

Natural Disasters: Sudden Impact, Permanent Consequences on Income Inequality?

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Abstract: Empirical work at a macro-economic level concludes that natural disasters have no long term adverse economic effects, even at a community level. However, household surveys suggest that households living at or near the subsistence level are unable to recuperate from natural disasters, and that a bad disaster can have intergenerational effects on household health and productivity. This paper aims to bridge macroeconomic and household level research by suggesting that aggregate recovery comes at the cost of increasing income inequality. The paper begins by providing a theoretical basis for why natural disasters can lead to increases in income inequality. Then, the paper focuses on a case study from the disaster prone region of Orissa, India to examine if consumption data from the National Sample Survey exhibits increasing trends in income inequality for disaster affected areas. Finally, the paper discusses why endogeneity concerns can hamper the use of econometric methods to measure the effects of disasters, and proposes a potential model that addresses these concerns.

Both the frequency and the scale of natural disasters have increased in recent decades, especially the frequency of disasters impacting developing countries. Despite their increasing frequency, natural disasters have frequently been ignored by economists because of the difficulty regarding making generalized conclusions about their impacts. Disasters are by definition events that exceed a community's ability to cope and respond independently. (Lindell and Prater 2003) Natural disasters are characterized not only by the natural force generating the disaster, but also by the community affected by this force. However, a community's ability to cope is shaped by pre-existing physical and social infrastructure, which consequently partially determine the severity of the event. For example, loss of life in Turkey after a 1999 earthquake was one magnitude higher than similar quakes in Northridge, CA and Kobe, Japan., though the intensity of the quake was less and population densities were similar. (Bibbee et. al 2000) Given that disasters are increasingly striking vulnerable populations, and that the disasters' impacts are in part defined by the vulnerability of the affected population, there is an increasing need to understand how disasters affect the most susceptible victims, namely the very poor. As an initial step towards this goal, this paper will explore the possibility that the recovery mechanisms available to the very poor depress their future consumption potential and lead to increases in income inequality.

Natural disasters merit study distinguished from other types of economic shocks because the common wisdom is that communities quickly recover from natural disasters, and in some cases may leapfrog their development as a direct consequence of the disaster. One study of 4 American communities affected by disasters in the 1960's concludes that there is no social impact to a community within 5-10 years of the disaster. (Wright et. al 1979) However, that study's conclusions cannot be broadly applied to the current experience of all disaster stricken communities. These

conclusions are based on American cities and are not necessarily applicable to the experience of developing nations. Additionally, while these results may represent the average recovery of a community, we do not know how this recovery is distributed across income deciles.

Micro-level research suggests that lower incomes are most likely to be impacted, and feel the impact most keenly. (Lindell and Prater 2003) The incomes and businesses of lower income deciles are more vulnerable to disruptions in their supply and demand chains, and have a harder time receiving formal credit to begin renovating their businesses. (Bibbee et al 2000) The homes of people in lower income deciles are more likely to be located in high risk areas. Families at these lower deciles are also already living close to the subsistence line. Consequently, smaller shocks can push them below the minimum subsistence line. (Carter and Maluccio 2003)

Micro-level research also suggests that communities respond to disasters by the following strategies: reducing consumption, drawing from savings, selling productive assets, migration, and borrowing money. Lower income populations do not have savings to utilize or the resources to migrate. Their remaining options lead to reductions in both current and future consumption. Therefore, there is a disconnect between large-scale surveys reporting aggregate recovery and micro-level research implying long-term reductions in consumption. If an economy recovers evenly across all income levels, then we should see no long term changes in income distribution or consumption. However, if assets are flowing from lower to higher income deciles, then we should see increased income inequality and lower consumption marked by increased volatility at lower income deciles. Therefore, the question at the heart of this study is: Do lower income deciles return to pre-impact consumption levels? If not, is the aggregate community recovery being biased by increasing income inequality?

In order to begin investigating this question, this paper will focus on a case study of Orissa, India, and changing consumption patterns in Orissa relative to changes at a national level following a 1999 super typhoon. While the Orissa typhoon received considerably less attention than the 2004 tsunami, its effects were estimated to have killed 10,000 people and impacted one third of the state's population. However, as the areas hit were primarily agricultural, and no major metropolitan areas were affected other than the deep water port of Paradip, the typhoon's effects are not considered to have had a significant impact on India's overall GDP or national economic activity. Orissa is also one of India's poorest states, both in terms of the dispersion and depth of poverty. That said, consumption patterns and income distribution in India vary substantially across states and time. Distinguishing the impacts of the typhoon from pre-existing trends is one of the largest challenges facing this line of research. To that extent, a review of spatial demographic trends will be appended to the general review of literature pertaining to natural disasters.

Unlike financial crises, disasters directly impact or destroy pre-existing physical and human capital. Most macroeconomic indicators will not capture this loss of wealth, though they will capture subsequent economic activity and inputs utilized towards replacing this capital. Therefore, impact assessments based on changes in GDP or other common economic activity indicators may positively bias the net effect of the disaster. (Tol and Leek 1999) A common, though somewhat controversial viewpoint suggests that aside from immediate death and injuries, disasters may stimulate an economy through recapitalization. The destruction of potentially obsolete physical capital allows for technological leapfrogging. Meanwhile, construction booms are assumed to reduce or capture any resulting unemployment. (Friesema et al 1979, Wright et al 1979) Disasters appear to postpone supply and demand for manufactured goods, but don't

reduce it. (Tol and Leek 1999) Though analysis often reports rapid return or increases in economic activity, the received view of affected populations does not match this analysis. (Tol and Leek 1999)

Damages from disasters are hard to estimate accurately for several reasons. Especially in more developed nations, total estimated costs of disasters may not include preventative costs aimed at mitigation. In developing nations, damages to poor households will not be accounted for in formal book-keeping, insurance receipts or other market indicators. (Tol and Leek 1999) One of the first long-term impact assessments was completed by Friesema, Caporaso, Goldstein, Lineberry, and McCleary in the late 1970's. These economists examined the effects of a 1955 flood in Yuba City, CA, a 1961 hurricane in Galveston, Texas, a 1965 tornado in Conway, AR, and a 1966 tornado in Topeka, KS. They used secondary accounts, key informant interviews, and time series data from municipal stats, court records, sales receipts, tax claims, etc. to examine pre and post economic activity patterns. Once the data was fitted into an interrupted time-series model fitted with a quadratic trend, they found that the disaster had no discernible impact on pre-existing trends or long-term effects on unemployment, retail sales, fiscal expenditures, or general business patterns (with the exception of increased unemployment in Topeka). They did notice a slight decline in small businesses but could not confidently attribute this decline to the relevant natural disaster.

A concurrent study by Wright, Rossi, Wright and Weber-Burdin analyzes the effects of all major tornadoes, floods, hurricanes, and earthquakes occurring between 1960 and 1970. The authors used census tract data to gauge housing and population trends for impacted regions and then compared their results to census data from counties with similar characteristics and growth patterns that weren't affected by any

natural disasters. Their results found no net effect to population or housing growth trends in affected communities.

Both of these surveys have been critiqued on the grounds that the lack of net effects may be obscuring distributive effects, and instead net effects should be evaluated in terms of the impact ratio – the amount of damage divided by the amount of community resources. (Lindell and Prater 2003) Natural disasters in the United States tend to have small impact ratios across all indicators because the country is large enough to finance recovery from unaffected areas, which may not hold true for smaller or less wealthy countries. Consequently, findings generalized from US data may not be globally representative of disaster recovery trends.

As highlighted by recent experiences with Hurricane Katrina, certain population segments are disproportionately affected, and may be poorly integrated back into the recovery process, even within the United States. Risk is inequitably distributed demographically because geographical locations often are systematically tied to their residents' demographic characteristics – especially their (lack of) economic and political power. (Lindell and Prater 2003) Not only are marginal populations more likely to be affected by a risky event, but this event is exponentially more likely to push them below their minimum subsistence line relative to the general population. (Carter and Maluccio 2003, Lindell and Prater 2003)

Recent empirical work suggests several reasons why marginal populations may never recover or have prolonged recovery paths. Carter and Maluccio's case study on the stunting of South African children following household level shocks supports the contention that individual households do not necessarily recover, and that these shocks have lasting effects on the consumption possibilities for that household, extending into future generations. Low income victims have less insurance and savings, and their

insurance is from riskier sources which are more likely to default on repayment in the event of a mass disaster. (Lindell and Prater 2003) In lieu of publicly provided social safety nets, household coping strategies may include selling productive assets that have long term effects on their ability to recover from the disaster or remove themselves from poverty. Even more damaging is the likelihood that the productive assets will be sold at price far below their pre-disaster value. Additionally, affected children that are unable to receive proper nutrition or return to school may become less productive as adults, creating intergenerational effects from the initial disaster. (Skoufias 2003, Carter and Maluccio 2003) Even with pre-existing social safety nets in place, most targeting systems are designed or oriented towards identifying the institutionally poor and cannot locate or distinguish “newly” poor households generated by the crisis. Since disasters affect en masse, people cannot rely on traditional support systems, like extended family networks. This caveat can be especially problematic in areas where entire familial units live in close proximity versus communities with more mobility that can receive remittances from distant relatives. (Lindell and Prater 2003)

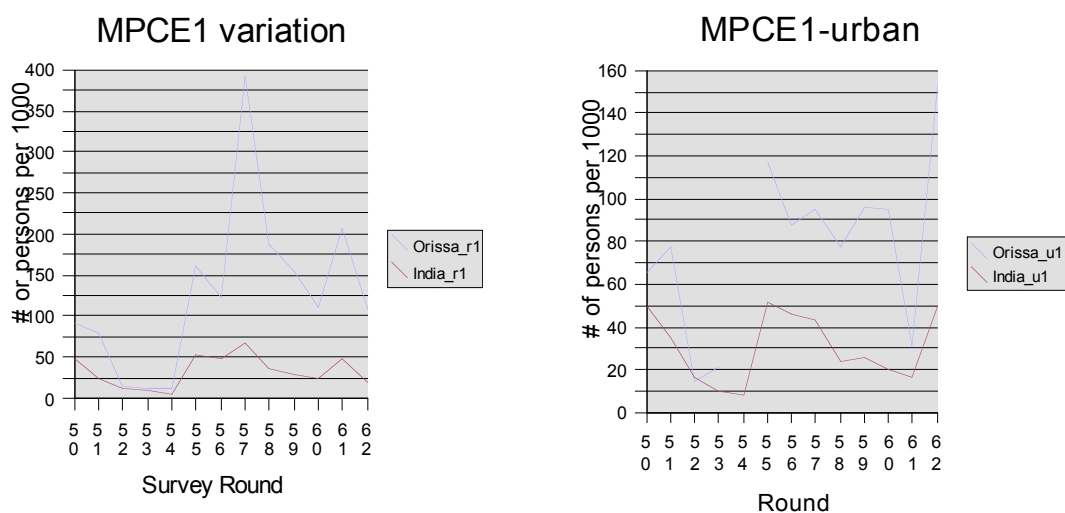
Given the large heterogeneity between populations and their response to disasters, a study by Roy, Mruthyunjaya, and Selvarajan (2002) which focuses on coping and response strategies among poor residents of disaster-prone Orissa is especially relevant to the research questions posed by this paper. The authors selected four sample villages (Jambu, Mangalpur, Gupti, and Sanwara) randomly from two blocks (Mahakalpara and Rajnagar) within the Kendrapara district of coastal Orisa that are especially vulnerable to climate induced disasters. They sample 200 households, or 50 from each village, and supplemented these surveys with group interviews and discussions. The authors found that at least 94% of households surveyed had employed some coping mechanism in response to disasters (specifically droughts, floods, or

cyclones). According to their survey result, respondents did prepare for shocks from disasters through income diversification, including diversifying composition of livestock and changing crop practices, building up stocks/reserves, risk management through sharecropping or crop insurance, and building up institutional support and collective action schemes. Furthermore, respondents reacted to shocks by reducing consumption (77% cut food intake) and social obligation spending (i.e. family festivals). Other strategies included selling livestock, migration, drawing down inventories, drawing upon communal resources, and borrowing from family/neighbors. These strategies mirror findings by similar surveys in other disaster prone regions such as the Phillipines. (cf. Hiugen and Jens 2006, Del Ninno, Dorosh and Smith 2003, Kantor and Nair 2003) Residents did not have systematic vulnerability reduction strategies for dealing with cyclones (which are idiosyncratic, unlike droughts or floods) but tended to use the same response mechanisms and coping strategies at a more intense level. Finally, the authors found that the poor households were frequently unable to buy back assets sold or destroyed in disaster years.

In order to bridge these macro-level results with the micro-level case studies, consumption data from Orissa India will be examined to see if Orissa's population exhibits declining consumption levels relative to India's general population. Consumption data collected annually by the National Social Survey Organization of India, known as the National Sample Survey, tracks consumption expenditures at a regional level and divides respondents in to 12 classes based on their reported monthly per capita expenditures. Consumption expenditures are a superior variable of analysis for developing regions because consumption intake and volatility are primary indicators for the well-being of low income populations, which may not be accurately represented by other common measurements of economic wealth. Additionally, consumption data

bypasses the aforementioned problem of quantifying net effects from the destruction of physical stock with the subsequent spike in economic activity. Instead, consumption can be considered an indicator of those net effects. If the subsequent spike in activity negates initial destruction, there should be no lasting changes in consumption.

In fact, Indian national accounts data, which has historically suggested significant consumption increases includes several sources of income in private consumption not included in NSS surveys, like financial services, spending by NGOs and housing rents. Therefore, NSS estimates of private consumption are only 60-70% of estimates calculated by National Accounts. This divergence disappears when the consumption of food is examined, suggesting that scaling up NSS data to match National Accounts data would underestimate the extent of poverty in India and that NSS data may be a better gauge for estimating poverty levels and changes in private consumption.



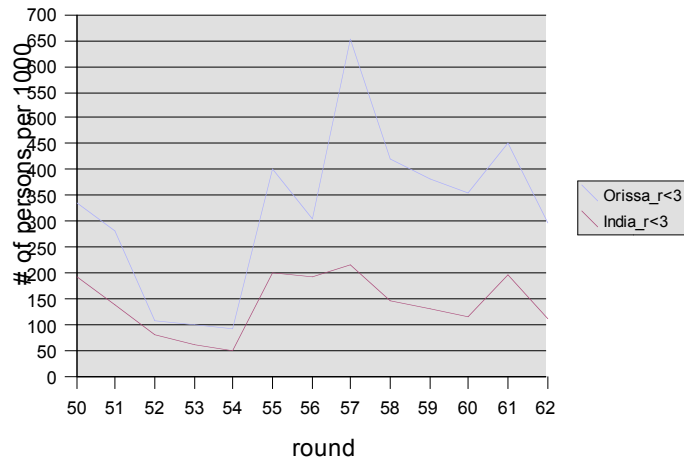
The above charts compare the number of households per thousand in the lowest monthly per capita expenditure bracket for the state of Orissa relative to the national average. The left hand chart tracks rural households, and demonstrates a sharp

divergence following survey round 55, which corresponds to the period July 1999-June 2000, the period which also covers the year immediately following the super cyclone. The disparity spikes in survey round 57, corresponding to the time period of July 2001 through June 2002, and then begins to fall. Though the number of rural households in the lowest consumption expenditure bracket appear to be converging to pre-cyclone levels, the number of individuals grouped in this bracket is still 306% of the national average, whereas in survey round 50 (corresponding with period 1993-1994), this number was only 130% of the national average.

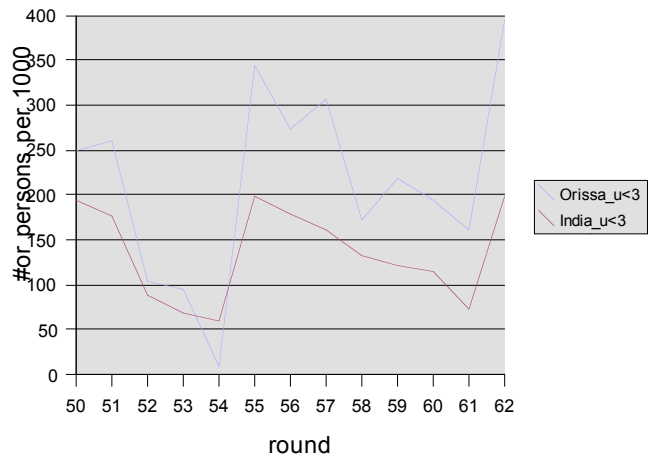
Results for the urban group display more volatility, with a structural break at round 54, when no households were reported as living in the lowest expenditure bracket for the state of Orissa. There is a sharp divergence for urban individuals after round 55 (the impact year), though the state distribution converges nearly to the national average by round 61, with an unexplained spike in the most recent survey round.

Results for the bottom 3 three expenditure classes (instead of just the lowest expenditure class) demonstrate the same patterns, though with less volatility for the urban group.

MPCE Variation for bottom 3 classes (rural)



MPCE Variation in Bottom 3 Classes (urban)



While these charts suggest that the super cyclone did have a lasting impact on income inequality, the divergence could have roots in several other causes, especially given India's rapid but uneven economic development in the past decade

In 1950, India began a planned development program, executed in a series of 5 year plans and annual plans, with the ultimate goal of diminishing poverty and accelerating economic growth. At that time, India was well situated with respect to development promoting infrastructure and institutions. From 1950 to 1992, per capita income in real terms grew at an average annual rate of 1.65%, due to low growth in national income and high population growth. In the 1990's, growth increased to 7%.

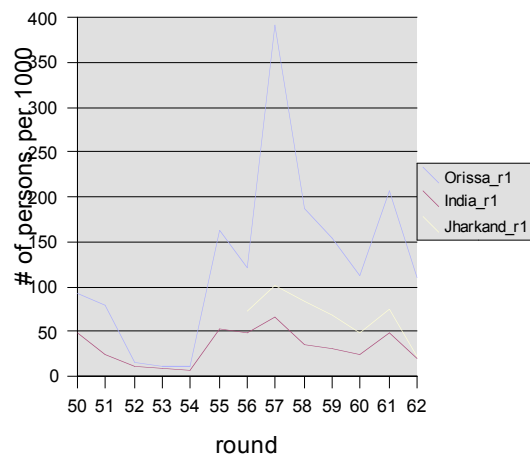
Despite this growth, there has been no consistent trend in the reduction of inequality in size distribution of income. The share of income held by the poorest 20% of the population has bounced around between 6.7% and 8.8% since 1964. Meanwhile, the share held by the top 20% of the population has fluctuated from 49% to 39.3% and back up to 46.1%. (Roy 2005) According to Roy, these development programs have also succeeded in maintaining low, balanced inflation, including food prices. This statement conflicts with assertions by the National Sample Survey (NSS) in their consumer expenditure reports.

Jha, Gaiha, and Sharma (2006) allude that the lack of change in income inequality is attributable to declines in agricultural income, rising food prices relative to general inflation, and persistence of poverty among specific geographic regions and groups (especially with respect to caste status). The contribution of net national income from agriculture has declined from 46.54% to 27.55%. Datt and Ravallion's review of literature regarding Indian income inequality and their own analysis of NSS data evidence suggest that the poverty incidence has fallen though not at the accelerated rates suggested by other studies. When Datt and Ravallion examined growth patterns at a state level, divergence in growth and poverty reduction becomes more apparent. Middle income states experienced the highest proportion of growth, as did urban areas, but with great variation across states. The model developed by Datt and Ravallion suggests that higher farm yields and development spending reduce poverty, while inflation and rising population pressures increase poverty. Much of the growth did not occur in states where it could have had the largest impact on poverty, and if growth had been more evenly distributed across geographic regions and sectors, then poverty may have been reduced by more than double the historical rate. Also, inequality and underdevelopment of human resources within states prevents most poor regions from

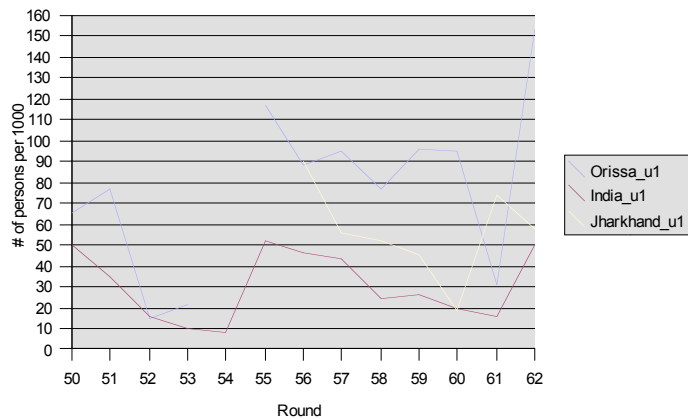
sharing equally in benefits of growth.

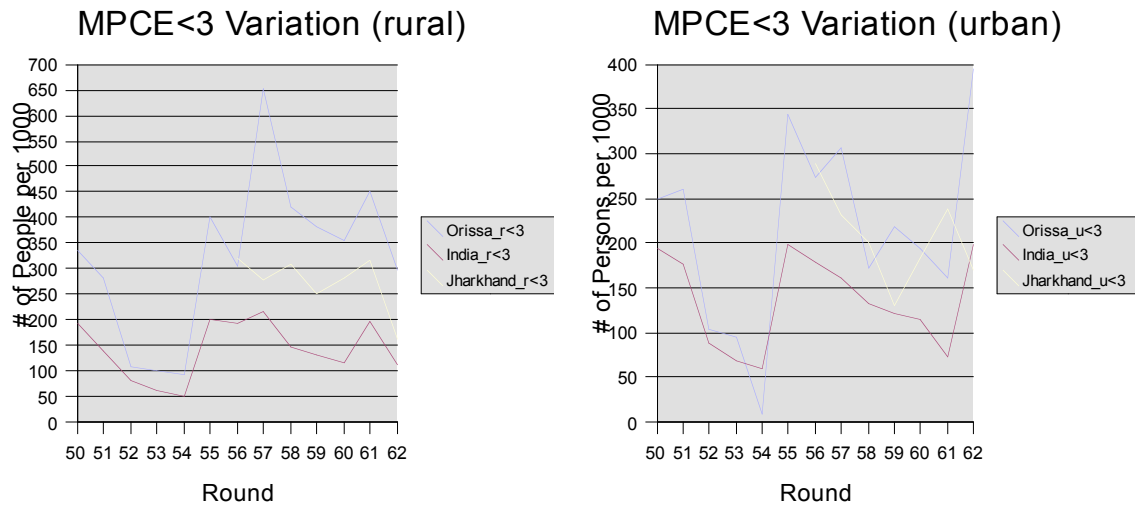
Therefore, there is some benefit to revisiting the previous charts, but with the inclusion of another state's statistics. Jharkhand, located directly above the northwest corner of Orissa, is an interesting comparison point because like Orissa, most of its economy is rooted in agriculture and mining. Unlike Orissa, Jharkhand is not located on the coast and is not vulnerable to idiosyncratic shocks from cyclones, though it is prone to the seasonal droughts and floods endemic to the entire region. Jharkhand was carved out of Bihar, another of India's poorest states, in 2000. So consumption expenditure data will not appear for this region until survey round 56.

MPCE1 variation (rural)



MPCE1 variation (urban)





With respect to rural households, Jharkhand has significantly more households in the lowest MPCE classes relative to the national average, but still has a much lower percentage of households than Orissa. These two lines appear to move together directionally, suggesting that regional or national trends impact the areas with similar magnitude. However, the charts do not explain why Orissa has such a sharper divergence from the national average compared to Jharkhand. Our urban results are again somewhat mixed, and maybe more influenced by local level changes in manufacturing and industrial opportunity.

Ideally, an econometric model would further separate exogenous economic trends from disaster effects. However, models that attempt to gauge changes in consumption as function of income or output based independent variables are likely to suffer from endogeneity bias, at least with respect to this case study. For example, the super cyclone and subsequent flooding destroyed cashew nut trees plantations, silted up fishing grounds and salinated most of the coastal crop land, thereby reducing the output

potential of the land for the next several years. Cashew nut trees, fishing, and farming are some of the primary sources of income for rural villagers in the most heavily affected areas. According to villagers in the Jaghatsinghpur district that opted to participate in a focus group discussing the cyclone's effects, their village's income declined after the cyclone, and has not returned to pre-cyclone levels.¹

A model of consumption or income which purely examined farm yields would not capture the detrimental effects of a disaster on the farms' productive capabilities. One approach to mitigating these endogeneity issues is to transform the left hand side income variables into exogenous determinants of income. An example of this model, constructed based on Orissa's primary economic sectors, is below:

$$C = \beta_0 + \beta_1 R_{it} + \beta_2 AT_{it} + \beta_3 P_{it} + \beta_4 T_{it} + \beta_5 M_{it} + \beta_6 I_{it} + \beta_7 D_{it}$$

where C = consumption expenditures, R = rainfall, AT = average temperatures, P = selling price of rice (the primary crop), T = incoming tourists, M = manufacturing output, I = Foreign Direct Investment, D = disaster score based on initial damage assessments

In this model, some independent variables may still suffer from endogeneity concerns, namely tourism, foreign direct investment, and the government/external aid vector. However, the relationship between the variables and disasters are unclear. Consequently, there is some merit to including the variables for now, and statistically testing for bias later. Also of note is that the above model does not specify specific functional forms. There are various ways the above variables could be modeled. For

¹ Interestingly, however, the villagers interviewed maintained that their overall standard of living had improved after the cyclone due to increased community participation and infrastructure improvements implemented by the government and NGO's following the cyclones.

example, consumption could be measured as percentage of individuals in the lowest MPCE classes, the gap between this percentage and the national average, or change in the percentage from the last survey. Similarly, rainfall and average temperature could be measured directly or as a quadratic function of deviation from the optimal seasonal rainfall and temperature levels. At this point however, the focus is not on the functional form, and primarily on the concept of modeling determinants of income that should not be impacted by a disaster.

The benefits of this model is that mitigates endogeneity, and by focusing on consumption should also capture the net costs of a loss of physicals stocks on the increased costs of inputs. If this information was gathered at a district level for the state of Orissa, the validity of the model could be tested by comparison on the values of the disaster dummy for different districts. In other words, the disaster score variable should have less effect on consumption changes for interior regions that were not as affected by the cyclone as the coastal areas. Unfortunately, the model does have several shortcomings. Its specificity to Orissa's economy limits cross-comparability potential to other disaster affected regions. Similarly, in its current form, some national determinants of income may still not be captured, and therefore may wrongly be attributed to the disaster score variable.

Despite these difficulties, modeling the effects of disasters, even with region specific models, remains an important task. Natural disasters are increasingly germane to development studies given their increasing frequency in less developed countries, and the poor's heightened vulnerability to these disasters. More information is needed on whether developing countries experience the aggregate recovery patterns exhibited by the United States, and if this recovery comes at the expense of already marginalized people. While economists may still be a long way away from one general model of

disaster recovery, building models at a regional level, or specific to types of disasters (like earthquakes vs. cyclones) can help foster a core understanding of if and how the poor recover, and what mitigation and alleviation strategies are successful.

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