The Economic Impact of Premature Adult Mortality: Panel Data Evidence from KwaZulu-Natal, South Africa

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1 Introduction

At the end of 2003, 5.3 million people were estimated to be living with HIV in South Africa, the highest number of any country in the world. Further, HIV prevalence among adults 15-49 years of age in South Africa is estimated at 21.5%, compared to 7.5% in sub-Saharan Africa and 1.1% globally. As the epidemic moves from infection into impact, premature adult mortality rates are increasing rapidly with an estimated 370,000 South Africans dying of AIDS-related illness in 2003, making the disease the leading cause of death in almost all South African provinces (MRC, 2004). Moreover, while it is thought that HIV prevalence in South Africa may be approaching its plateau, the majority of AIDS-related deaths have yet to happen (MRC, 2004).

An increasing number of studies are focusing on the measurement of the economic impact of AIDS-related deaths at the level of the household (Gertler et al, 2004; Naidu and Harris, 2005; Yamano and Jayne, 2003; Yamano et al, 2004), and most conclude that this impact is likely to be significant. A limitation of some studies is the tendency to treat those affected as a homogenous group with similar trajectories prior to the shock that is induced by the AIDS-related death. As a result, the impact measured is for the 'average' household observed at a single moment in time. As UNECA (2003:5) have commented, economic models of the impact of AIDS-related illness and death have thus yet to capture the immiseration impact at the household level.

Some studies do make use of panel data to delve into the dynamics of poverty status and the impact that premature deaths have on successful pathways from poverty (Chapoto and Jayne, 2005; Grimm, 2006; Jayne et al. 2006). Using such data, in an unpublished paper,

Dercon, Beegle and de Weerdt describe the possibility of recovery from the shock that may vary according to wealth and the time that has elapsed since the death event. Using similar data from South Africa, we break down the impact of the premature death of adults from illness according to the initial conditions of the households in which these deaths have occurred.

2 The Economic Impact of HIV/AIDS: Medical Approaches and Impact Assessments

In countries in which there has been high HIV prevalence, death is preceded by a comparatively lengthy episode of illness that presents households with a protracted shock episode characterized by a series of events that occur as the illness progresses. This is recognized in public health studies of other diseases which have noted events such as increasingly frequent bouts of illness, withdrawal from the labour market, high economic and social costs of the illness that increase over time, and eventually, the death itself. Moreover, in many cultures, this is not necessarily an event that signals the end of the episode since funeral celebrations are required that necessitate further expenditure and possible indebtedness (Stover and Bollinger, 1999). Even these may extend over several years if there are annual celebrations or customs that are observed.

In this context, illness resulting from HIV infection, and the death that may follow, can be conceptualized as a 'dosage' which varies in its duration and severity. Likewise, in the language of vulnerability analysis, households may be thought of as social units with varying ability to cope with the shock (Moser, 1998). Davies (1996) offers useful insights from an anthropological perspective that shows how a poverty trap situation can emerge for resource-poor households. The living standards of vulnerable households that face

multiple shocks over time may ratchet down over time to the point at which they eventually become trapped in a situation of structural poverty.

In this context of high HIV prevalence, these ideas of repeated shocks have an important resonance. However as already mentioned there are some key features that distinguish premature adult mortality from the economic shocks described by Davies. First, morbidity diminishes labour capacity over the duration of illness, whereas a death results in the permanent loss of an individual. This implies that households will need to adjust to the long-term loss of this individual's labour and related income, in addition to the loss of management and caring skills and acquired human capital investments. Second, in the case of higher mortality due to AIDS-related illness, the deaths are preceded by severe debilitating illness resulting in limitations in activities of daily living. Moreover, these deaths are concentrated among younger adults, who are typically the most economically productive household members. Finally, adult mortality due to illness may be anticipated to some extent by the household. Thus, households may adopt ex ante strategies to cope with an impending adult death, alternatively thought of as ex post illness response (Beegle, 2003).

Some of these changes are not necessarily unique to the HIV epidemic. Discussing the impact of malaria, Sachs and Malaney (2002:3) note the costs associated with changes in the behaviour of household members concerning decisions such as schooling, child-bearing, savings and work-seeking are often overlooked when measuring the economic impact of disease. Correspondingly, some of the changes adopted in the case of AIDS-related illness or death may well be similar. In Tanzania, for example, it has been shown

that children may marry earlier, drop out of school to help support the family, and take on informal labor schemes (Ainsworth and Semali, 2000).

Delving further into the sequencing of these changes, notions of 'episodes of illness' and 'episodes of care' have been used in other health analyses to show how time matters when measuring the impact of illness and death (Hornbrook et al, 1985). In the case of AIDS related deaths, Beegle (2003) reports that the average length of debilitating illness preceding death in Tanzania was 12 months, while another Tanzanian study shows that on average, an adult experiences 17 different episodes of illness prior to dying (Bollinger et al, 1999:5). Each of these is likely to be accompanied by episodes of care which become more costly as death approaches.

While these studies are revealing in terms of the hardship experienced by those who are living with HIV, and those who are providing care, the approach also offers new clues as to how the full economic impact of the disease can be assessed at the household level. Notions of dosage and episode are similar to ideas used in the impact assessment literature, more usually concerned with identifying the changes that can be ascribed to specific interventions whether in health care as first applied, or more recently in social policy. In turn, impact assessment has shown the particular usefulness of panel data when analyzing the economic impact of the death.

3   The KwaZulu-Natal Income Dynamics Study

The KwaZulu-Natal Income Dynamics Study (KIDS) opens a window of analysis on to a pre-HIV era, as well as the period leading up to the mortality rates noted earlier. The data collected for this study were initially part of the Project for Statistics on Living Standards and Development (PSLSD) undertaken in second half of 1993: the first nationally

representative household survey in South African to investigate poverty, inequality and socio-economic dynamics (PSLSD 1994).

African and Indian households visited by the PSLSD were re-surveyed in the KwaZulu-Natal province in 1998 and again in 2004 to form the KIDS panel data. May *et al*, (2000) and (2007) provide full details of the resurvey and its limitations. For this purposes of this paper we should note that households for eligible for resurvey were those in which key decision-makers resided, termed 'Core' persons as is documented by May et al (2000). Households where cores spilt during this period were followed up wherever feasible, along with the adult children of core household members who had established their own households and who had children of their own.[2] On completion of fieldwork in 2004, data had been collected from 865 households containing core members from 760 of the 1354 eligible households first interviewed in 1993. For 180 of these 760 'dynasties', information was also collected on one or more next generation households that had split off from them. Information is thus available from 2004 for 74% of the dynasties contacted in 1998 and 62% of the eligible households interviewed in 1993.

As May et al, (2007:12) report, the KIDS data show that at ages 20-44, the proportion of people dying between the second and third waves was nearly three times the proportion dying between the first two waves. The implication is that mortality in these age groups has more than doubled. The age-specific mortality patterns within these age groups reveal patterns similar to those found elsewhere in African populations with a high HIV prevalence, a pattern found to be attributable to deaths from AIDS-related illness in KwaZulu-Natal (Hosegood *et al.*, 2004).

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[2]/ Signed informed consent was obtained before interviews were undertaken. Ethical approval was obtained through the Ethical Committees of the University of Natal and Wisconsin-Madison.

The third wave of KIDS reported the deaths of 309 people between 1998 and 2004 who were 20-50 years of age when they died; of which 74 were cases in which the person died of an injury. Since we are interested in the impact of death associated with illness, we have chosen to exclude this group and designate the remaining 235 deaths as Premature Adult Mortality (PAM).[3]

4 Methodology

Evaluating the impacts of a PAM on the economic status of a family is difficult because we cannot observe what the family's status would have been (counterfactually) in the absence of the death. The economic status of other families, unaffected by an adult death, may be a very bad proxy for the counterfactual status of those affected by a death, especially in the case of the HIV epidemic where specific behaviours and situations are known to make infection and death more likely.

Our solution to this problem is to observe the families' economic trajectories (their growth in well-being) in the period prior to the onset of the epidemic. Using this information, and a few modest statistical assumptions, we can use fixed effects statistical methods to reliably predict what the affected family's economic status would have been in the absence of a premature adult death. Effectively, this procedure allows each family's past experience to shape or inform the counterfactual that is used to judge the impact of a premature adult death.

Our use of fixed effects methods parallels the work of Grimm (2006) and Yamano and Jayne (2005). Propensity score and matching methods (as used by Gertler, Levine and

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[3]/ Premature mortality refers to death occurring before some standard age. We have used South African life expectancy in 2004 (51.4 years) as a guideline for this standard (Stats SA, 2004:11). Other authors have used 50 years as the separation point between prime-age adults (15-50), the approximate group most at risk of HIV infection, and the beginning of old age (cf. Ainsworth & Dayton 2003).

Ames, 2004) provide an alternative approach. However, these methods can only control for observable differences between affected and unaffected households, whereas the fixed effect approach controls for all time invariant characteristics of the household.

The KIDS data described above contains measures of household economic well-being at three points in time, 1993, 1998 and 2004. We denote the economic well-being of household i in time period t as, y_{it}.[4] In turn, we define the growth rate of household well-being between period $t-1$ and t as: $g_{it} = \dfrac{y_{it} - y_{it-1}}{y_{it-1}}$. Under our data structure, we observe g_{it} twice: once for t=1998, measuring the growth (positive or negative) in well-being between 1993 and 1998, and once in 2004 (measuring the growth since 1998). We begin with the following fixed effects regression model for this growth in economic wellbeing measure:

$$g_{it} = \beta_1 h_{it} + \delta_1 S_{it} + \delta_2 [\ln(y_{it-1})] + \upsilon_i + \lambda_t + \varepsilon_{it},$$

where h_{it} is a binary indicator variable which takes a value of 1 when family i experienced a premature adult death between times $t-1$ and t, and is 0 otherwise. In other words, h_{it} is our PAM indicator. The variable S_{it} signifies other unfavourable events that struck the household between times $t-1$ and t, including crop loss, theft, spousal abandonment, death of an elderly household member. The terms υ_i, λ_t, the δ and β are all parameters to be estimated, and ε_{it} is a random error term that we assume is unrelated to the included variables. Consistently estimating the coefficient β_1, which gives the impact of an adult death on the growth in well-being, is of course our primary interest.

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[4]/ Economic well-being is measured as total household expenditures per-capita.

Note that this specification assumes that the impact of a premature adult death on wellbeing is the same for all households. We will later relax this assumption.

This "homogenous effect" regression model (which restricts the effect of a PAM to be the same for all households) thus says that growth in household well-being over time depends on a household-specific growth factor that does not change over time (υ_i), as well as on a time-specific intercept ($\lambda_t, t = 98 \; or \; 04$) that is assumed to be the same for all households.

Our ability to us fixed effects panel data methods control for the household specific effect is key to our effort to identify the impact of a prime age adult mortality on economic wellbeing. Note that the υ_i will capture time invariant observable and unobservable factors that influence the growth in household well-being. It is precisely these unobservable differences between households that make it difficult to estimate the impact of premature adult death. Once we control for the fact that households with adult deaths are likely to grow more slowly (or, perhaps more rapidly) than the typical household, we be more confident in our estimate of β_1.[5] Given that the performance of the South African economy improved over the 1998 to 2004 period, a change which is reflected in the profile of poverty of the KIDS sample, we would expect $\lambda_{04} > \lambda_{98}$.[6]

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[5] More formally, failing to control for the household-specific fixed effect would tend to exaggerate the impact of a premature death if households that suffer such deaths tend on average to experience lower growth even in the absence of the death.

[6] Note, however, that our methodology does not account for the spillover effects of premature death. In an analysis of Zambia, Jayne *et al*. (2006) estimate that local economic growth is negatively influenced by high concentrations of AIDS-related deaths. While such macro effects may occur in South Africa, the urbanized and well-integrated nature of the South African economy makes it less likely these effects can be picked up at the local community level.

As does Grimm (2006), we control for other shocks that potentially affect the growth rate of household economic well-being. As measures of these shocks, we simply employ binary indicator variables as to whether the household experienced the shock. Grimm also controls for changes in household demographic composition. We choose explicitly not to control for demographic changes as we suspect that such changes are themselves coping strategies employed by families that suffer a PAM. Statistically, demographic changes would be directly related to the error term ε_{it} in (1) and including would yield biased estimates of the effect of a PAM. While it would be possible to employ simultaneous equation methods to address the statistical endogeneity of demographic changes, we prefer here to estimate reduced form models like (1). The parameter estimates we obtain thus give us the full or bottom line effect of a PAM on household well-being after the household has utilized available coping strategies (including demographic changes). Note also that model 1 does not condition on the characteristics of the adult who has died (as Yamano and Jayne 2004 do). While we have no doubt that these characteristics matter (as they do in the Yamano and Jayne analysis of agricultural decisions and productivity), we are here interested in identifying the average or typical effect of PAM in our South Africa data.

Finally, the basic regression model includes a term that allows the expected growth in economic well-being to be different depending on the household's initial level of well-being (measured as the natural logarithm of household's level of well-being at the beginning of the period, y_{it-1}). Conventional economic theory predicts that $\delta < 0$, indicating that initially less well-off households experience more rapid growth. Other theory, suggests the opposite (see Carter and Barrett, 2006). For purposes here, we are

simply concerned to control for the impact of initial levels of well-being on subsequent

changes.

Table 1

**Fixed Effects Estimates of the Impact of Premature Adult Mortality on the Growth Rate of
Economic Well-being**

Explanatory Variables	Homogenous Effects Model	Heterogeneous Effects Model	Impact Persistence Model
PAM Impact			
Common Effect, β_1	-0.21	1.8*	5.4**
Differential Effect, β_2	--	-0.37*	-0.96**
Persistence of PAM Effect			
Common Effect, β_3	--	--	-0.10*
Differential Effect, β_4	--	--	0.02
Convergence, δ	-1.8**	-1.8**	-1.8**
Time Effects			
1998 Intercept, λ_{98}	10.8**	10.4**	10.4**
2004 Intercept, λ_{04}	11.3**	10.9**	10.9**
Other Shocks			
Illness	0.15	0.16	0.16
Job Loss	-0.05	-0.05	-0.05
Lose Remittances	-0.12	-0.12	-0.17
Lose Grant	-0.02	-0.02	-0.01
Abandonment	-0.34	-0.27	-0.24
Theft	0.02	0.01	0.02
Crop Loss	-0.27	-0.26	-0.25
Elderly Death	0.33	0.32	0.32
Household Fixed Effects, υ_i	Included	Included	Included
R^2 *within*	0.34	0.34	0.35

* Statistically significant at the 10% level
** Statistically significant at the 5% level

Table 1 displays the fixed effects estimates for the homogenous effects model. The

estimated coefficient of the PAM variable is negative, but, surprisingly, it is not

statistically significant. Its value (-0.21) means that a household experiencing a PAM has

a 21 percentage points lower than it would be, controlling for the unobserved time-

invariant factors that influence each household's growth rate (υ_i) and other variables.

The estimated coefficient of the initial level of well-being signals a convergent process, with initially less well-off households estimated to grow faster than others.

None of the shock variables are statistically significant, though most are negative. Their insignificance may signal that most of these shocks are of a short-term nature, and whatever their short-term effects on consumption, households had largely recovered their expected level of economic by the time of the survey. The death of an elderly household member is not a short-term event like an illness. The positive, but statistically insignificant coefficient on the elderly death variable may seem surprising in the context of South Africa where the death of an older person nearly always results in the loss of significant pension income. Its insignificant effect may reflect the fact that the households were prepared (economically) for the death. One such coping strategy may be through the shedding of the household members whom other studies show tend to immigrate into households when an elderly person becomes of pensionable age.

While it is common to think of a premature adult death reducing household economic well-being, it of course need not be so, especially when large numbers of adults are un- or underemployed.[7] In this circumstance, an adult death may actually increase the living standards of those remaining alive in the household as there are now fewer needs to meet from the family's modest resources (see also Kanbur, 2002).[8] The opposite could of course be the case for somewhat better off households where the premature death of an adult results in a net reduction of the goods available for others.

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[7] Negative effects could also be muted if other family members involved in care-giving were also un- or under-employed at the time of the onset of an AIDS-related illness

[8] It should be stressed that the analysis here ignores other benefits (even those that are solely economic) that an individual may bring to the household, including support for children, their socialization and education (see Bell *et al*, 2003).

From a statistical perspective, these observations suggest that our basic regression model above mixes together two different regimes—one where the immediate livelihood effects of a PAM are negative, and another where they may be positive. The average effect estimated in Table 1 would, in this case, be a data-weighted average of the two underlying regimes or regression relationships. From this perspective, we see that this data-weighted average effect is negative, but not surprisingly, it is insignificant.

In an effort to pull these two regimes apart, and allow for heterogeneous PAM effects, we modify the basic fixed effect regression equation as follows:

$$g_{it} = \beta_1 h_{it} + \beta_2 [h_{it} \ln(y_{it-1})] + \delta_1 S_{it} + \delta_2 [\ln(y_{it-1})] + \upsilon_i + \lambda_t + \varepsilon_{it},$$

where the new coefficient β_2 allows the impact of a premature adult mortality to change with the household's level of initial economic well-being. As discussed above, we might expect $\beta_2 < 0$, and $\beta_1 \geq 0$.

The second column in Table 1 shows the results of this expanded, heterogeneous effects model. All the estimated PAM coefficients are now significant, and the impact coefficients have the anticipated signs.[9] The estimated impacts of the other shock variables are qualitatively identical to those in the homogenous effect model. The impact of a PAM is now harder to infer as it depends on the initial income level of the household. However as can be seen, the pattern of the coefficients are such that the immediate well-being impacts of a PAM will be positive for a poor enough household, and become negative for a better-off household.

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[9]/ We have varied the age cutoff to the mid-40's and find that the estimated coefficients remain largely the same, but become statistically significant at the 5% level. If we increase the age towards 60, the coefficients remain stable, but begin to lose statistical significance. This pattern is consistent with the notion that the earning power of adults begin to fall off as they enter their 50's. In addition, households presumably become better prepared for an adult death as that death becomes (statistically) more likely.

In order to better extract the meaning of these regression estimates, we used them to calculate the impact of a PAM on the livelihood trajectories for three typical households: one that began in the 20th percentile of the initial well-being distribution, another at the 50th and a third at the 80th percentile. For each of these typical household, we took the average of the fixed effect terms (the v_i) for economically similar households.[10] Using this estimate, plus the household's initial level of well being (y_{i93}) we then calculated the predicted growth that would be expected for such a household over the 1993 to 1998 period, the period prior to the onset of significant AIDS-related deaths. Using this predicted growth, we then calculated the household's predicted standard of living for 1998. To make this value more easily interpretable, we have divided it by the poverty line such that a standard of living of 1 would imply a living standard exactly equal to the poverty line, 2 a living standard double the poverty line, and so forth. Figure 1 shows these pre-PAM estimate for each of the three typical households.

In order to assess the predicted impact of a PAM, we then performed the same exercise for the 1998 to 2004 period for the three typical households.[11] For each household a growth rate (and resulting living standard level) was calculated both with and without a premature adult death. As can be seen, the predicted impact of a PAM on the household that began at the 20th percentile are slightly negative, but imperceptibly so. They grow larger for the 50th percentile household, and are quite significant for 80th percentile household. Regarding the latter, these figures indicate that without a PAM, the household would have grown to a living standard in excess of 225% of the poverty line.

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[10]/ For example, for the 20th percentile household, we took the average fixed effect estimates for all households between the 15th and the 25th percentile. A similar band was used for the other two household estimates.

[11] The starting point for each household was their predicted level of well-being for 1998, as described above.

With the PAM, the household's well-being is only 175% of the poverty line. This 50%

drop is correctly interpreted as the impact of a PAM on initially better-off households.

Figure 1

Impact of Premature Adult Mortality on Livelihood Trajectories
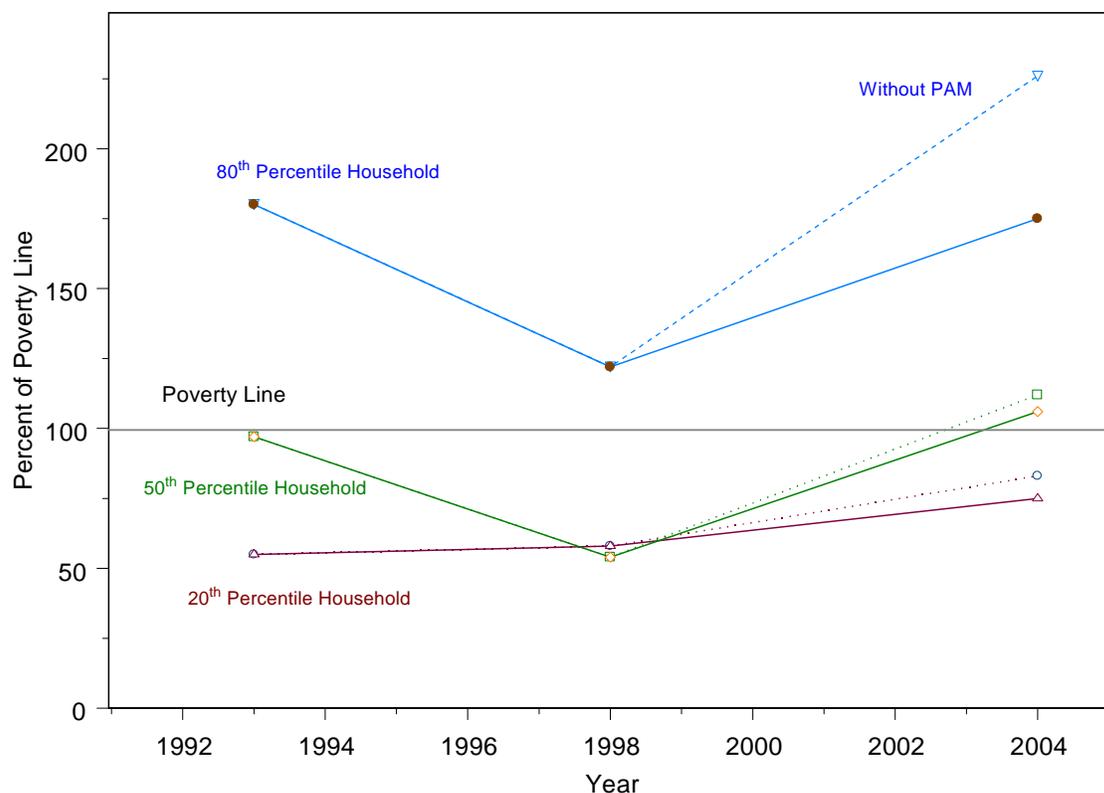
Finally, our data permit us to explore whether these estimated PAM impacts tend to

dissipate over time. To do this, we modify the model by including an additional variable

that indicates the number months between the premature death and the date of the survey.

This same variable was also interacted with initial expenditures to give the following

'impact persistence model':

$$g_{it} = \beta_1 h_{it} + \beta_2 [h_{it} \ln(y_{it-1})] + \beta_3 p_{it} + \beta_4 [p_{it} \ln(y_{it-1})] + \delta_1 S_{it} + \delta_2 [\ln(y_{it-1})] + \upsilon_i + \lambda_t + \varepsilon_{it},$$

where the new variable p_{it} measures the passage of time (in months) between the PAM and the survey. Note that this model permits the rate of recovery from a PAM to vary by income level. If households tend to eventually recover following a PAM, we would expect the effect of time-since-death to be positive, as found by Beegle, De Weerdt and Dercon (2006) in their study of Tanzania. In contrast, Yamano and Jayne (2004) do not find evidence that the impacts of a PAM dissipate over time (though their time period is shorter than that in the Beegle *et al.* work).

The estimates (reported in the third column of Table 1) are statistically significant at the 10% and 15% level. While this evidence is thus a bit weak, the estimated coefficients imply that a household that began in the 80th percentile of the well-being distribution would have begun to recover its growth rate five years after the PAM. Better off households would be estimated to recover more quickly. Less well-off households (for whom the effects are less pronounced) would recover less quickly.

5   Conclusion

We find that whatever the social and human costs associated with premature adult deaths, the impact on the growth of the economic well-being of the household is significantly larger on those just above the poverty line. Recovery may be possible for some of these economic costs, such as replacing assets or scrimping to make up for income lost, other will not be easily replaced, such as the human capital embedded in the person who has died. In this regard, our data tell a rather provocative story: better off households tend to recover as time passes, while less well-off households do not.

However there are problems that may confuse analyses of the type that we have attempted here. Issues of endogeniety have already been mentioned: the strategies of

both those living with HIV and the households in which they are located may impact on the outcomes that we are trying to measure. Ill people may join households seeking care; shocked households may fragment in order to survive. The PAM itself may affect our analysis simply by its demographic impact of reducing the size of the household over which the same resources might stretch. Finally, it is possible that our time frame is too short to permit recovery to be visible. Nonetheless, these results stand as a stark reminder that the effects of an AIDS-related death can be not only large, but also perhaps but long-lasting and self-reinforcing.

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