Targeting the Vulnerable and the Choice of Vulnerability Measures: Review and Application to Pakistan

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Abstract: In this paper, the concept of vulnerability of the poor's welfare and its practical measures are scrutinized in order to derive implications for targeting poverty reduction policies toward vulnerable households. As illustration, various measures of vulnerability proposed in the literature are applied to a panel dataset collected in rural Pakistan. The empirical results show that different vulnerability rankings can be obtained depending on the choice of the measure. By utilizing these measures, we can identify who and which region is more vulnerable to a particular type of risk. This kind of information is useful in targeting poverty reduction policies. Since the nature of vulnerability is diverse, it is advisable to use the whole vector of various vulnerability measures.

1. INTRODUCTION

In this paper, the concept of vulnerability of the poor's welfare and its practical measures are scrutinized in order to derive implications for targeting poverty reduction policies toward vulnerable households. How different is the concept of vulnerability from that of poverty in a narrow sense and how significant is the expansion of the poverty concept into vulnerability? How has the vulnerability concept been operationalized into measures that can be estimated from quantitative and qualitative data? And what is the weakness of these measures we need to keep in mind when we would like to target our policies toward vulnerable households based on these measures? These are the issues addressed in this paper.

Recently, interest on the dynamic characteristics of poverty in low income countries has increased, partly due to the availability of high quality panel data and partly due to the development of microeconometric tools to analyze household dynamics under uncertainty [Dercon (2005), Fafchamps (2003), Townsend (1994), Udry (1994)]. A large attention is now paid to poverty dynamics and security issues in designing poverty reduction policies as well [World Bank (2000)]. An emerging consensus is that poor households are likely to suffer not only from low income and consumption on average but also from fluctuations of their welfare. The concept of vulnerability is often employed in these analyses of the poverty dynamics. In the non-technical literature, Chambers (1989) described vulnerability as "defenselessness, insecurity, and exposure to risk, shocks, and stress" (p.1), while the World Bank (2000)

described it as "the likelihood that a shock will result in a decline in well-being" (p.139). This paper accepts these non-technical definitions and attempts to translate them into the terminology of economics. A natural way to define vulnerability in economics terms is to define it as a loss in forward-looking welfare due to low expected consumption, high variability of consumption, or both [Ligon and Schechter (2003)].

There exists an emerging literature in development economics that attempts to operationalize the concept of vulnerability.[1] One strand of the literature approaches this issue based on the expected utility theory. Another strand proposes measures of vulnerability that are readily estimable from household datasets, without specifying the household utility function. These attempts are reviewed in the second section of this paper.

As illustration, these measures of vulnerability are empirically estimated in the third section, using a panel dataset collected by the author in the North-West Frontier Province (NWFP),[2] Pakistan. The empirical exercise investigates the robustness of ranking households based on various vulnerability measures.[3] Pakistan is a part of South Asia, where more than 500 million people or about 40% are estimated to live below the poverty line [World Bank (2000)]. In recent debates on poverty in Pakistan, the issue of vulnerability has been mentioned frequently [e.g., Govt. of Pakistan (2003), World Bank (2002)]. Furthermore, the

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[1] See for example, Ligon and Schechter (2002), Hoddinott and Quisumbing (2003), Calvo and Dercon (2005), and Dercon (2006) for a survey of the literature on vulnerability analyses in developing countries.
[2] In April 2010, the constitution of Pakistan was amended, including the renaming of the former NWFP as "Khyber Pakhtunkhwa." In this paper, since all data correspond to a period before this constitutional amendment, the expression "NWFP" is used to infer the current province of "Khyber Pakhtunkhwa."
[3] Among the existing studies, Ligon and Schechter (2004) implemented a similar exercise of comparing the performance of various vulnerability measures. They investigated the cases of Vietnam and Bulgaria.

poverty incidence in NWFP is higher and agriculture is more risky than in other parts of Pakistan. These additional hardships make the NWFP case study an interesting one to investigate vulnerability. In the final section, implications of vulnerability analyses to poverty reduction policies are discussed.

2. ANALYTICAL FRAMEWORK

2.1 Basic Concept of Welfare under Uncertainty

This paper assumes that the welfare level of an individual belonging to household i in period t is determined by the level of per-capita real consumption, y_{it}. The most important determinant of y_{it} is household income per capita, x_{it}. Due to exogenous shocks occurring to the income generating process, such as drought, flood, price changes in the world commodity markets, sickness and injury to the labor force, and changes in policies, x_{it} fluctuates. However, y_{it} need not to be equal to x_{it}. Households can smooth consumption over time and across states of nature using various assets and insurance arrangements, *ex post* [Townsend (1994), Udry (1994), Kurosaki and Fafchamps (2002)]. When households' *ex post* risk-coping measures are limited, possibly due to the underdevelopment of credit and insurance markets in low income countries, they may adopt income smoothing measures, such as income diversification and asset portfolio choices [Morduch (1994), Kurosaki and Fafchamps (2002)]. Since these attempts to avoid unnecessary fluctuations in consumption are usually far from

perfect, fluctuations in consumption as well as income are commonly observed in a household panel dataset, including the one used in this paper.

An implicit assumption underlying this discussion is that households have risk-averse preferences. Since the focus of this paper is on the well-being of people whose average consumption is low, a small reduction of consumption might imply a serious survival crisis for such people. Thus the assumption of risk aversion can be justified. Unwanted fluctuations in future consumption indeed imply a loss in *forward-looking* welfare. This loss is regarded as vulnerability in this paper. The vulnerability concept thus captures an aspect that cannot be captured by orthodox poverty measures that aggregate the deprivation of *current* welfare below the poverty line. Herein lies the significance of the vulnerability concept.

2.2 Vulnerability Analysis Based on the Expected Utility Theory

When the preference of household i is represented by a von Neumann-Morgenstern utility function, $U_i(y_i)$, with $U'_i(.)>0$, $U''_i(.)<0$, and given the distribution of y_i, we can calculate the value of the expected utility, $E[U_i(y_i)]$, which is a convenient measure of welfare under uncertainty. Ligon and Schechter (2002, 2003) thus proposed a convenient way of defining vulnerability, V_i, as the deviation of the welfare from the level corresponding to the poverty line without uncertainty:

$$V_i = U_i(z) - E[U_i(y_i)], \qquad (1)$$

where z is the poverty line, exogenously fixed. Equation (1) can be decomposed as

$$V_i = \{U_i(z) - U_i(\mathrm{E}[y_i])\} + \{U_i(\mathrm{E}[y_i]) - \mathrm{E}[U_i(\mathrm{E}[y_i|W])]\} + \{\mathrm{E}[U_i(\mathrm{E}[y_i|W])] - \mathrm{E}[U_i(y_i)]\}, \quad (2)$$

where $\mathrm{E}[y_i|W]$ indicates the expected consumption level conditional on a vector of aggregate variables W, such as weather shocks. The first term on the right-hand-side of equation (2) shows the vulnerability due to income poverty, the second term shows the vulnerability due to welfare fluctuations arising from aggregate shocks, and the last term shows the vulnerability due to welfare fluctuations arising from idiosyncratic shocks. By aggregating over individuals belonging to a particular group, we can calculate the value of the group's vulnerability with neat decomposition. This is what Ligon and Schechter (2002, 2003) implemented for the case of Bulgaria.

One aspect that cannot be directly analyzed in their approach is endogenous income smoothing adopted by households. The size of income shocks may not be a fixed household characteristic. Faced with uninsurable income shocks, households may choose an income portfolio that yields a low return and low risk. In such a case, the expected consumption level, $\mathrm{E}[y_i]$ in equation (2), may decline, but the real cause of the decline is not the income poverty but the uninsurable aggregate or idiosyncratic risks. A straightforward but only recently developed approach to incorporate this aspect into a vulnerability analysis is to completely specify a stochastic dynamic programming model for households and then to employ simulation analyses [Elbers and Gunning (2003), Zimmerman and Carter (2003)]. Then, the

total measure of vulnerability can be further decomposed into several factors by simulating the household economy under different counterfactual scenarios.

However, this approach requires panel data with detailed household information over a long period. Such high quality panel data are seldom available from developing countries. In addition, the simulation results of this approach are difficult to interpret due to its complicated dynamic interference. Furthermore, to make the model computationally tractable, the number of state variables needs to be limited to one or two (or at most three). This limits the applicability of the simulation approach. The methodology by Ligon and Schechter (2002, 2003) can be understood as a shortcut to avoid this problem by employing drastic assumptions to simplify the household's optimization problem.

2.3 Measures of Vulnerability in the Existing Literature

In contrast to the utility-based approach described above, a more traditional approach has been to use practical measures of vulnerability that are readily estimable from household datasets without specifying a microeconomic model of households. Panel data of households usually include information on household income, consumption, demographic characteristics, and assets. Since the household welfare is determined by per-capita real consumption (y_{it}), most of the vulnerability measures are the transformation of the observed level and variability of y_{it} in one way or another. The transformation can be interpreted as a crude approximation

of $U_i(z)$ - $E[U_i(y_i)]$ in equation (1). In this review, such measures are broadly classified into two: those based on the observed level of variability of y_{it} in the past and those capturing the expected poverty in the future. The two are intrinsically interrelated. Since vulnerability is a forward-looking concept, measures based on the dynamics of consumption in the past can be interpreted as a proxy for the dynamics of consumption in the future.

2.3.1 Measures characterizing consumption changes in the past

(i) Those who fell into poverty

If it is assumed that only the deprivation below the poverty line (z) should matter when vulnerability is evaluated, a transition matrix analysis can be employed. Given panel data with information on y_{it} and $y_{i,t+1}$, households are classified into four categories: those who remained poor ($y_{it}<z$ and $y_{i,t+1}<z$); those who fell into poverty ($y_{it}\geq z$ and $y_{i,t+1}<z$); those who escaped poverty ($y_{it}<z$ and $y_{i,t+1}\geq z$); those who remained non-poor ($y_{it}\geq z$ and $y_{i,t+1}\geq z$). The second type of households may be regarded as vulnerable. This analysis closely replicates the non-technical definition of vulnerability as "the likelihood that a shock will result in a decline in well-being" [World Bank (2000), p.139]. See Sen (1981), Grootaert and Kanbur (1995), and Sen (2003) for empirical application of this approach.

(ii) Size of consumption decline

It may not be necessary to employ poverty lines in vulnerability analyses if the major

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concern is on the household's exposure to downside risk regardless of the level of consumption. Then, given a two-period panel dataset, the lower Δy_{it} (or $\Delta\ln(y_{it})$), the more vulnerable the household is. This is the approach adopted by Ravallion (1995), Jalan and Ravallion (1999), and Glewwe and Hall (1998).

(iii) Decomposition of poverty measures into transient and chronic components

When the household consumption level y_{it} falls below the poverty line z, the welfare level of the household may go down substantially, accelerating as poverty deepens. Most of the popular poverty measures, such as FGT measures [Foster et al. (1984)], are the average over individuals of an individual's poverty score function $p(z, y_{it})$, which takes the value of zero when $y_{it} \geq z$ and a positive value when $y_{it} < z$. Then, the increase of a household's poverty score attributable to the variability of y_{it} can be interpreted as a measure of vulnerability. This is achieved by subtracting $p^C{}_i$ ($= p(z, E[y_i])$), the chronic poverty score, from $p^P{}_i$, i.e. the time average of $p(z, y_{it})$, or the total poverty score [Ravallion (1988)]. The residual component of observed poverty can be attributable to risk, denoted by $p^T{}_i$, which is a measure of household-level transient poverty, thus a measure of vulnerability.[4]

Since this decomposition is both practically manageable and has a theoretical foundation (the expected utility hypothesis), it has been applied to a number of household datasets from developing countries to analyze the dynamics of poverty [Ravallion (1988),

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[4] Note that for this approach to be consistent with a risk-averse behavior of households, the poverty score function $p(z, y_{it})$ should be increasing and convex with the size of deprivation $z-y_{it}$. For this reason, the squared poverty gap index is the most popular choice as a functional form for $p(z, y_{it})$.

Jalan and Ravallion (1998, 2000), McCulloch and Baulch (2000)]. As an extension, Kurosaki (2006b) investigated the sensitivity of this decomposition to the poverty line or to the average consumption level and finds that poverty measures associated with prudent risk preferences (such as Clark-Watt's measures) perform better than FGT measures.

(iv) Excess sensitivity of consumption to income

A variant to these approaches defines a household as vulnerable to risk when y_{it} shows excess sensitivity to shocks in x_{it}, due to insufficient insurance. Typically, an empirical model

$$\Delta y_{it} = a_0 + b_{vt}D^v_t + \xi_i \Delta x_{it} + \Delta u_{it}, \tag{3}$$

is estimated, where D^v_t is a village-year dummy, a_0, b_{vt}, and ξ_i are coefficients to be estimated, and u_{it} is an error term. Then the size and statistical significance of ξ_i show how household i is vulnerable to idiosyncratic income shocks.[5] Although Amin et al. (2003) is the first study that explicitly defines the estimate for ξ_i as a measure of vulnerability, followed by Skoufias and Quisumbing (2005), earlier studies that estimate ξ_i interpret it as a measure of vulnerability implicitly, such as those by Jalan and Ravallion (1999) and Dercon and Krishnan (2000). This measure of vulnerability is a very partial one in the sense that it captures the *potential* degree of suffering from adverse shocks in terms of how much consumption is likely to fall when

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[5] For a theoretical base of this interpretation, see Townsend's (1994) model of Pareto-optimal risk sharing among villagers. Since the model assumption of Pareto-optimality is unlikely to be satisfied in the empirical reality, his theoretical model should be regarded as a benchmark to evaluate the actual situation. See also Ravallion and Chaudhuri (1997) for further notes required in implementing empirical analyses based on his model.

income is reduced by a *fixed amount* due to exogenous shocks.

Kurosaki (2006a) extended the equation above by treating the positive and negative

shocks separately and defined vulnerability only when a household hit by a *negative* shock

reduces its welfare level. He also allowed the vulnerability parameter to differ across

households systematically according to the household asset status. Therefore, in the empirical

model of Kurosaki (2006a), ξ_i differs depending on the sign of Δx_{it} and it is approximated as a

linear function of household attributes that are likely to affect the level of consumption

smoothing at the household level. In the next section, ξ_i is estimated based on the approach by

Kurosaki (2006a).

2.3.2 Measures capturing expected poverty in the future

Another strand of studies propose a measure of "vulnerability to poverty," defined as

the expected value of a poverty score in the near future, conditional on the information up to

the last period of the household (panel) data. A general model according to Chaudhuri (2000)

and Chaudhuri et al. (2002) could be written as

$$\pi_i = \mathrm{E}[p(z, y_{i,T+1}) \mid I_T],$$

where I_T is the information set included in the panel dataset of length T. As a poverty score

function, headcount index (HCI) is the most popular one because π_i in this case has an

intuitive meaning of the future probability of household i falling below the poverty line given

the current information. Although the HCI-based measure of vulnerability is useful in

assessing the poverty status of households, it does not account for the depth of poverty below

the poverty line. Because of this shortcoming, it may not be a good indicator of vulnerability

to risk. For instance, when the variability of welfare becomes larger (mean-spreading risk),

the measure becomes smaller for households whose average welfare status is below the

poverty line, although the welfare level of such households is likely to decline because of the

increase in risk.[6] Noticing this problem, Kamanou and Morduch (2005) proposed that π_i - $p(z,$

$y_{i,T})$ should be a measure of vulnerability rather than π_i itself and convex functions such as

those associated with the squared poverty gap should be used for function $p(.)$ rather than the

one associated with the headcount measure.

In estimating π_i, Chaudhuri (2000) and Chaudhuri et al. (2002) suggested that it can

be estimated from cross-section information only, if an identifying assumption is accepted that

the expected level of $y_{i,t+1}$ is a function of household attributes in t and the time-series variance

of $y_{i,t+1}$ is the same as the cross-section variance of y_{it}, which is also a function of the same

variables.[7] Since the identifying assumption is hard to accept, it is not adopted in the next

section of this paper. At the other extreme from Chaudhuri's assumption, McCulloch and

Calandrino (2003) estimated π_i using observed values of time-series means and variances of

y_{it} for each i. This methodology is useful if T is sufficiently large, but their dataset includes

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[6] See also Ravallion's (1988) decomposition, where he demonstrated that not all poverty measures respond positively to the increase in consumption variance. The headcount index has the least desirable property.

[7] Extending this approach based on the cross-section variation of y_{it}, Christiaensen and Subbarao (2005) incorporated observed time-series variation of semi-macro variables.

only five time periods. In between, Pritchett et al. (2000), Mansuri and Healy (2001), and

Kamanou and Morduch (2005) estimated π_i using cross-section variation of Δy_{it}. See Ligon

and Schechter (2004) for Monte Carlo experiments varying the number of periods T, in order

to see how the different measures perform.

For the case of Pakistan, Mansuri and Healy (2001) estimated π_i using five-year

panel data collected by the International Food Policy Research Institute (IFPRI), covering

districts of Dir, Attock, Faisalabad, and Badin, for the period 1986/87-1990/91.[8] It is

important that their estimates are based on the information on cross-section variation of Δy_{it}

(observed changes in consumption), which is available only from panel data. Following their

approach, in the next section, the expected value of the headcount measure is estimated for

NWFP using a model where the mean and variance of Δy_{it} are assumed to be functions of

household attributes in the initial period.

In non-technical literature, the vulnerable are sometimes defined as those who are

just above the poverty line z. For instance, Pakistan's Poverty Reduction Strategy Paper calls

those whose income is between 100% and 125% of z "transitory vulnerable" [Govt. of

Pakistan (2003), Figure 3.1, p.13]. This concept can be interpreted as an application of π_i (the

probability of being below the poverty line in the near future). If we admit that purely

cross-section data do not contain meaningful information on the individual-level income

variability over time, the only alternative is to assume that the variance of the individual-level

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[8] Their methodology and results are summarized in World Bank (2002), pp.28-32, and pp.135-138.

income variability over time is constant. With this simplifying assumption, the individuals who were just above the poverty line z are those subject to the largest risk of being poor in the near future among the non-poor. In other words, the concept of the vulnerable as those who are just above z has a theoretically-sound base. The underlying assumption is more acceptable than Chaudhuri's (2000) assumption applied to a purely cross-section data that the time-series variance of y_{it} can be inferred from its cross-section variance.

2.3.3 Measures using information other than income and consumption

Since economists tend to focus on monetary aspects of well-being, vulnerability measures reviewed so far are defined on the consumption space. However, we need to recall that consumption is only one of the determinants of well-being. When other determinants such as education, health, mortality, and so on, are controlled for, we can infer the level and variability of welfare only from looking at the level and variability of consumption.

Therefore, it is desirable to extend the vulnerability analysis with a focus on welfare indicators other than consumption. In this direction, Carter and May (2001) first searched for an asset that is highly correlated with various determinants of welfare, and then applied the vulnerability measures surveyed in this subsection to this asset. Alternatively, Dercon and Krishnan (2000) regarded the change of body mass index (BMI) as an index of individual's vulnerability and applied the vulnerability measure of excess sensitivity to income shocks (ξ_i)

to the BMI change in Ethiopia. Similar analyses can be applied to education investment as well, as done by Jacoby and Skoufias (1997) and Sawada and Lokshin (2009). These authors showed that less landed households in South Asia are more vulnerable to education interruption than more landed households.

3. EMPIRICAL APPLICATION TO PAKISTAN

3.1 Data

As illustration, this section applies the various measures of vulnerability reviewed in Subsection 2.3 to a panel dataset compiled from sample household surveys implemented in 1996 and 1999 in the Peshawar District, NWFP.[9] The incidence of income poverty in NWFP was estimated at around 40 to 50% throughout the 1990s, the highest among the four provinces [World Bank (2002)]. Not only income poverty but also the deprivation in other aspects of human development is serious in NWFP. Achievement in education and health development in NWFP is lagging behind other provinces and gender disparity in education is especially huge in rural NWFP.

Three villages surveyed are similar in their size, socio-historical background, and tenancy structure, but are different in levels of economic development (irrigation and market

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[9] See Kurosaki and Hussain (1999) and Kurosaki and Khan (2001) for details of the 1996 household survey and the 1999 household survey, including the definition of "household." Regarding the issues discussed in this paper, Kurosaki (2006b) investigated the sensitivity of Ravallion's poverty decomposition into transient and chronic components, and Kurosaki (2006a) estimated the excess sensitivity parameter of consumption to incomes, using the same dataset.

access). Table 1 summarizes characteristics of the sample villages and households. Village A is rainfed and is located some distance from main roads. This village serves as an example of the least developed villages with high risk in farming. Village C is fully irrigated and is located close to a national highway, so serves as an example of the most developed villages with low risk in farming. Village B is in between.

Out of 355 households surveyed in 1996, 304 households were resurveyed in 1999. From these sample households, a balanced panel of 299 households with two periods is compiled for analysis in this section. Average household sizes are larger in village A than in villages B and C, reflecting the stronger prevalence of an extended family system in village A. Average landholding sizes are also larger in village A than in villages B and C. Since the productivity of rainfed land is substantially lower than that of irrigated land, effective landholding sizes are similar among the three villages.

Real consumption per capita, y_{it}, was calculated by summing annual expenditures on each consumption item including its imputed value when domestically produced, divided by the household size and by the consumer price index.[10] Average consumption per capita is lowest in village A and highest in village C, although intra-village variation is much larger than inter-village variation. During the three years since the first survey, Pakistan's economy suffered from macroeconomic stagnation, resulting in an increase in poverty [World Bank

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[10] The actual number of household members was used in this paper as a measure of household size. Alternatively, the household size can be estimated in terms of an equivalence scale that reflects differences in sex/age structure and corrects for the scale economy [Lanjouw and Ravallion (1995)]. Results under the alternative specifications were qualitatively the same as those reported in this paper.

(2002)]. Reflecting these macroeconomic shocks, the general living standard stagnated in the villages during the study period.

The official poverty line determined by the Government of Pakistan is adopted in this section. It is set at 673.54 Rs. in 1998/99 prices per month per adult, which is estimated econometrically as the total consumption expenditure amount corresponding to the food consumption of 2,350 kcal per day per adult. Based on this poverty line, 55.0% of individuals are classified as "always poor" ($y_{it} < z$ in both periods), 13.1% as "usually poor" ($\text{average}_t[y_{it}] < z$ and $\max_t[y_{it}] \geq z$), 16.4% as "occasionally poor" ($\text{average}_t[y_{it}] \geq z$ and $\min_t[y_{it}] < z$), and 15.5% as "always non-poor" ($y_{it} \geq z$ in both periods) in this dataset [Kurosaki (2006b)].

3.2 Empirical Results

The main question to be asked is: What is the best criterion for targeting the most vulnerable? To answer this question, three candidates for the targeting criterion were investigated: (i) geographical targeting: villages A, B, or C, (ii) land-based targeting: households belonging to the land-owning families versus others,[11] and (iii) education-based targeting: households whose head was educated in formal schools versus others.

Table 2 lists empirical measures estimated from the Pakistan data. In addition to vulnerability measures based on per-capita real household consumption, y_{it}, those based on

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[11] To avoid endogeneity problems and to control for life-cycle factors, we adopt the classification whether the household belongs to the land-owning families, rather than the classification based on the current landholding status. The two classifications are positively correlated but the correlation coefficient is less than one.

education and subjective assessment of vulnerability were also calculated. Regarding education, the ratio of individuals belonging to households that experienced a decline in children's enrollment (i.e., those households whose age 6-7 enrollment ratio in 1996 was larger than their age 9-10 enrollment ratio in 1999) was calculated as a measure of education vulnerability. The subjective assessment of vulnerability by the household head is based on questions on whether the household experienced downside risk in 1996-99, and, if yes, how the household responded to the downside risk in 1996-99. Unfortunately, the current dataset does not include useful information on health.[12] In addition to the vulnerability measures, measures of chronic poverty are also reported in the table for comparison. All vulnerability measures in the table require panel data, except for the subjective assessment of vulnerability that can be elicited through retrospective questions. In contrast, most measures of chronic poverty can be estimated from a single cross-section dataset.

The empirical results are shown in Table 3.[13] Among villages, chronic poverty is most serious in village A and least serious in village C. This reflects the survey design. Landed households suffer less from chronic poverty than landless households and households with educated heads suffer less from chronic poverty than households with uneducated heads.

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[12] Health indicators based on the household head's judgment were collected in the survey but they were subject to severe reporting errors.

[13] The values reported as π_0 and ξ_neg are the group averages of $\pi_{0,i}$ and ξ_neg_i that were estimated for each household i. $\pi_{0,i}$ was estimated by a model reported in Subsection 2.3.2 with the mean and variance of Δy_{it} as functions of households' initial attributes such as the household size, dependency ratios, the age and education levels of household heads, sources of income, land assets, and other assets. ξ_neg_i was estimated by a model reported in Subsection 2.3.1 (iv) with ξ_i on the income decline approximated by a linear function of similar variables [Kurosaki (2006a)].

The contrast is clearly shown regardless of the choice of a particular measure of chronic poverty.

Among the seven vulnerability measures based on per-capita real consumption, four measures show the contrast among villages, landholding status, and education status very similar to the one found from chronic poverty measures. The four measures include the average consumption decline (*Cons_decline*), the ratio of individuals who experienced a consumption decline (*S_c_decline*), the size of transient poverty a la Ravallion (1988) (*Trans_Pov*), and the expected value of poverty headcount index (π_0).

On the contrary, the ratio of individuals belonging to the "occasionally poor" (*S_occ_poor*) shows an exactly opposite pattern: the ratio is higher in village C, among landed households, and among educated households. This is because this measure of vulnerability puts a heavy weight on consumption variability on the condition that the chronic poverty level is not high. The reason for the ratio of individuals who fell into poverty (*S_fell_poor*) to be higher in village C is similar, although this ratio is higher among landless and among uneducated households. The estimates for the excess sensitivity parameter to income decline (ξ_neg) show that landless households are more vulnerable than landed households, reflecting the advantage of landholding in consumption smoothing [Kurosaki, (2006a)]. Against the expectation that more educated households are more able to smooth consumption, ξ_neg is higher for educated households than for uneducated households.

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Kurosaki (2006a) showed that the unexpected result was due to a fact that households with educated heads were on average richer than others so that they had room to reduce consumption expenditure when hit by a negative shock without reducing the core components of consumption. After controlling for the difference in average consumption level, ξ_neg was found to be smaller for educated households than for uneducated households.

Table 3 also reports three vulnerability measures based on education and subjective risk assessment. *S_no_cope* shows a contrast similar to the one found from chronic poverty measures. This ratio shows the household's subjective assessment that the household had no other way to cope with income decline than to reduce their consumption. Therefore, the inability to cope with downside risk through asset markets or through reciprocity networks is closely related with the depth of chronic poverty. Those who are chronically poor are also very vulnerable in this sense. On the other hand, *S_enrl_decline* (the ratio of individuals belonging to households who experienced a decline in their children's school enrolment ratio) does not show such a contrast. This is because this measure of education vulnerability becomes positive only when households were able to send some or all of their children to school in the initial period. In rural Pakistan, many of the households who suffer from chronic poverty do not send their children to school at all [Sawada and Lokshin (2009)]. In such cases, this measure of education vulnerability is not very useful; measures of chronic deprivation in education could be more useful.

Let us summarize the empirical answer to the main question. First, among the three villages, households in village A seem more vulnerable than those in villages B and C. Six out of the ten vulnerability measures in Table 3 show this ranking. However, several vulnerability measures that put a heavy weight on the decline of a determinant of well-being do not agree with this conclusion (vulnerability is highest in village C, not in village A), since these measures become positive only when the initial welfare status is not at the bottom. Second, households belonging to the land-owning families are less vulnerable than others. Eight out of the ten vulnerability measures in Table 3 support this contrast. Here again, several vulnerability measures do not agree with this pattern, especially when the measures are sensitive to farming risk. Third, households whose head is educated are less vulnerable than others. Six out of the ten vulnerability measures in Table 3 show this contrast. Several measures, especially the measure of education vulnerability, show the opposite pattern, mostly due to the reason that they can take a positive value only when the initial enrollment ratio was strictly positive. Fourth, these results show that it is not possible to draw a definite conclusion regarding the best criterion for targeting the most vulnerable: geographical, land-status, or education-status. Depending on the choice of vulnerability measures, the conclusion differs.

For those vulnerability measures that are the average of continuous scores at the household level, correlation coefficients using micro observations were calculated and

reported in Table 4.[14] Most of the coefficients among the four vulnerability measures were small in absolute values. This indicates that these measures capture different aspects of vulnerability. Since each of them has information not included in others, these measures can be employed simultaneously as complementary measures. When correlation coefficients between the vulnerability measures and the chronic poverty measures were calculated (Table 4), the expected value of headcount index (π_0) was found to be highly correlated with the chronic poverty measures based on per-capita real consumption (*Cons_low* and *Chron_Pov* in the table). This is as expected since the expected HCI decreases with the observed consumption level by definition. Therefore, the information gain additional to the one already included in chronic poverty measures may not be large if the expected HCI is employed while it is likely to be substantially large if other measures of vulnerability are employed. Since these measures capture different aspects of the welfare cost of consumption variability, all of them can serve as useful tools to extend the poverty analysis in the dynamic context.

4. CONCLUSION

This paper surveyed the literature on the concept of vulnerability of the poor's welfare and its practical measures and then applied the measures to a panel dataset collected in rural Pakistan. By specifying a household's utility and the expected flow of its consumption, it is possible to decompose vulnerability into several sources and to evaluate the impact of

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[14] See Ligon and Schechter (2004) for similar exercises done for the cases of Vietnam and Bulgaria.

policy changes numerically. However, this utility-based methodology requires drastic assumptions to simplify the household's optimization problem, or, simulations based on a stochastic dynamic model using high quality panel data. In contrast, there have been proposed a number of practical measures of vulnerability that are readily estimable from household datasets, such as the average consumption decline, the sensitivity of consumption changes to income changes, the component of observed poverty attributable to the fluctuation of consumption, and the probability of falling below the poverty line in the future. The empirical exercise showed that different conclusions can be drawn on the question who is more vulnerable, depending on the choice of the measure.

These results suggest that the various measures of household vulnerability to risk are useful tools to extend the poverty analysis in the dynamic context. Each of the existing measures captures different aspects of vulnerability. Most of them include information not included in chronic poverty measures. This kind of information is especially useful in targeting poverty reduction policies. Since the nature of vulnerability is diverse, it is not advisable to search for a single index of vulnerability. Instead, the whole vector of various vulnerability measures could be employed as a useful source of information. When the majority of the measures unanimously indicate a particular group to be vulnerable, the group should be targeted with the first priority for any type of poverty/vulnerability reduction policies. When only a subset of the measures indicate another group to be vulnerable, the

group should be targeted with a policy that attempts to reduce the particular type of risk.

The survey in this paper showed that most of the vulnerability measures summarize micro-level information on consumption and income. Since the welfare of an individual depends not only on consumption but also on other non-monetary aspects such as education and health, extending the vulnerability analysis to incorporate these aspects is important. This is one of the areas that require more research.

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Table 1: Sample Villages and the Panel Data (NWFP, Pakistan)

	Village A	Village B	Village C
1. Village Characteristics			
Agriculture	Rainfed	Rain/irrig.	Irrigated
Distance to main roads (km)	10	4	1
Population (1998 Census)	2,858	3,831	7,575
Adult literacy rates (1998 Census)	25.8	19.9	37.5
2. Characteristics of Panel Households			
Number of sample households	83	111	105
Average household size			
in 1996	10.75	8.41	8.95
in 1999	11.13	7.86	9.3
Average farmland owned			
in 1996 (ha)	2.231	0.516	0.578
in 1999 (ha)	2.258	0.517	0.595
Average per capita income			
in 1996 (nominal US$)	194.4	231.2	336.6
in 1999 (nominal US$)	147.8	164.7	211.6
Average per capita consumption			
in 1996 (nominal US$)	134.4	157.0	200.8
in 1999 (nominal US$)	133.5	143.1	198.3

Notes: (1) "Average per capita income" and "Average per capita consumption" are averages based on individuals. They were calculated as the household average with household size as weights.

(2) "Average farmland owned" is an average over all the sample households.

Source: The author's calculation (the same for the following tables).

Table 2: Definitions of Vulnerability/Poverty Measures Used in the Empirical Analysis

Measure	Definition
Vulnerability measures (the larger its value, the more vulnerable)	
1. Those based on per-capita real consumption (y_{it})	
Cons_decline	Average size of consumption decline (group-average of $-\Delta \ln(y_{it})$)
S_c_decline	Ratio of individuals who experienced consumption decline ($y_{it} > y_{i,t+1}$)
S_fell_poor	Ratio of individuals who "fell into poverty" ($y_{it} \geq z$ and $y_{i,t+1} < z$)
S_occ_poor	Ratio of individuals belonging to the "occasionally poor"
Trans_pov	Ravallion's decomposition: Squared poverty gap attributable to consumption fluctuations
ξ_neg	Parameter estimate for "excess sensitivity" of consumption to income decline according to the model of Kurosaki (2006a)
π_0	Expected value of poverty headcount index based on the information on consumption changes
2. Those based on non-monetary measures	
S_enrl_decline	Ratio of individuals belonging to households with the age 6-7 enrollment ratio in 1996 larger than the age 9-10 enrollment ratio in 1999.
S_drisk	Ratio of individuals belonging to households with subjective risk assessment that the household experienced downside risk in 1996-99
S_no_cope	Ratio of individuals belonging to households with subjective risk assessment that the household responded to the downside risk in 1996-99 mainly by reducing consumption
Measures of chronic poverty (the larger its value, the poorer)	
1. Those based on per-capita real consumption (y_{it})	
Cons_low	Average deprivation below the poverty line [$=(z-\text{average}_t(y_{it}))/z$]
S_chronic	Ratio of individuals whose average consumption was below the poverty line
Chron_pov	Ravallion's decomposition: Squared poverty gap attributable to the low level of average consumption
2. Those based on non-monetary measures	
Edu_head	Household head's schooling years as the deprivation below the overall average
Illiterate	Adult (age 15 and above) illiteracy ratio
S_enrl_low	Ratio of individuals belonging to households with the age 6-7 enrollment ratio in 1996 smaller than unity

Table 3: Estimated Values of Vulnerability/Poverty Measures (NWFP, Pakistan, 1996-2000)

	Total	By village			By land		By education	
		A	B	C	Land-less	Landed	No educ.	Primary or more
NOB	299	83	111	105	159	140	217	82
Vulnerability measures (the larger its value, the more vulnerable)								
1. Those based on per-capita real consumption (y_{it})								
Cons_decline	-0.033	-0.008	-0.026	-0.063	0.008	-0.076	-0.023	-0.058
S_c_decline	0.274	0.366	0.252	0.207	0.334	0.212	0.294	0.221
S_fell_poor	0.136	0.126	0.131	0.149	0.156	0.115	0.143	0.116
S_occ_poor	0.164	0.157	0.099	0.233	0.140	0.190	0.156	0.187
Trans_pov	0.017	0.021	0.016	0.014	0.018	0.015	0.019	0.011
ξ_neg	0.084	0.053	0.092	0.105	0.165	0.001	0.073	0.111
π_0	0.586	0.720	0.662	0.387	0.679	0.490	0.610	0.522
2. Those based on non-monetary measures								
S_enrl_decline	0.073	0.082	0.048	0.089	0.076	0.070	0.067	0.090
S_drisk	0.637	0.714	0.601	0.598	0.634	0.641	0.631	0.652
S_no_cope	0.323	0.416	0.359	0.202	0.334	0.312	0.351	0.251
Measures of chronic poverty (the larger its value, the poorer)								
1. Those based on per-capita real consumption (y_{it})								
Cons_low	0.066	0.230	0.133	-0.152	0.171	-0.043	0.133	-0.110
S_chronic	0.681	0.816	0.755	0.484	0.810	0.548	0.732	0.545
Chron_pov	0.069	0.102	0.088	0.020	0.082	0.056	0.075	0.054
2. Those based on non-monetary measures in 1996								
*Edu_head**	0.000	0.448	0.088	-0.507	0.311	-0.322	1.000	-2.625
Illiterate	0.753	0.809	0.804	0.651	0.799	0.705	0.850	0.498
S_enrl_low	0.361	0.538	0.361	0.192	0.363	0.358	0.391	0.281

Notes: (1) All figures are weighted averages among households with the number of household members as weights. Thus, these figures can be interpreted as the individual-level averages. "NOB" gives the number of sample households included in each category.

(2) * indicates that the deviation is from the overall average and then divided by the overall average. For example, the value of 0.448 for *Edu_head* in village A indicates that households in village A have 44.8% below the average in terms of the head's schooling years.

Table 4: Correlation Coefficients among Vulnerability/Poverty Measures

(NWFP, Pakistan, 1996-2000)

	Vulnerability measures				Chronic poverty measures	
	Cons_decline	*Trans_pov*	*ξ_neg*	π_0	*Cons_low*	*Chron_pov*
Vulnerability measures (the larger its value, the more vulnerable)						
Cons_decline	1.000	-0.049	0.170	0.536	0.034	0.015
Trans_pov		1.000	-0.006	0.003	0.084	-0.113
ξ_neg			1.000	0.224	0.059	-0.067
π_0				1.000	0.691	0.632
Measures of chronic poverty (the larger its value, the poorer)						
Cons_low					1.000	0.627
Chron_pov						1.000

Note: Correlation coefficients are calculated among households with the number of household members as weights.