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Can Safety Nets Offset the Impact of Risk on Wage Inequality and Social Welfare?

Paul Makdissi* Quentin Wodon†

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Abstract

Income variability reduces social welfare if individuals are risk averse, and it is likely to increase inequality if poorer households are more vulnerable to shocks. Using a simple method to estimate risk-adjusted measures of inequality and welfare and wage data from Mexico, this note shows that it is easier for safety nets to offset the impact of risk on wage inequality than on welfare. This is because apart from its impact on inequality, risk reduces the certainty equivalent income of individuals.

Keywords: Inequality, Welfare, Risk, Safety Nets, Mexico

JEL Codes: D81, D63, I30

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1 Introduction

When performing distributional analysis, economists usually rely on cross-sectional data which give information on income at a point in time (e.g., Atkinson and Bourguignon, 2000 and Lambert, 2002). However, it has long been recognized that incomes are subject to variability and that this may affect welfare if individuals are risk averse.

Atkinson (1970), Yitzhaki and Slemrod (1991) and Davies and Hoy (1995) argue that there are links between the literatures on risk and inequality, because the mathematical structures used to discuss both concepts are similar. In this note, we show that both concepts can in fact be used jointly to estimate risk-adjusted measures of inequality and social welfare. We propose a simple method to do so and we use this method to test whether safety nets are likely to be able to offset the impact of risk on inequality and social welfare.

The idea consists in replacing the mean income observed over a period of time in panel data by the certainty-equivalent income. This is done using various parameters for risk aversion among the population in order to test for the sensitivity of the results to the level of risk aversion. We can then assess, for example, whether safety nets such as unemployment benefits for workers who lose their jobs are able to offset the negative impact of risk aversion¹. Section 2 presents the approach, which is then illustrated in section 3 using Mexican wage data.

¹As pointed out by Ravallion (1988), when assessing income variability from conventional data sets, one may have difficulties in distinguishing between two sources of variability: social mobility, which is linked to opportunities for self-advancement, and income risk. In this note, we focus on the risk component of income variability. Because we use a panel with quarterly interviews over a relatively short period of time, we assume that the income variability observed in the data is entirely due to risk.

2 Framework

Consider an individual i with income x_{it} at time t . The individual is exposed to variability in income over the time period T . As defined in the risk theory literature, the certainty equivalent of the individual's income, y_i , is

$$u(y_i) = \frac{1}{T} \sum_{t=1}^T u(x_{it}). \quad (1)$$

Within a social welfare context, $u(\cdot)$ does not represent the Bernoulli utility function of the individual, but rather a social judgement on the welfare value of the random variable x , as suggested by the argument on the impartial evaluation of welfare behind a veil of ignorance (see Vickrey, 1945 and Harsanyi, 1953, 1955). We assume that $u(\cdot)$ is continuous with $u'(\cdot) \geq 0$ and $u''(\cdot) \leq 0$ for all y . The assumption on the first derivative implies non-satiation. The assumption on the second derivative implies that the social welfare evaluation function is risk averse². One such function is the Constant Relative Risk Aversion (CRRA) utility function

$$u(x) = \begin{cases} \frac{x^{1-\rho}}{1-\rho} & \text{if } \rho \neq 1 \\ \log x & \text{if } \rho = 1 \end{cases}, \quad (2)$$

where ρ is the constant Arrow-Pratt relative risk aversion coefficient. The CRRA function is interesting because it is similar in structure to the Atkinson indices of inequality and social welfare. Using (2), the certainty equivalent income is

$$y_i = \begin{cases} \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]^{\frac{1}{1-\rho}} & \text{if } \rho \neq 1 \\ y_i = \prod_{t=1}^T x_{it}^{1/T} & \text{if } \rho = 1 \end{cases}. \quad (3)$$

²Although not necessary, it is possible to make higher order assumptions such that for order s we have $(-1)^{i+1} u^{(i)}(\cdot) \geq 0$ for all $i = 1, 2, \dots, s$. Those assumption of order s describe the class Θ^s of utility functions and are linked to the s -th order of stochastic dominance described in Thistle (1993). An increase of the order of stochastic dominance implies an increase of the minimum risk aversion in the set of admissible utility functions.

Given the vector of certainty equivalent incomes $y = (y_1, y_2, \dots, y_n)$ where n is the number of individuals, social welfare W is measured additively:

$$W = \frac{1}{n} \sum_{i=1}^n v(y_i), \quad (4)$$

where $v(y_i)$ is the social evaluation of the contribution to total welfare of individual i . As shown by Blackorby and Donaldson (1978), the family of the social welfare functions in (4) can be associated with an Atkinson-Kolm-Sen inequality index of the form

$$I = 1 - \frac{y^e}{\mu_y}, \quad (5)$$

where μ_y is the mean of the elements of the vector y and y^e is the equally-distributed-equivalent income implicitly defined as

$$u(y^e) = W = \frac{1}{n} \sum_{i=1}^n v(y_i). \quad (6)$$

The indices in (5) are relative inequality indices if and only if the function $v(\cdot)$ is isoelastic, which gives the Atkinson (1970) inequality index

$$I_A = \begin{cases} 1 - \left[\frac{1}{n} \sum_{i=1}^n \left(\frac{y_i}{\mu_y} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} & \text{if } \varepsilon \neq 1 \\ 1 - \frac{\prod_{i=1}^n y_i^{1/n}}{\mu_y} & \text{if } \varepsilon = 1 \end{cases}. \quad (7)$$

where ε is an inequality aversion parameter. Using (3), the risk-adjusted

Atkinson index of inequality is thus

$$I_A = \begin{cases} 1 - \frac{\left\{ \frac{1}{n} \sum_{i=1}^n \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]^{1-\varepsilon} \right\}^{\frac{1}{1-\varepsilon}}}{\frac{1}{n} \sum_{i=1}^n \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]} & \text{if } \rho \neq 1 \text{ and } \varepsilon \neq 1 \\ I_A = 1 - \frac{\left\{ \frac{1}{n} \sum_{i=1}^n \prod_{t=1}^T x_{it}^{\frac{1-\varepsilon}{T}} \right\}^{\frac{1}{1-\varepsilon}}}{\frac{1}{n} \sum_{i=1}^n \left[\prod_{t=1}^T x_{it}^{1/T} \right]} & \text{if } \rho = 1 \text{ and } \varepsilon \neq 1 \\ 1 - \frac{1}{(1-\rho)} \frac{\sum_{i=1}^n \log \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]}{\sum_{i=1}^n \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]} & \text{if } \rho \neq 1 \text{ and } \varepsilon = 1 \\ I_A = 1 - \frac{\prod_{i=1}^n \prod_{t=1}^T x_{it}^{1/Tn}}{\frac{1}{n} \sum_{i=1}^n \prod_{t=1}^T x_{it}^{1/T}} & \text{if } \rho = 1 \text{ and } \varepsilon = 1 \end{cases}. \quad (8)$$

In turn, the Atkinson social welfare function is

$$W_A = \begin{cases} \frac{1}{n(1-\varepsilon)} \sum_{i=1}^n \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right]^{\frac{1-\varepsilon}{1-\rho}} & \text{if } \rho \neq 1 \text{ and } \varepsilon \neq 1 \\ \frac{1}{n(1-\varepsilon)} \sum_{i=1}^n \prod_{t=1}^T x_{it}^{\frac{1-\varepsilon}{T}} & \text{if } \rho = 1 \text{ and } \varepsilon \neq 1 \\ \frac{1}{n(1-\rho)} \sum_{i=1}^n \log \left[\frac{1}{T} \sum_{t=1}^T x_{it}^{1-\rho} \right] & \text{if } \rho \neq 1 \text{ and } \varepsilon = 1 \\ \frac{1}{Tn} \sum_{i=1}^n \sum_{t=1}^T \log x_{it} & \text{if } \rho = 1 \text{ and } \varepsilon = 1 \end{cases}, \quad (9)$$

In theory, inequality may be increased or reduced when risk aversion is taken into account. If those who suffer from volatility are ranked near the top of the distribution, risk-adjusted inequality measures may be lower than measures not taking into account risk. In practice however, since much of the volatility in income is likely to come from losses in employment, and since poorer households tend to be more exposed to such losses, we would expect risk-adjusted measures of inequality to be larger than inequality measures estimated on the mean income over period T . In the case of social welfare, it is clear from the inspection of (4) that taking into account risk will decrease the index because it lowers some income without increasing any income. Note

that the same idea could easily be applied to poverty measurement, since we could use the certainty-equivalent income of individuals to compute standard poverty measures.

3 Illustration

The above framework is illustrated using data from Mexico's urban employment survey (ENEU) for 1996. Information on wage income is given on a quarterly basis, and we have five observations for each individual. We restrict the sample to adult males who have a positive income in at least one of the five periods. Note that while the data are good for the measurement of wage inequality, one could wonder whether the data are appropriate for estimating social welfare since we don't have information on other sources of income, and we estimate welfare measures at the individual rather than household level. Unfortunately, other surveys in Mexico which have information on non-wage income sources such as the Income and Expenditure Survey (ENIGH) do not have panel data. Furthermore, it is perfectly valid to apply social welfare functions to wage data, provided it is clearly understood that we are analyzing the distribution of wages rather than that of equivalent household income. However, it is clearly not valid to use wage data only for estimating risk-adjusted poverty measures, so we will not do this here.

To deal with zero observations ($x_{it} = 0$) and to simulate the potential impact of safety nets on inequality and welfare, we assume that instead of having no resources at all, individuals actually have a minimum level of resources. For baseline estimates of inequality and social welfare, we set this minimum at $1/20^{th}$ of the mean wage observed in the data. We then test for the sensitivity of the impact of risk aversion to increases in this

subsistence level wage. The simulations can thus be interpreted as a test of whether various levels of unemployment benefits (which are currently not existing in Mexico, although there are several safety net programs available) for individuals with zero income would be able to offset the impact of risk aversion. For example, if with a transfer of $1/5^{th}$ of the mean wage to all those with zero income, the level of risk-adjusted inequality (or welfare) is not higher (lower) than the level of inequality (welfare) observed with the mean wage over the five periods (which assumes no risk aversion) and a subsistence wage of $1/20^{th}$ of the mean wage, we will say that the transfer is successful in offsetting the impact on inequality (welfare) of risk aversion.

Said differently, the empirical question is what level of transfers might be necessary to offset the impact of risk aversion. A higher level of risk aversion will require a higher transfer to compensate for the impact of risk aversion on inequality and welfare. As mentioned earlier, we can conjecture that the impact of risk aversion on welfare is going to be more difficult to offset with a transfer for those with zero income than the impact on inequality, because in the case of social welfare, risk aversion reduces the mean certainty-equivalent income level apart from potentially increasing inequality.

Table 1 provides the estimates of the Atkinson indices of inequality and welfare for different values of ρ and ε . We compute estimates for values of $\rho \in [0, 8]$, because these are the values typically used in the literature. For instance, Mehra and Prescott (1985) use $\rho \in [0, 10]$. Arrow (1971) has argued on theoretical grounds that ρ should be around 1, but Friend and Blume (1975) have presented empirical evidence based on portfolio holdings that the coefficient may be around 2, and Hildreth and Knowles (1982) have obtained estimates between 1 and 2. By considering a larger interval, as done by Mehra and Prescott (1985), we can be confident that we cover most

possible values for this coefficient.

Consider the first row of Table 1 as the base case (minimum income support and no risk aversion). For $\varepsilon = 0.5$, the Atkinson index of inequality is 0.17. This increases to 0.18 with $\rho = 2$ and 0.19 with $\rho = 4$. The question is: what level of transfer for those with zero income would be enough to offset the impact of risk aversion, namely the increase in inequality from 0.17 to 0.18 or 0.19. Table 1 shows that a transfer equal to $1/10^{th}$ of the mean wage would be sufficient to offset the impact of risk aversion, since for both $\rho = 2$ and $\rho = 4$ and that level of transfer, we remain at a level of inequality of 0.17. For social welfare by contrast, with $\varepsilon = 0.5$, $\rho = 0$, and a transfer of $1/20^{th}$ of the mean wage, the baseline estimate of welfare is 9.55. This drops to 8.54 if $\rho = 2$ and 8.07 if $\rho = 4$. A transfer of $1/10^{th}$ of the mean wage would not be sufficient to offset the impact of risk aversion since the level of welfare would increase only to 8.22 with $\rho = 4$ and 8.68 with $\rho = 2$. Even a transfer equal to half the mean wage would not be enough to offset risk aversion, since welfare would then be equal to 8.62 with $\rho = 4$ and 9.06 with $\rho = 2$ which remains well below 9.55

The impact of risk aversion, and the fact that it is easier to offset this impact on inequality than on welfare, are illustrated in Figures 1 and 2. Figure 1 shows the impact of risk aversion (as represented by the curves for different values of ρ) and aversion to inequality (on the horizontal axis) on both welfare (downward sloping curves and left vertical axis for measurement) and inequality (upward sloping curves and right vertical axis for measurement) under the baseline scenario (subsistence wage equal to $1/20^{th}$ of the mean wage.) Higher aversion to risk and higher aversion to inequality both increase inequality measures and decrease welfare measures. Figure 2 shows how inequality and welfare measures behave with a transfer of $1/3^{rd}$ of mean

wage. The transfer is able to offset most of the impact of risk aversion on inequality, but it is not sufficient to offset the impact of risk aversion on welfare. Again, the reason is that the impact of risk on social welfare is double. First, risk reduces the certainty-equivalent income (this is always the case), and second, it increases inequality (this need not be the case, but is likely to be observed in practice).

4 Conclusion

Analysts often rely on cross-sectional statistics on income to assess inequality, social welfare and poverty. But the results do not reflect the risk component associated with income variability. In this note, we have provided a simple method for ensuring that risk is taken into account. The method is based on the concept of the certainty-equivalent income standard in the risk literature. An illustration for Mexico suggests that transfers for those who lose their income due to unemployment and other factors have the potential to offset the impact of risk aversion on inequality, but counteracting the impact of risk aversion on social welfare is more difficult.

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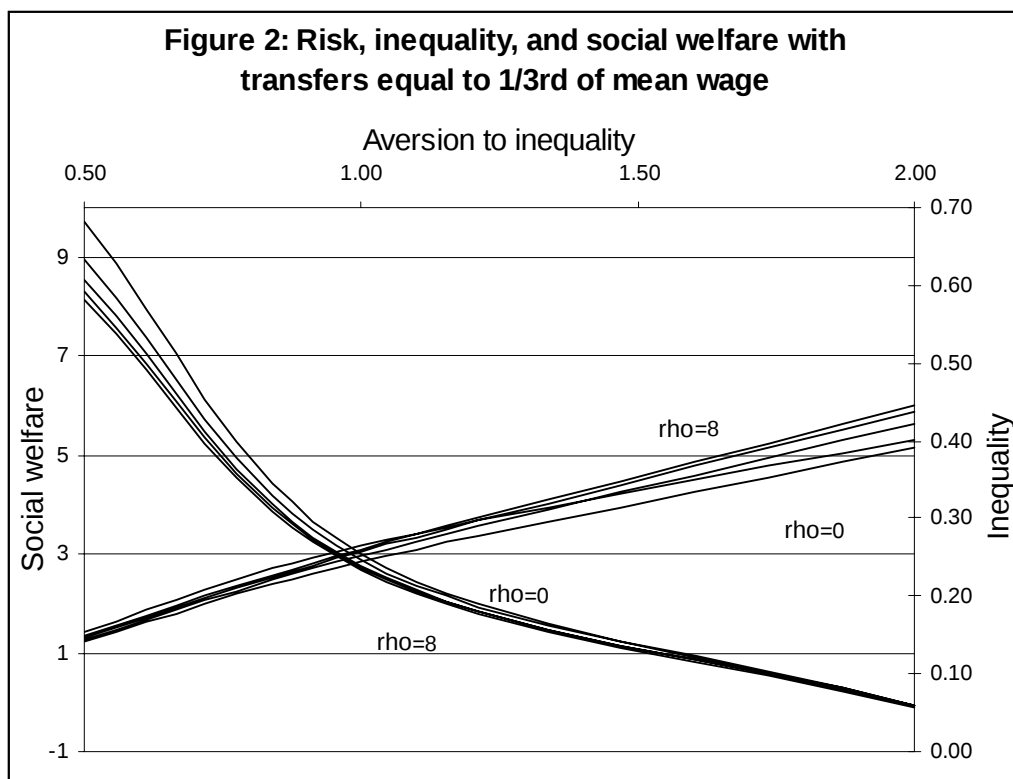
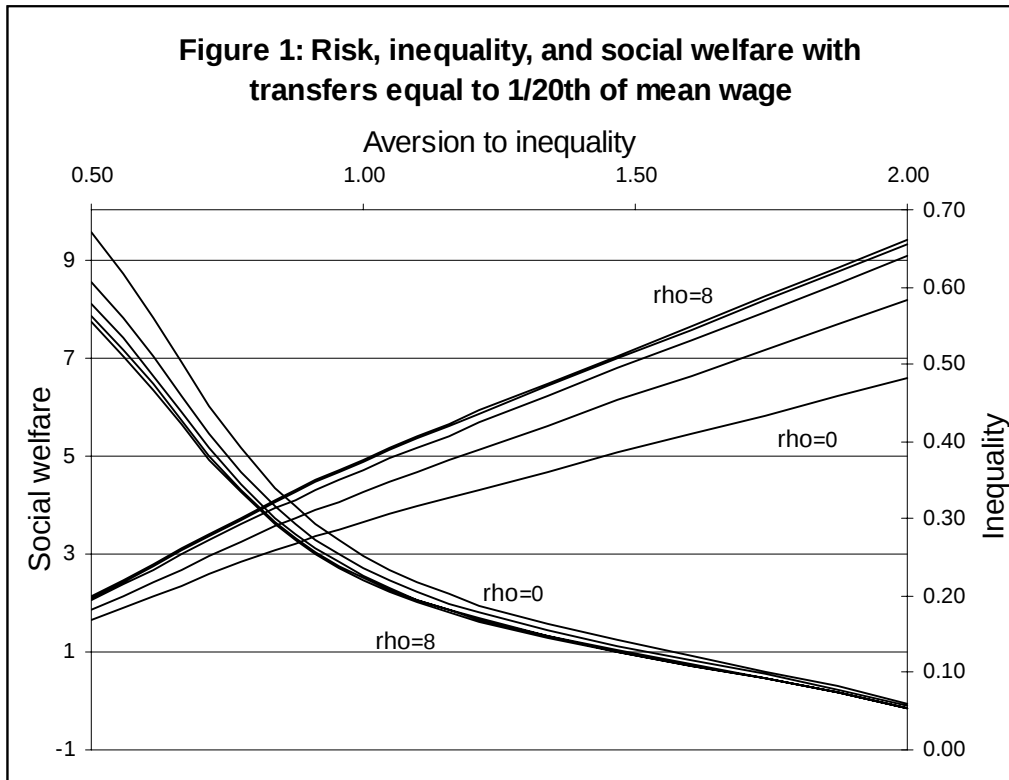
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Table 1: Inequality and welfare under risk aversion and alternative safety nets

Aversion to Risk (ρ)	Inequality (Atkinson measure)			Social welfare (Atkinson measure)		
	A(0.5)	A(1)	A(2)	W(0.5)	W(1)	W(2)
Transfer equal to 1/20 th of mean wage for those with zero wage						
0	0.17	0.29	0.48	9.55	2.96	-0.07
2	0.18	0.33	0.58	8.54	2.70	-0.11
4	0.19	0.36	0.64	8.07	2.55	-0.14
6	0.20	0.37	0.66	7.84	2.49	-0.15
8	0.20	0.38	0.66	7.70	2.45	-0.16
Transfer equal to 1/10 th of mean wage for those with zero wage						
0	0.17	0.29	0.45	9.59	2.98	-0.07
2	0.17	0.29	0.48	8.68	2.77	-0.09
4	0.17	0.31	0.53	8.22	2.64	-0.10
6	0.18	0.32	0.54	7.98	2.58	-0.11
8	0.18	0.32	0.55	7.84	2.54	-0.12
Transfer equal to 1/5 th of mean wage for those with zero wage						
0	0.16	0.27	0.42	9.64	3.00	-0.06
2	0.15	0.26	0.42	8.84	2.83	-0.07
4	0.16	0.27	0.45	8.39	2.72	-0.09
6	0.16	0.28	0.46	8.15	2.66	-0.09
8	0.16	0.28	0.47	8.01	2.62	-0.10
Transfer equal to 1/3 rd of mean wage for those with zero wage						
0	0.16	0.26	0.40	9.71	3.02	-0.06
2	0.14	0.25	0.39	8.96	2.87	-0.07
4	0.14	0.25	0.42	8.52	2.77	-0.08
6	0.15	0.26	0.44	8.29	2.70	-0.09
8	0.15	0.26	0.44	8.14	2.67	-0.09
Transfer equal to half of mean wage for those with zero wage						
0	0.15	0.26	0.39	9.78	3.04	-0.06
2	0.14	0.24	0.38	9.06	2.90	-0.07
4	0.14	0.24	0.41	8.62	2.79	-0.08
6	0.14	0.25	0.43	8.38	2.73	-0.09
8	0.14	0.25	0.44	8.23	2.69	-0.09

Source: Authors' estimation using Mexico's ENEU for 1996.



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