty: A Review*. Oxford: Oxford University Press.

Fafchamps, M., & Gubert, F. (2007). Risk Sharing and Network Formation. *American Economic Review, 97*, 75-79.

Fafachamps, M., & Lund, S. (2003). Risk-Sharing Networks in Rural Philippines. *Journal of Development Economics, 71*(2), 261-287.

Fischer, G. (2013). Contract Structure; Risk Sharing, and Investment Choice. *Econometrica, 81*(3), 883-939.

Habtom, G., & Ruys, P. (2007). Traditional Risk-Sharing Arrangements and Informal Social Insurance in Eritrea. *Health Policy, 80*, 218-235.

Jalan, J., & Ravallion, M. (1999). Are the Poor Less Well Insured? Evidence on Vulnerability to Income Risk in Rural China. *Journal of Development Economics, 58*, 61-81.

Kurosaki, T., & Fafchamps, M. (2002). Insurance Market Efficiency and Crop Choices in Pakistan. *Journal of Development Economics, 67*(2), 419-453.

Laczo, S. (2015). Risk Sharing with Limited Commitment and Preference Heterogeneity: Structural Estimation and Testing. *Journal of the European Economic Association*, *13*, 265-292.

Lam, L. M., & Paul, S. (2013). Displacement and Erosion of Informal Risk-Sharing: Evidence from Nepal. *World Development, 43*, 42-55.