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Abstract

According to national household survey data for Myanmar, spanning the five-year interval 2005 to 2010, average real household consumption expenditures remained stagnant, but measured poverty incidence and inequality both declined significantly. The distribution of the economic pie shifted in favor of the poor while the overall size of the pie barely changed. This paper examines the possibility that the hitherto unexplained reduction in measured inequality was caused, at least partly, by a natural disaster, Tropical Cyclone Nargis, which devastated parts of Myanmar in May 2008. This hypothesis is supported by a recent historical study which argues that, globally, large reductions in inequality normally occur only through either man-made or natural disasters. The paper develops a method, based on regression analysis of household level data, for isolating the impact of an exogenous natural event like a cyclone. The estimated regression model is used to simulate a counterfactual distribution of expenditures in which, hypothetically, the cyclone did not occur. The estimated impact of the cyclone is the difference between the observed outcome, in which the cyclone happened, and this simulated, counterfactual outcome in which it did not. The findings indicate that the cyclone reduced inequality between regions of Myanmar, because the negatively affected regions were on average better-off than the unaffected regions, both before and after the cyclone. Within the affected regions the negative impact of the cyclone was largest in absolute terms among richer households, but as a proportion of household expenditures, these negative effects were larger among the poorer households. The cyclone therefore increased economic inequality within the affected regions. Overall measured inequality declined because the between-region reduction exceeded the within-region increase. The hypothesis that the cyclone caused the reduction in inequality is rejected.

Key words: Expenditure distribution, inequality, decomposition analysis, regression-based decompositions, Myanmar.

JEL codes: C12; C51; D31; D63

1. Introduction

Poverty reduction is normally associated with economic growth. The faster the growth the more rapid the decline in poverty. The absence of growth typically means no reduction in poverty incidence, or even an increase. This paper explores a recent five-year episode in Myanmar (formerly Burma) in which, somewhat surprisingly, measured poverty incidence declined substantially even though average real consumption expenditures barely changed. These are the findings of a household consumption survey conducted by the Myanmar government in conjunction with the United Nations Development Program and other international research groups, in 2005 and 2010.[1] The two surveys are known in Myanmar as the Integrated Household Living Conditions Assessment (IHLCA) surveys. They used an internally consistent statistical methodology and remain the only reliable household survey data set currently available for Myanmar.[2]

Calculations of household expenditures, poverty and inequality, based on the IHLCA surveys, are summarized at the national level for Myanmar in Table 1. These data relate to household consumption expenditures, as amended by the present authors, using the methods described below. In 2010 mean household real consumption expenditure per adult equivalent,[3] as measured in the survey, was only 1.5 per cent higher than five years earlier. But at the same time, poverty incidence declined from 32 to 25 per cent of the population. This reduction of poverty

[1] The raw household data were collected between November-December 2004 and May 2005 and between December 2009 and May 2010, respectively. For brevity, we refer to these as the 2005 and 2010 surveys. The survey methods and a summary of statistical findings are outlined in IDEA International Institute and IHLCA Project Technical Unit (2007a, b and c) —hereafter referred to as IDEA and IHLCA (2007a, b and c)— and IHLCA Project Technical Unit (2011a, b and c) —hereafter referred to as IHLCA (2011a, b and c)—, respectively.

[2] In 2015 an additional survey was conducted by a Myanmar government team with World Bank participation, using somewhat different methods from the earlier 2005 and 2010 surveys studied in this paper. The 2015 survey data are not yet publicly available.

[3] 'Adult equivalence' is calculated using the intra-household weighting method recommended by Deaton and Zaidi (2002).

incidence without growth of mean real expenditures was associated with a large decline in inequality. The Gini coefficient of expenditure inequality fell over the same interval from the already low level of 0.256, to 0.220.[4] Viewed at the national level, the distribution of the economic pie moved significantly in favor of the poor while the overall size of the pie hardly changed. Nevertheless, the source of this large shift in distribution remains unknown. It is difficult to identify any policy intervention during that period that might have caused it.

In a recent book, the historian Walter Scheidel (2017) has argued that over several millennia of human history substantial reductions in economic inequality have generally resulted from only two types of events: man-made disasters such as warfare, revolution and state collapse; and natural disasters such as mass epidemics, earthquakes, volcanic eruptions, tsunamis and unexpected climatic disruptions. Sheidel argues that this outcome results from the fact that disasters destroy the assets owned by better-off people, leveling the distribution of economic welfare among the survivors. In the case of Myanmar, a major natural disaster did occur during the period of our data. In May 2008 Tropical Cyclone Nargis severely damaged large areas of coastal and near-coastal Myanmar, as identified by post-cyclone satellite imagery, containing about 14 per cent of the country's total population), leaving the rest of the country seemingly untouched (Tripartite Core Group 2008). Within this affected area, the cyclone killed an estimated 138,000 people and obliterated public and private assets on a vast scale (Guha-Sapir *et al.* 2016).

Comparative data on natural disasters within Asia, summarized in Table 2, show that, measured in terms of estimated deaths, Cyclone Nargis was one of the most destructive natural

[4] The mean expenditure, poverty incidence and Gini coefficient numbers cited in this paragraph and in Tables 1 and A1 are based on the authors' calculations, as explained in Section 2 below. These calculations include some expenditure categories recorded in the survey data but omitted from the IHLCA calculations. The numbers cited above for mean expenditure in both years and poverty incidence in 2010 therefore differ slightly from the IHLCA reported findings. Table 3 below compares them. The IHLCA documents did not report Gini coefficients for either year. On this, see footnote 10.

disasters to affect Asia in recent decades. Property damage was also massive. In those regions of the country directly affected by the cyclone, virtually all standing crops and stored food stocks, along with most capital goods such as vehicles and other machinery were destroyed, along with many buildings, and in coastal farming areas, salt-water inundation permanently harmed soil fertility (Larkin 2010). Steinberg (2013, p. 46) cites estimates of property damage equivalent to 27 per cent of annual GDP and describes Cyclone Nargis as "the single most devastating disaster to strike Burma/Myanmar in recorded history."

Scheidel's argument suggests that the cyclone may partly explain the reduction in measured inequality. To what extent, if any, is this true? Aside from its historical interest, the significance of this question is that to the extent that an unavoidable natural event like a cyclone caused the decline in measured inequality, there is no need to search for structural or policy-based explanations. Consistent with Scheidel's account, it might be presumed that the economic assets destroyed by the cyclone belonged disproportionately to better-off households. Table A.1 shows that inequality did indeed decline in the areas directly affected by the cyclone, while poverty incidence increased in those areas, even though it declined nationally.

The cyclone could not have been the sole cause of lower inequality at the national level. Table A.1 shows that inequality also declined in those areas not directly affected – although the measured decline in the Gini coefficient was larger in the cyclone-affected area. Factors other than the cyclone must have contributed to the decline in inequality in regions outside the cyclone-affected areas. But in any case, the possible inequality-reducing impact of the cyclone cannot be captured fully by these within-region observations.

In 2005, prior to the cyclone, the regions that were subsequently affected by the cyclone, labeled 'Nargis area' in Table A1, were the best-off in the country. In this region, mean real expenditures per adult equivalent[5] were 12.5 percent lower in 2010 than in 2005, while comparable declines did not occur elsewhere. But the Nargis-affected region still remained better-off in 2010 than any other region. National-level inequality changed between 2005 and 2010, partly because of a reduction in the gap in mean real household expenditures *between* better-off and poorer regions, as well through changes in distribution among households *within* regions. But to what extent can these changes in measured inequality outcomes be attributed to the cyclone?

The cyclone caused widespread suffering. It would be absurd to imagine that it reduced poverty, merely because it may have reduced inequality. The cyclone undoubtedly reduced the size of the national economic pie, compared with what would otherwise have happened, and not just its distribution. As Table A1 shows, although poverty incidence declined at the national level, it increased in the region directly impacted by the cyclone. It seems probable that if the cyclone had not occurred, poverty would have declined in this region, as it did almost everywhere else. Poverty reduction at the national level would then have been more rapid than it actually was. But how much more so?

The impact that the cyclone had on inequality and poverty is not readily discernable from summary data like those in Table 1. In both the cyclone-affected and non-affected regions, factors other than the cyclone changed between 2005 and 2010 and these factors must have affected measured poverty and inequality, both within and between regions. Both inequality and poverty incidence would have changed over this period if the cyclone had not occurred. The observed changes in the aggregate outcomes cannot be attributed to the cyclone alone.

The objective of this paper is to develop a methodology to isolate the effect of the cyclone on measured real expenditures, inequality and poverty incidence. The method is to use the available household-level survey data to construct a statistical model of the determinants of

[5] For the statistical definition of 'adult equivalent', see the notes to Table 1.

household expenditures and then to use this model to simulate a hypothetical, counterfactual distribution for 2010 in which the cyclone did not occur, but in which all other exogenous factors were the same as those observed. Our measure of the impact of the cyclone will rest on the comparison between the observed data and this unobserved counterfactual.

After 2010 Myanmar entered a period of political democratization and economic reform (Asian Development Bank 2013; Warr 2016), including general elections in November 2015. During this ongoing process, monitoring the level and changes in poverty incidence and economic inequality will continue to be of vital policy concern, along with efforts to accelerate the rate of overall economic growth. Understanding the determinants of changes in poverty and inequality is important for the guidance of the reform process. The availability of good household data for the period immediately prior to the reforms, 2005 to 2010, offers a valuable baseline for this analysis.

The available data on household expenditures, together with calculations of poverty and inequality based on them, are described in Section 2. Section 3 then asks whether, considering that the data are based on a sample survey of limited size, rather than a census of the whole population, the observed changes in poverty incidence and inequality are statistically significant, or whether random sampling error could reasonably explain these measured changes.

To what extent did the measured reduction in inequality between 2005 and 2010 account for the measured reduction in poverty incidence? This question is addressed in Section 4 by constructing a hypothetical distribution of expenditures for 2010 in which the real expenditure of every household of the distribution changes by the same proportion – the proportional change in the mean. The difference between this hypothetical level of poverty incidence in 2010 and the observed level can then be associated with the change in inequality.

In Section 5, we explore the extent to which the observed changes in poverty and inequality can be attributed to the impact of Cyclone Nargis. This section of the paper uses panel data statistical methods, exploiting the fact that roughly half of the household data set discussed above covers the same set of households.[6] Section 6 concludes.

2. Household survey data, 2005 and 2010

IHLCA household expenditure data

The IHLCA surveys were conducted by Myanmar's Ministry of National Planning and Economic Development with the assistance of the United Nations Development Programme and other international agencies. The full survey included roughly 18,000 households in 2005 and a similar number in 2010, with data collected throughout the country. Around half of the sample was a panel, covering the same households in each of the two years. The panel component of the sample will be drawn upon in Section 5, below and will be discussed there. Meanwhile, our discussion will relate to the full sample, as summarized in Table 1 and the left panel of Table A1. The data shown in these tables are the authors' calculations, derived from the raw sample data, as amended below. The sample methodology is described in detail in IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Comparisons of poverty incidence and inequality estimates across countries are highly problematic. In the case of poverty estimates, poverty lines can differ across countries, but a deeper statistical problem, affecting both poverty and inequality estimates, is that the household level data themselves are often constructed differently. It is well-known that some countries use household expenditures as the basis for their calculations which others use incomes. But the items included in the calculation of income or expenditure also differ widely. A recent study by Warr *et al*. (2017) makes this point by comparing poverty and inequality measurement in the eight

[6] The panel data set is summarized in the right panel of Appendix Table A1 and is discussed in Section 5 of this paper. Sections 1 to 4 use the full data set, summarized in Table 1 and in the left panel of Appendix Table A1.

poorest Association of Southeast Asian Nations (ASEAN) countries, including Myanmar. No two countries include the same items in their definitions of household incomes or expenditures.

In the case of Myanmar, the IHLCA reports estimate poverty incidence based on household expenditures including: (i) food consumption expenditures, including estimates of the value of home-produced food; (ii) non-food consumption expenditures, including clothing and other apparel, home appliances, house repair, education, travel and other household personal services; and (iii) housing expenditures, represented by yearly user costs, approximated by actual rental value, in the case of rented housing, or estimated rental value in the case of owner-occupied housing.

Amended expenditure data

In the IHLCA calculations of household expenditures, two important omissions were health-related expenditures and expenditures on household consumer durables. The proportion of expenditure allocated to these items may be a function of the level of household income, so measured inequality and changes in it may be affected by their omission. The raw household survey data include actual expenditures on both of these two items and the ownership of consumer durables. The present study amends the data used by the IHLCA team to include them. Health expenditures and the user costs of durable goods per year per adult equivalent are deflated by a Paasche index of purchaser prices within survey periods estimated by the IHLCA team and adds them to non-food consumption expenditures for 2005 and 2010. In the case of consumer durables, our calculations convert the value of items owned or purchased by the household into an annual user cost, based on the real interest rate, the rate of depreciation, age and purchase price of the durable good.

Table 3 summarizes the results of these amendments to the IHLCA expenditure data. All data shown are household expenditures per adult equivalent per year, expressed in real terms, using the national consumer price index as a deflator, classified by expenditure decile. The amended expenditures exceed the IHLCA expenditures in all cases, but the differences do not seem large. The proportional difference between our amended expenditure data and the IHLCA data is largest for the 10th (richest) decile, reflecting larger expenditures on health and consumer durables for this group. The percentage change between real expenditures in 2005 and 2010 is different between the two data sets, depending on the decile group. Our amended data show a slightly smaller percentage increase in real expenditures for the poorer deciles and much larger declines for the richer deciles. The amended data set indicates an even larger decline in inequality than the IHLCA data.[7] Except for the left panel of Table 3, all findings reported in this paper relate to the amended data set summarized in the right panel of Table 3.

Poverty lines

The IHLCA report for 2005 explains in detail its method of constructing a poverty line for that year, based on quantities of food and non-food deemed to be essential. The report for 2010 describes a similar but independent exercise, without reference to the 2005 calculations. It is unclear from the 2010 report whether the resulting poverty line is the same in real purchasing power as the 2005 poverty line. In this study, our purpose is not to question the *base level* of poverty incidence in 2005, but to study *changes* in poverty over the interval between the two surveys. We calculate the poverty lines applied to our amended expenditure data as follows. First, we find the poverty line for 2005 that replicates for our data the level of national poverty incidence

[7] At the national level, the amended data assembled for this study show a decline in the Gini coefficient from 0.256 to 0.220, a decline of 0.036 (14%), while the authors' calculations from the unamended IHLCA data shows a decline in the Gini coefficient from 0.221 to 0.199, a decline of 0.022 (9.7%).

in 2005 reported by the IHLCA, 32.1 per cent. Our poverty line for 2010 is then this 2005 level adjusted by the change in the consumer price index (CPI) over the five year interval (Central Statistical Organisation, 2005 and 2010). We then apply this 2010 poverty line to our amended 2010 expenditure data. This exercise generates roughly similar poverty incidence numbers for 2010 to the IHLCA numbers.[8]

Assignment of households to Nargis-affected and non-Nargis-affected categories

The allocation of sampled households to the 'Nargis-affected' and 'non Nargis-affected' categories is based Tripartite Core Group (2008), subsequently TCG, which drew upon satellite imagery conducted in the weeks immediately following the cyclone. A hexagonal geographical lattice frame was used by the TCG to identify visually the areas at the township level that were affected by the cyclone and these township allocations were then mapped into the households identified in the 2005 and 2010 surveys, based on their location.[9] The visual differences were stark. Within affected areas the images showed devastation. Within the non-affected areas, no damage was apparent.

3. Statistical significance

Because of the cost of conducting detailed household surveys, poverty and inequality at the population level are almost always estimated through sample surveys, covering only a small

[8] The IHLCA estimate of poverty incidence in 2010 was 25.6 per cent (IHLCA 2011a), similar to our estimate of 24.99.

[9] The number of townships in the affected area was around 58, compared with around 221 in the non-affected area. The TCG report states that "These designations are based on the determination of areas in the direct path of the cyclone as well as the immediate neighboring ones" (TCG, 2010, p. ix). The term 'affected' was defined as "the loss of life and/or property that has an impact on an individual's, family's or community's livelihood, without any consideration for their ability to cope with the damage and destruction" (Tripartite Core Group, 2008, p. 55).

fraction of a country's heterogeneous population.[10] These samples produce estimates of population statistics which inevitably involve error. Statisticians endeavor to minimize sample bias, such that the statistically expected value of sample-based estimates are equal to their true population values, but because of limited sample sizes, sampling error is unavoidable. Sample-based estimates have a variance and when these estimates change over time, it is reasonable to ask the likelihood that these changes could have arisen by chance, due to random sampling error.

Table 4 shows the results of this enquiry. We are interested in the probability that the estimated changes in mean household expenditures, poverty incidence and the Gini coefficient of inequality could have arisen by chance. The 1.5 per cent increase in measured mean real expenditures at the national level was not significantly different from zero, but mean real expenditures did decline significantly in the Nargis-affected region and increased significantly in the non-Nargis region. Poverty incidence declined significantly at the national level and in the non-Nargis region, but the measured increase in poverty incidence in the Nargis region was not statistically significant. The Gini coefficient declined significantly at the national level and in the non-Nargis region, but the decline within the Nargis-affected region was not statistically significant.

4. Poverty-reducing effect of lower inequality

The fact that a change in measured inequality is statistically significant does not necessarily mean that it is 'large'. One way of assessing the size of a change in inequality is to calculate its magnitude in units of poverty incidence. We shall do this by decomposing observed changes in poverty incidence into two analytical components: a growth effect and a distributional effect.

[10] The IHLCA survey data cover 18,600 households in a population of 41 million persons and roughly 8 million households, implying that about 0.23 percent of households are surveyed. Some regions could not be included, due to inaccessibility.

The growth effect is the change in poverty incidence that would, hypothetically, have occurred if every household's real expenditure had changed at the observed mean rate – that is, if the change in the distribution of real expenditures had been mean-preserving but distributionally-neutral. The distributional effect is the change in poverty incidence occurring because of the departure from distributional neutrality, calculated as the difference between the observed change in poverty incidence and the estimated growth effect. By construction, the growth effect and the distributional effect must add to the observed change. The analytical purpose of this decomposition is to describe the relative sizes of these two components of the change in observed poverty incidence. No assumption is being made about whether distributionally-neutral growth would actually have been feasible.

The method is illustrated in Figure 1. The cumulative distribution of the logarithm of nominal household expenditures in each of the two years is shown by the graphs '2005' and '2010', along with the logarithm of the official poverty lines for the corresponding years.[11] The vertical intersections between these cumulative distributions and the corresponding poverty lines give poverty incidence for the two years, 32.14 percent and 24.99 percent, respectively. The hypothetical distribution marked '2010*' is computed by multiplying nominal expenditure at every point on the '2005' distribution by the ratio of the means of 2010 and 2005.[12] The result is shown by the dashed line, a distribution that preserves the mean of '2010', but which retains the same distribution as '2005'. Poverty incidence under this hypothetical distribution is then calculated using the 2010 poverty line, giving 31.4 percent.

[11] The diagram is presented in nominal terms here for illustrative convenience. It can equally be presented in real terms, in which case the poverty lines for the two years are the same. The results are identical, but when the diagram is presented in this way the distributions are so close together that the differences cannot readily be seen from the diagram.

[12] The ratio of mean nominal household expenditures in 2010 and 2005 is 542,971/ 230,308 = 2.3576. Since the graphs are shown in logarithms of nominal expenditures, the computation of the 2010* distribution shown in the diagram adds the logarithm of 2.3576 horizontally to each point on the 2005 distribution.

The actual change in poverty incidence was 24.99 - 32.14 = - 7.15 per cent. The growth effect is the difference between poverty incidence under '2010*' and '2005', or 30.52 - 32.14 = - 1.62 per cent of the population. The inequality effect is the difference between poverty incidence under '2010' and '2010*', or 24.99 - 31.4 = 5.53 per cent of the population. The growth effect contributed 23 percent of the measured reduction in poverty incidence, and the distributional effect contributed the remaining 77 percent.

Because of the centrality of Cyclone Nargis to our analysis, it is of interest to conduct this decomposition separately for the Nargis-affected and non-Nargis-affected regions of the country. The results are summarised in the two lower panels of Table 5. In the Nargis-affected region poverty incidence increased by 3.93 per cent of the population. The 'growth' effect, due to the large reduction in mean expenditures, was an increase in poverty incidence of 9.5 per cent. Partly counter-balancing that, the distribution effect, due to the reduction in inequality, was a reduction in poverty incidence of 5.57 per cent. In the non-Nargis region, the growth effect was significant, producing a reduction in poverty incidence roughly twice as large as the additional reduction caused by the decline in inequality occurring in that region.

5. Estimation of cyclone impact on poverty and inequality

In estimating the impact of a natural event, we wish to compare what actually happened, as observed, with what would have happened, hypothetically, in its absence – the counterfactual. The problem is the construction of the unobserved counterfactual. It might be hoped that some other, unaffected region of Myanmar could conveniently play that role. But no such region can be identified. The experience of other regions varied considerably and none of them seemingly provides a sensible counterfactual. If one region was arbitrarily chosen for this purpose, the results would depend entirely on that choice.

Our solution is to construct a statistical model of the determinants of real expenditures at the *household* level, controlling for all other factors, and to use this estimated model to simulate what would have happened to Nargis-affected households without the cyclone. For this purpose, we use the panel component of the full data set, summarized in the right panel of Table A1. All subsequent discussion relates to this panel data set. The panel data set comprises about half of the full sample. The advantage of using it is that it covers the same households in the two years, meaning that characteristics specific to the household but not captured by the household-specific control variables are held constant in the two rounds of the survey.

Constructing the counterfactual

The estimated model is:

$$\ln E_t^h = \alpha + \beta D_{2010} + \sum_{k=1}^{3} \gamma_k R_k + \sum_{k=1}^{3} \delta_k R_k D_{2010} + \theta \ln E_{2005}^h D_{2010} + \sum_{k=1}^{3} \mu_k R_k \ln E_{2005}^h D_{2010} + \sum_{j=1}^{J} \pi_j X_{jt}^h + \varepsilon_t^h, \quad (1)$$

where: E_t^h denotes real expenditure per adult equivalent in household *h* at time *t*; D_{2010} is a binary (0, 1) dummy variable for the year 2010 (when *t* = 2005 the value is zero and when *t* = 2010 the value is 1); $R_k, (k = (1,2,3))$ denotes a set of three binary dummy variables representing the four regions listed in Table A1.[13] The omitted region is Hills, whose impact is included in the intercept term); X_{jt}^h represents a set of *j* control variables for household *h* at time *t*, as listed in appendix Table A2, and ε_t^h is an error term. The $\alpha, \beta, \gamma_k, \delta_k,$ θ and π_j variables are parameters to be estimated.

Each of the terms of equation (1) can now be interpreted, as follows. The term βD_{2010} captures a pure time effect; each term $\gamma_k R_k$ captures a pure regional effect; each term $R_k D_{2010}$

[13] The four regions are Nargis, Hills, Dry zone and Coastal. For dummy variable purposes, one must be omitted. The findings are not affected by this choice.

captures the interaction between regional and time effects; $\ln E_{2005}^{h} D_{2010}$ captures the lagged effect of the level of expenditure in 2005 when *t* = 2010; each $R_k \ln E_{2005}^{h} D_{2010}$ term captures the interaction between the lagged effect of the level of expenditure in 2005 and the regional dummy variable; and each term $\pi_j X_{jt}^{h}$ captures the impact of household characteristic *j* at time *t*; and the error term ε_t^h captures the impact of omitted variables influencing the dependent variable for household *h* at time *t*.

Table A2 summarizes the estimation results. Our analysis then uses this estimated model to project the levels of household expenditure for households in the Nargis-affected region in year 2010 when the Dummy variable for 'Nargis', is set at zero, instead of one, as in the estimation. The value for (the logarithm of) expenditure in 2010 is projected, including the value of the error term estimated in the regression. The estimated error term is included because it captures the effect of household-specific variables not captured in the set of household characteristic terms, X_{jt}^{h} above. This projected value of the dependent variable can be denoted $\widehat{\ln E_{2010}^{h}}$. The observed value of $\ln E_t^h$ in the data is identically equal to the right hand side of the estimated equation, including the error term, when the dummy variable for 'Nargis' is set at one. We then take the anti-log of $\widehat{\ln E_{2010}^{h}}$, denoted $\widehat{E_{2010}^{h}}$.

The estimated impact of the cyclone on household *h* is then given by

$$I_{2010}^{h} = E_{2010}^{h} - \widehat{E_{2010}^{h}} \,. \qquad (2)$$

For example, a negative value for I_{2010}^{h} would mean that the cyclone is projected to have reduced, in absolute terms, that household's 2010 level of real expenditure, compared with the value it would have taken without the cyclone, controlling for all other factors.

Three important qualifications must be mentioned. First, our method estimates the cyclone's impact on the survivors, taking no account of non-survivors. Second, it is assumed that for all households outside the 'Nargis-affected' region, the cyclone had no impact. Indirect impacts on other regions could have occurred, operating through commodity prices, and could be positive or negative. In addition, households outside the Nargis-affected region could be affected negatively through family or other obligations to assist cyclone-affected households. Nargis-affected households could also have moved from the Nargis-affected region, to non-Nargis-affected regions, because of the effects of the cyclone.[14]

Third, because the survey data are available only for 2005 and 2010, our methodology attributes to the cyclone all changes occurring between those years which are specific to the households in the Nargis-affected area and which are not accounted for by the control variables (other than 'Nargis') appearing on the right-hand side of equation (1). This includes the cyclone itself, but also the impact of remedial efforts by outside groups to assist cyclone-affected households.[15] Our analysis captures those negative impacts on surviving cyclone-affected households that were observable roughly two years after the event, in 2010.

Simulating cyclone impact

Figure 2 shows the distribution of estimated impacts in absolute terms, as measured by I^h_{2010} in equation (2). The six panels show the absolute magnitude of the estimated cyclone impact at the national level (panel A.1) and for five other sub-groups in the other panels. For each sub-group, the absolute impact is shown on the vertical axis, measured in December 2009 prices. The horizontal axis shows households in that sub-group arranged by centile groups according to their

[14] The last of these possibilities (migration to non-Nargis-affected areas because of the cyclone) was apparently minor. A question in the 2010 IHLCA survey Round 1 (December 2009) related to individuals relocating and their reasons for doing so. Of the 95,021 respondents, 122 (0.13 per cent of all respondents) reported relocating since 2005 because of the cyclone. Of these, only 18 (0.02 per cent of all respondents) reported relocating to non-Nargis affected areas.
[15] Sadly, remedial efforts were minimal. Larkin (2010, pp. 10-11) states that the ruling government "in an unfathomable decision of near-genocidal proportions, blocked international aid from entering the country and provided little relief themselves." Steinberg (2013, p. 46) concurs and attributes this behavior to fear of foreign military intervention, especially from the United States.

base level of expenditures per adult equivalent, from the worst-off (left side) to the best-off (right side). The mean absolute impact is shown by the horizontal line in each panel. At the national level and for all five sub-groups, the estimated negative impact of the cyclone was largest in absolute value for the better-off households.

Figure 2 does not reveal changes in measured inequality, because these depend on *proportional* changes in the measured variable (in this case real household expenditures), not absolute changes.[16] Figure 3 repeats the same exercise, but with impacts calculated as a percentage of the base level of expenditure for each household. Panel A.1 shows that at the national level the negative impact of the cyclone increased with the level of expenditure. Better-off households were affected more severely, confirming that, at the national level, the cyclone reduced inequality. But Panel A.2 shows a very different story for the Nargis-affected region. The mean impact on all Nargis-affected households (-14.85%) was, of course, much larger in absolute terms than for the population as a whole (-4%), but within the Nargis area, the negative impact was largest, in proportional terms, for poorer households. According to these results, Cyclone Nargis *increased* inequality within the Nargis-affected area.

A similar apparent paradox arises at both the urban and rural level. The mean impact on urban households was moderate at the national level (Panel B.1, mean value -6.4 %), and this negative impact was similar in proportional terms for better-off and poorer urban households. But for urban households within the Nargis-affected area (Panel B.2, mean value -14%) poorer households were affected much more severely. For rural households, at the national level (Panel C.1, mean value -2.9%) the impact was larger for better-off households, while within the Nargis-

[16] The following simple example illustrates this point. Suppose there are two groups, 'poor' and 'rich'. All members of the poor group experience an x per cent change in real expenditure (or any other variable used to measure inequality) while all members of the rich experience a y per cent change, where x and y can be positive or negative. If $x = y$, inequality is unchanged. If $x < y$, inequality rises and if $x > y$, inequality falls.

affected area (Panel C.2, mean value -15.9%) the negative impact is smaller, in proportional terms, for better-off households. Within the Nargis-affected region, the negative effects of the cyclone were proportionally most severe for the poorest households, within both urban and rural areas, and especially the former.

Decomposing the inequality impact of the cyclone

Why was the distributional impact so different at the national level and within the directly affected region? Table 6 explains these findings by decomposing the inequality impact of the cyclone at the national level into within-region and between-region effects. This exercise requires an inequality measure that supports additive decomposition. Unfortunately, the Gini coefficient does not possess this property. The class of inequality measures that does support it is known as the Generalized Entropy (GE) class (Bourguignon 1979; Mookherjee and Shorrocks 1982; Houghton and Khandker 2009).

Table 6 uses the three commonly used GE measures, known as the GE(α) measures, with the parameter α = 0, 1 and 2, respectively, to decompose three distributions: (i) observed household expenditures in 2010 (with the cyclone); (ii) estimated, counterfactual expenditures in 2010 (without the cyclone); and (iii) the estimated impact of the cyclone, (i) – (ii), as in equation (2) above. In each case, inequality is decomposed into two additive parts: between-groups (between the Nargis-affected and non-Nargis-affected areas); and within-groups (within each of these two areas). By assumption, the non-Nargis area was unaffected, so the estimated impact on within-group inequality within this area is zero.

The findings are qualitatively similar for all three GE(α) measures. The two effects were offsetting – the cyclone reduced between-group inequality but increased within-group inequality.

Total inequality declined because the former effect was larger.[17] Between-region inequality was reduced because the destructive impact was concentrated in better-off regions of the country, including the largest city and central commercial area, Yangon. The cyclone increased inequality within the directly affected region because its negative impacts were most concentrated, in proportional terms, on the most vulnerable – the poorest households.

Summary of estimated impacts

Table 7 now summarizes our findings on the cyclone's estimated impact on mean expenditures, poverty inequality, based on the panel component of the data.[18] At the national level mean real household expenditures per adult equivalent increased by 2.35 per cent between 2005 and 2010, but without the cyclone this increase would have been 6.37 per cent, 4.02 percentage points higher. That is, the cyclone reduced the expansion of real mean household expenditures that would otherwise have occurred by about two thirds.

Observed poverty incidence declined by about seven per cent of the population, but in the absence of the cyclone this decline would have been almost ten per cent, 2.8 percentage points higher. Out of a surveyed total population of 41 million, the cyclone thus increased the number of people with real expenditures below the poverty line in 2010 from 9.1 million, who would still have been poor without the cyclone, to the observed number of around 10.3 million - a difference of around 1.2 million people.

Within the panel component of the data set the Gini coefficient of inequality declined from 0.248 in 2005 to 0.221 in 2010. Without the cyclone the 2010 level would have been 0.226. That

[17] In the case of the GE(0), GE(1) and GE(2) measures the between group effect was 3.1, 3.6 and 2.9 times as large as the within-group measure, respectively.
[18] It should be noted that the properties of the panel data set are similar, but not identical to the properties of the full sample data set summarised in Table 1. See Table A1 for the comparison.

is, the cyclone reduced the measured Gini coefficient at the national level, accounting for about 20 per cent of the observed decline.[19] Within the Nargis-affected region, the Gini coefficient declined from 0.267 in 2005 to 0.255 in 2010, a decline of 0.012 points. But without the cyclone the decline would have been substantially larger, leading to a 2010 level of 0.245. The cyclone therefore increased the measured Gini coefficient within this affected area by 0.010 points. Without the cyclone, the estimated decline in the Gini coefficient within the Nargis-affected region would have been 85 per cent larger than the observed decline. The cyclone reduced between-region inequality while increasing within-region inequality. The overall impact was a reduction in inequality, because the former effect was larger.

6. Conclusions

This paper draws upon a large household survey for Myanmar, covering the years 2005 and 2010, to analyse changes in poverty and inequality occurring over that interval. Mean real household expenditures per adult equivalent barely changed over this period, but estimated poverty incidence declined at the national level, by about seven per cent of the population. At the same time the Gini coefficient of inequality declined from 0.265 to 0.220. The reduction in inequality at the national level accounted for almost all of the decline in poverty incidence. The causes of the reduction in inequality are unknown and largely unexplored.

A severe natural disaster, Tropical Cyclone Nargis, devastated parts of Myanmar in May 2008 and this event must have influenced the above economic outcomes. The paper explores the impact that the cyclone had on each of them. A regression-based methodology is developed to estimate a counterfactual distribution of household expenditures representing what would have

[19] Using the GE(1) measure, the results are very similar. The cyclone accounted for an estimated 19 per cent of the observed decline at the national level and in the absence of the cyclone the decline would have been 72 per cent larger.

happened in the absence of the cyclone. This is possible only for the panel component of the data set, representing about half of the full data set of around 18,000 households in each of the two years.

Economic inequality declined over the five years from 2005 to 2010. At the national level, the cyclone contributed to this outcome, but this was hardly something desirable. The devastation caused by the cyclone was concentrated in the better-off areas of the country. The cyclone thereby reduced measured inequality at the national level because it reduced the proportional gap between the better-off, cyclone-affected regions and the non-affected parts of the country. This occurred, even though the cyclone raised inequality within the affected region, because its negative effects were proportionately more severe among poorer, rather than richer households. Overall inequality declined because the between-region decline outweighed the within-region increase.

Scheidel (2017) concludes that, historically, disasters – man-made and natural – are virtually the only means by which inequality can be reduced. Our findings do not support this hypothesis. Scheidel's argument is not that disasters just happen to impinge on better-off regions, reducing between-region inequality, but that the assets of better-off households are destroyed, reducing the gap between them and their worse-off neighbours, thereby reducing within-region inequality. In the case of Cyclone Nargis, our findings are the opposite. The absolute impacts of the disaster are indeed larger for richer households, but the proportional impacts, which are relevant for measured inequality, are larger for the poor. The cyclone does not satisfactorily explain the decline in inequality that occurred in Myanmar. Further research will be required to identify those causes.

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Table 1. Summary: Mean expenditures, poverty and inequality - national level

Variable	2005	2010	Absolute change	Percent change
Mean nominal expenditures	230,308	542,971	312,663	135.8%
Mean real expenditures	534,826	542,971	8,145	1.5%
Poverty incidence	32.14	24.99	-7.15	-22.2%
Gini coefficient of inequality	0.256	0.220	-0.036	-16.4%
Observations	18,634	18,609	n.a.	n.a.
Memo item:				
Consumer price index	100	232.2	132.2	132. 2%

Notes:
1. '2005' refers to the IHLCA survey data collected between November-December 2004 and May 2005. '2010' refers to IHLCA survey data collected between December 2009 and May 2010.
2. Real expenditures mean household expenditures per adult equivalent per year, calculated at December 2009 prices using the consumer price index as deflator. The calculation of 'adult equivalent' uses the weights recommended in Deaton and Zaidi (2002). Poverty incidence means headcount measure, using the poverty line explained in the text.
3. Deflation for different months of data collected within each of the two survey periods used a household-specific Paasche index of consumer prices reflecting price variation across states, assembled by the IHLCA survey team for the months of the survey but not for the inter-survey years. This deflator was used by the IHLCA survey team to produce data for the two survey periods in December 2004 and December 2009 prices, respectively. These data were then converted to December 2009 prices using the nation-wide consumer price index published by the Central Statistical Office, Yangon (December 2004 = 428.55; December 2009 = 995.19, an inflation rate of 132.22 per cent).
4. Consumption expenditures comprise: (i) food; (ii) non-food, including clothing and other apparel, home appliances, house rent and repair, education, travel and other household worker services; (iii) housing expenditures are the yearly user costs, approximated by rental value, measured by actual monthly rental value or estimated monthly rental value, as in IDEA and IHLCA (2007c, pp. 11-16); IHLCA (2011c, pp. 45-48), which describe the detailed steps of construction of the consumption aggregate, but also incorporating the authors' estimates of health expenditures and expenditures on durable goods, based on the IHLCA data.
5. All calculations are weighted by (survey weights X household size). Survey weights are calculated as the inverse of the sampling fraction.

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c). Consumer price index from Central Statistical Organization (2005 and 2010).

Table 2. Estimated mortalities and damage from natural disasters in Asia, 1990 to 2015

Year	Country	Disaster Type	Deaths ('000)	Injured ('000)	Homeless ('000)	Total affected ('000)	Total damage (US$ mill.)
1990	Iran	Earthquake	40	105	106	732	8,232
1991	Bangladesh	Cyclone	139	139	300	15,439	1,780
1999	Turkey	Earthquake	18	50	655	1,585	21,000
1999	India	Cyclone	10	4	700	13,870	2,990
2001	India	Earthquake	20	167	1,790	6,322	2,623
2003	Iran	Earthquake	27	23	66	297	522
2004	Indonesia	Tsunami	166	0	533	533	4,452
2004	Sri Lanka	Tsunami	35	23	480	1,019	1,317
2004	India	Tsunami	16	7	622	655	1,023
2004	Thailand	Tsunami	8	8	51	67	1,000
2005	Pakistan	Earthquake	73	128	5,000	5,128	5,200
2008	**Myanmar**	**Cyclone**	**138**	**20**	**2,262**	**2,420**	**4,000**
2008	China	Earthquake	88	368	414	47,370	85,492
2011	Japan	Tsunami	20	6	343	369	210,000
2013	Philippines	Cyclone	7	29	0	17,945	10,137
2015	Nepal	Earthquake	9	20	5,613	5,642	5,174

Source: Adapted by the authors from Guha-Sapir, *et al.* (2016).

Table 3. Measures of real consumption expenditure per year by decile group
(Kyat, December 2009 prices, CPI deflator)

	IHLCA study (June, 2011) (without health and user-costs of durables)				**Present study (with health and user-costs of durables)**			
Consumption Deciles	2005	2010	Difference	% change	2005	2010	Difference	% change
1st decile (Lowest 10%)	237,975 (1,303)	269,243 (1,498)	31,269	13	248,285 (1,276)	278,846 (1,549)	30,561	12
2nd decile	303,981 (528)	334,790 (311)	30,809	10	318,390 (445)	346,744 (438)	28,354	9
3rd decile	348,715 (298)	373,587 (326)	24,872	7	366,813 (498)	389,627 (387)	22,814	6
4th decile	387,806 (313)	410,356 (311)	22,550	6	410,146 (376)	429,729 (366)	19,583	5
5th decile	425,840 (407)	444,731 (257)	18,891	4	452,640 (421)	467,626 (350)	14,986	3
6th decile	465,255 (341)	481,188 (337)	15,932	3	497,832 (386)	508,546 (434)	10,714	2
7th decile	511,326 (567)	523,733 (415)	12,406	2	552,711 (524)	557,300 (373)	4,589	1
8th decile	569,438 (703)	577,382 (552)	7,945	1	625,204 (835)	619,818 (641)	-5,386	-1
9th decile	662,945 (1,682)	660,362 (1,056)	-2,583	0	741,722 (1,295)	720,766 (1,251)	-20,956	-3
10th decile (Highest 10%)	934,223 (37,580)	911,582 (21,886)	-22,641	-2	1,241,957 (34,189)	1,110,998 (26,799)	-130,959	-11
National	484,733 (11,411)	498,661 (7,095)	13,928	3	545,555 (13,442)	542,971 (8,854)	-2,584	0

Notes:
1. See notes to Table 1. Kyat is the currency unit of Myanmar.
2. The calculations for consumption deciles of IHLCA data (without health expenditures and user costs of durables) are also weighted by (survey weights X household size). Accordingly, the results are slightly different from IHLCA (2011a).
Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Table 4. Statistical significance of changes in poverty and inequality, 2005 to 2010

Measure	2005 observed	2010 observed	Absolute change	Percent change	p-value
Mean real expenditures					
National	534,826	542,971	8,144	2	0.5937
	(13,110)	(8,854)	[15,266]		
Nargis-affected area	679,283	594,154	-85,130*	-13	0.0851
	(43,610)	(28,942)	[49,438]		
Non-Nargis-affected area	493,059	527,612	34,553***	7	0.0038
	(9,567)	(7,774)	[11,935]		
Poverty Incidence					
National	0.3214	0.2499	-0.0715***	-22	0.0005
	(0.0164)	(0.0135)	[0.0205]		
Nargis-affected area	0.1775	0.2168	0.0393	22	0.2056
	(0.0250)	(0.0216)	[0.0311]		
Non-Nargis-affected area	0.3630	0.2599	-0.1031***	-28	0.0000
	(0.0172)	(0.0161)	[0.0228]		
Gini Coefficient					
National	0.2564	0.2205	-0.0360***	-14	0.0027
	(0.0100)	(0.0074)	[0.0120]		
Nargis-affected area	0.2916	0.2499	-0.0417	-14	0.1536
	(0.0229)	(0.0211)	[0.0292]		
Non-Nargis-affected area	0.2310	0.2090	-0.0220***	-10	0.0042
	(0.0059)	(0.0054)	[0.0077]		

Notes:
1. Standard errors (round brackets) for poverty incidence and Gini coefficients are based on the STATA code of Jenkins (2008), based Kovacevic and Binder (1997).
2. Z-statistics [square brackets] are calculated using the method of Barrett and Pendakur (1995) and Davidson and Duclos (2000).
3. *, ** and *** indicate significance at 10%, 5% and 1% levels respectively.

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Table 5. Decomposition of changes, 2005 to 2010 - growth and distributional effects

	Variable values			Decomposition of change, 2005 to 2010 (%)		
	2005 observed	**2010 observed**	**2010* hypothetical**	**Total change**	**Growth effect**	**Distributional effect**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mean real expenditure						
National	534,826	542,971	542,971	1.5	1.5	0
Nargis-affected area	679,283	594,154	594,154	-12.5	-12.5	0
Non-Nargis area	493,059	527,612	527,612	7.0	7.0	0
Poverty incidence						
National	32.14	24.99	30.52	-7.15	-1.62	-5.53
Nargis-affected area	17.75	21.68	27.24	3.93	9.50	-5.57
Non-Nargis area	36.30	25.99	29.48	-10.31	-6.82	-3.49
Gini Coefficient						
National	0.256	0.220	0.256	-0.036	0	-0.036
Nargis-affected area	0.292	0.250	0.292	-0.042	0	-0.042
Non-Nargis area	0.231	0.209	0.231	-0.022	0	-0.022

Notes:
1. See notes to Table 1.
2. Columns (1) and (2) are the observed data from the full sample, some repeated from Table 1, for convenience. Column (3) 2010* hypothetical describes the constructed distribution in which all households' expenditures change between 2005 and 2010 at the same rate - the observed change in the mean.
3. In the case of mean real expenditure, columns (4) to (6) are expressed as a percentage of the 2005 level of real expenditure. Column (4) (*Total change*) is the difference between the 2010 and 2005 level of the variable expressed as a percentage of the 2005 level [(4) = 100*((2) - (1))/(1)]. Column (5) (*Growth effect*) is the difference between the level of a variable under the Hypothetical 2010* and Observed 2005 distributions, expressed as a percentage of the 2005 level [(5) = 100*((3) – (1))/(1)]. Column (6) (*Distributional effect*) is the difference between the level under the Observed 2010 and Hypothetical 2010* distributions, again as a percentage of the 2005 level [(6) = 100*((2) – (3))/(1)]. By construction, (4) = (5) + (6).
4. In the case of poverty incidence and Gini coefficient, the decomposition is based on the simple difference between the 2010 and 2005 levels of the variable concerned. Column (4) is the simple difference between the 2010 and 2005 levels of the variable. [(4) = (2) - (1)]. Similarly, (5) = (3) – (1) and (6) = (2) – (3)].

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Table 6. Decomposition of GE indices of inequality, 2010

	Inequality in observed distribution: (With cyclone)	Inequality in counterfactual distribution: (Without cyclone)	Difference in inequality: (With – without)
	(1)	(2)	(3) = (1) – (2)
GE(0) index			
Between Group	0.0012	0.0070	-0.0058
Within Group	0.0802	0.0784	0.0019
- Within Nargis area	0.0235	0.0216	0.0019
- Within non-Nargis area	0.0567	0.0567	0.0000
Total	0.0814	0.0853	-0.0039
GE(1) index			
Between Group	0.0012	0.0073	-0.0061
Within Group	0.0963	0.0946	0.0017
- Within Nargis area	0.0311	0.0293	0.0017
- Within non-Nargis area	0.0652	0.0652	0.0000
Total	0.0975	0.1018	-0.0043
GE(2) index			
Between Group	0.0013	0.0077	-0.0064
Within Group	0.1779	0.1758	0.0022
- Within Nargis area	0.0563	0.0541	0.0022
- Within non-Nargis area	0.1217	0.1217	0.0000
Total	0.1792	0.1834	-0.0043

Note: GE(0), GE(1) and GE(2) refer to the Generalized Entropy class of measures GE(α), with α = 0, 1 and 2, respectively. The parameter α affects the sensitivity of the GE measure to inequality in different parts of the distribution. See Cowell (1995), Bourguignon (1979) and Mookherjee and Shorrocks (1982).

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Table 7. Estimated Impact of Cyclone (panel data set)

Variable	Before Cyclone	After Cyclone			
	2005 Observed	2010 Observed (With Cyclone)	2010 Projected (Without Cyclone)	Observed change	Impact of Cyclone
	(1)	(2)	(3)	(4) = (2) - (1)	(5) = (2) - (3)
National level					
Mean real expenditures[a]	530,058	542,505	565,237	2.35%	-6.37%
Poverty incidence (%)	31.74	24.93	22.09	-6.81	2.83
Inequality - Gini coefficient	0.2480	0.2207	0.2261	-0.0273	-0.0054
Inequality – GE(1)	0.1200	0.0975	0.1018	-0.0225	-0.0043
(Observations - panel data)	(9,102)	(9,102)	(9,102)	(9,102)	(9,102)
Nargis-affected area					
Mean real expenditures	664,638	593,652	697,213	-10.68%	-14.85%
Poverty incidence (%)	15.71	21.59	8.68	5.88	12.91
Inequality - Gini coefficient	0.2667	0.2547	0.2445	-0.012	0.0102
Inequality – GE(1)	0.1567	0.1373	0.1234	-0.0194	0.0140
(Observations - panel data)	(1,239)	(1,239)	(1,239)	(1,239)	(1,239)
Non-Nargis-affected area					
Mean real expenditures	493,989	528,121	528,121	6.91%	0
Poverty incidence (%)	36.04	25.87	25.87	-10.17	0
Inequality - Gini coefficient	0.2297	0.2086	0.2086	-0.0213	0
Inequality – GE(1)	0.0917	0.1031	0.0977	0.0114	0.0054
(Observations - panel data)	(7,863)	(7,863)	(7,863)	(7,863)	(7,863)

Notes:
1. All calculations shown in this table are based on the panel data set. See Table A1, right side.
2. See notes to Table 1.
3. In the case of mean real expenditures, observed change and impact of cyclone are presented as percentages of the 2005 level. Thus (4) = 100[(2) - (1)]/(1) and (5) = 100[(2) - (3)]/(1).
4. In the case of poverty incidence and Gini coefficient, observed change and impact of cyclone are the simple difference between the 2010 and 2005 levels. Thus (4) = (2) - (1) and (5) = (2) - (3).

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Appendix Table A1. Household data summary: full sample and panel sample

Variable	Full sample 2005	2010	Difference	Panel sample 2005	2010	Difference
Number of households						
Nargis area	2,673	2,660		1,239	1,239	
Yangon	923	916		438	438	
Non-Yangon	1,750	1,744		801	801	
All non-Nargis area	15,961	15,949		7,863	7,863	
Non-Nargis Hills	4,027	4,020		1,988	1,988	
Non-Nargis Dry	9,199	9,199		4,538	4,538	
Non-Nargis Coastal	2,735	2,730		1,337	1,337	
All urban	5,529	5,523		2,706	2,706	
All rural	13,105	13,086		6,396	6,396	
National sample	18,634	18,609		9,102	9,102	
Mean nominal expenditures						
Nargis area	292,514	594,154		286,207	593,652	
Yangon	345,619	686,057		328,824	672,657	
Non-Yangon	243,811	513,353		245,050	522,764	
All non-Nargis area	212,322	527,612		212,722	528,121	
Non-Nargis Hills	209,763	514,161		212,217	511,335	
Non-Nargis Dry	212,093	539,926		212,055	542,128	
Non-Nargis Coastal	215,605	499,760		215,553	497,363	
All urban	297,297	670,972		289,059	660,760	
All rural	206,740	497,924		207,084	500,974	
National sample	230,308	542,971		228,254	542,505	
Mean real expenditures (‘Difference’ means per cent change, 2005 to 2010)						
Nargis area	679,283	594,154	-12.5%	664,638	593,652	-10.7%
Yangon	802,605	686,057	-14.5%	763,603	672,280	-12.0%
Non-Yangon	566.184	513,353	-9.3%	569,062	522,589	-8.2%
All non-Nargis area	493,059	527,612	7.0%	493,989	528,121	6.9%
Non-Nargis Hills	487,118	514,161	5.6%	492,816	511,335	3.8%
Non-Nargis Dry	492,528	539,926	9.6%	492,439	542,128	10.1%
Non-Nargis Coastal	500,683	499,760	-0.2%	500,562	497,363	-0.6%
All urban	690,392	670,972	-2.8%	671,260	660,760	-1.6%
All rural	480,098	497,924	3.7%	480,895	500,974	4.2%
National sample	534,826	542,971	1.5%	530,058	542,505	2.3%
Poverty incidence (‘Difference’ means poverty incidence 2010 - poverty incidence 2005)						
Nargis area	17.75	21.68	3.93	15.71	21.60	5.89
Yangon	11.42	12.38	0.96	9.30	14.16	4.86
Non-Yangon	23.55	29.85	6.30	21.90	28.26	6.36
All non-Nargis area	36.30	25.99	-10.31	36.04	25.87	-10.17
Non-Nargis Hills	40.31	28.91	-11.40	39.52	29.34	-10.18
Non-Nargis Dry	36.42	23.04	-13.39	36.17	22.88	-13.29
Non-Nargis Coastal	31.98	32.97	1.00	32.16	32.56	0.40
All urban	20.88	14.25	-6.63	19.92	14.63	-5.29
All rural	36.10	28.78	-7.33	35.86	28.55	-7.31
National	32.14	24.99	-7.15	31.74	24.93	-6.81

Table A1. (continued) Household data summary: full sample and panel sample

Variable	Full sample 2005	2010	Difference	Panel sample 2005	2010	Difference
Gini Coefficient ('Difference' means Gini coefficient 2010 - Gini coefficient 2005)						
Nargis area	0.292	0.250	-0.042	0.267	0.255	-0.012
Yangon	0.321	0.261	-0.060	0.281	0.272	-0.009
Non-Yangon	0.230	0.212	-0.018	0.226	0.218	-0.008
All non-Nargis area	0.231	0.209	-0.022	0.230	0.209	-0.021
Non-Nargis Hills	0.253	0.209	-0.044	0.255	0.205	-0.050
Non-Nargis Dry	0.229	0.207	-0.022	0.227	0.208	-0.019
Non-Nargis Coastal	0.215	0.212	-0.004	0.213	0.210	-0.003
All urban	0.315	0.262	-0.052	0.295	0.264	-0.031
All rural	0.212	0.188	-0.024	0.210	0.190	-0.020
National	0.256	0.220	-0.036	0.248	0.221	-0.027

Notes:
1. See notes to Table 1.
2. 'Nargis area' means the area of the country impacted directly by Cyclone Nargis in May 2008, as identified in (Tripartite Core Group 2008), comprising about 14 per cent of the total population. 'Non-Nargis area' means the three regions of the country not impacted directly, divided into Hill Zone, Dry Zone and Coastal Zone.

Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Appendix Table A2. Regression results

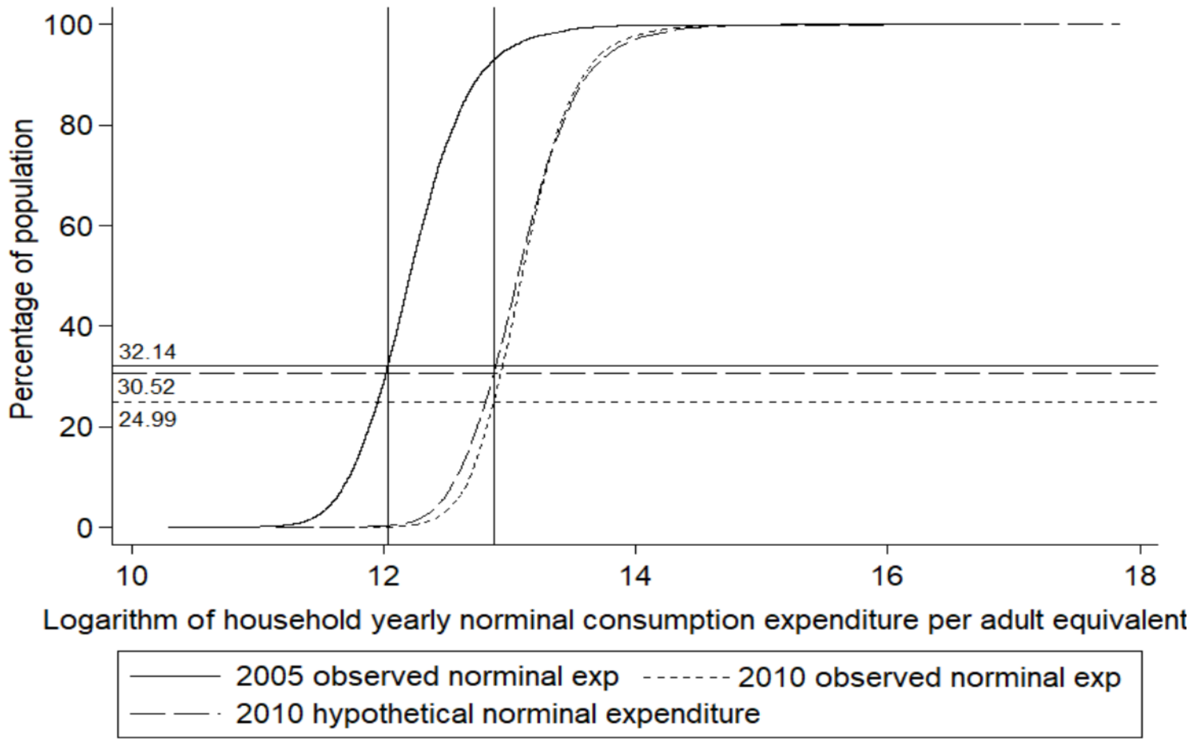
Dependent Variable: Log of household expenditure per adult equivalent	Coefficients	Standard errors
Effects of Nargis		
Nargis region * 2010	-0.99681***	0.33733
Lagged effect of 2005 level of expenditure in 2005 interacted with Nargis region	0.06242**	0.02577
Regional effect		
Dryzone region (dummy)	-0.03742***	0.01361
Coastal region (dummy)	0.01809	0.01401
Nargis-affected region (dummy)	0.19773***	0.01827
Time effect		
t = 2010	-1.816084***	0.1939808
Regional effect interacted with time effect		
Dryzone * 2010	-0.15702	0.26808
Coastal * 2010	-0.52773*	0.31237
The lagged effect of the level of expenditure in 2005 when t = 2010	**0.14548*** **	**0.01489**
The lagged effect of the level of expenditure in 2005 interacted with regional effect		
Lagged effect of 2005 level of expenditure interacted with Dryzone region	0.01181	0.02060
Lagged effect of 2005 level of expenditure interacted with Coastal region	0.03301	0.02392
Characteristics of the household head		
Age of household head (Years)	-0.00099	0.00153
Age square of household head (Years)	0.00001	0.00001
Gender of household head (dummy)	0.03277***	0.00701
Ethnicity of household head (Myanmar) (dummy)	0.04835***	0.00869
Years of non-agricultural business in operation	0.00417***	0.00046
Household size	-0.10032***	0.00438
Household size squared (number of persons)	0.00409***	0.00031
Proportion of members aged under 6	0.12782***	0.03731
Proportion of members aged 6-10	0.26583***	0.03646
Proportion of members aged 11-15	0.23821***	0.03632
Proportion of members aged 16- 65	0.07437***	0.02849
Proportion of members with tertiary education	0.31835***	0.02357
Proportion of members with upper secondary education	0.16192***	0.02041
Proportion of members with lower secondary education	0.08517***	0.01930
Proportion of members with primary education	0.02623	0.01859
Proportion of members illiterate	-0.06381***	0.02162
Proportion of members sick/ ill/ injured	0.19274***	0.01748
Proportion of household members who worked in the last 7 days, working as:		
Legislators, senior officials and managers	0.33339***	0.02965
Professionals	0.07985***	0.03047
Technicians and associate professionals	0.17318***	0.03082
Service workers and shop and market sales workers	0.19946***	0.02567
Skilled agricultural and fishery workers	0.11463***	0.02610
Craft and related trades workers	0.05175**	0.02611
Plant and machine operators and assemblers	0.17221***	0.02802
Elementary occupations	0.02218	0.02473
Land ownership and access, along with cultivation of crops		
Owned and accessed irrigated land area per capita (acres)	0.03427***	0.00606
Owned and accessed unirrigated land area per capita (acres)	0.02671***	0.00680
Landless (dummy)	-0.04419***	0.01002
Cultivation of cereal crops (dummy)	0.02384***	0.00771
Cultivation of pulses (dummy)	0.02323***	0.00856
Cultivation of oilseed crops (dummy)	0.01089	0.00808
Cultivation of tuber/root crops, spices/medicinal plants and vegetables (dummy)	0.00835	0.00965
Cultivation of fruit crops (dummy)	0.07627***	0.02123
Cultivation of industrial crops (dummy)	0.03368***	0.01149

Appendix Table A2. (continued) Regression results

Dependent Variable: **Log of household expenditure per adult equivalent**	**Coefficients**	**Standard errors**
Proportion of household members with open unemployment in the last 6 months	-0.18769***	0.04122
Proportion of household members who worked in the last 6 months in:		
Agriculture, forestry, fishing and mining sector	0.02089	0.02466
Manufacturing and construction sector	0.01696	0.02415
Services sector	0.05011**	0.02304
Location and other regional effects		
Village Tract/Wards: Inland plains (dummy)	0.02414***	0.00792
Village Tract/Wards: Hills (dummy)	-0.01644	0.01341
Village Tract/Wards: Mountains (dummy)	-0.11238***	0.01370
Village Tract/Wards: Delta (dummy)	-0.12063***	0.01365
Village Tract/Wards: Valley (dummy)	0.03730**	0.01577
Distance to nearest market (miles)	0.00023	0.00036
Distance to nearest financial services (miles)	-0.00162***	0.00028
Distance to nearest health services (miles)	-0.00391***	0.00060
Distance to primary and monastic school (miles)	0.00042	0.00102
Distance to lower secondary school (miles)	-0.00326***	0.00068
Distance to upper secondary school (miles)	-0.00033	0.00054
Infrastructure		
Road density by state and region	-0.01309***	0.00130
Bituminous (dummy)	0.02675***	0.00695
Gravel roads (dummy)	-0.00619	0.00586
Laterite roads (dummy)	-0.00448	0.00664
Dirt roads (dummy)	-0.02951***	0.00889
Months on road by car/four wheels and on waterway by boat	0.00110	0.00076
Water supply (dummy)	0.00503	0.00642
Electricity supply (dummy)	0.03259***	0.00594
Common mode of transportation: taxi/bus (dummy)	0.03583***	0.00593
Common mode of transportation: ship/boat (dummy)	0.01027	0.00776
Common mode of transportation: bullock cart (dummy)	-0.02786***	0.00601
Common mode of transportation: horse (dummy)	0.00700	0.00818
Constant	13.21606***	0.06154
Number of observations	17,007	
F-statistic	Prob. > F = 0.00***	
R^2-statistic	0.3493	

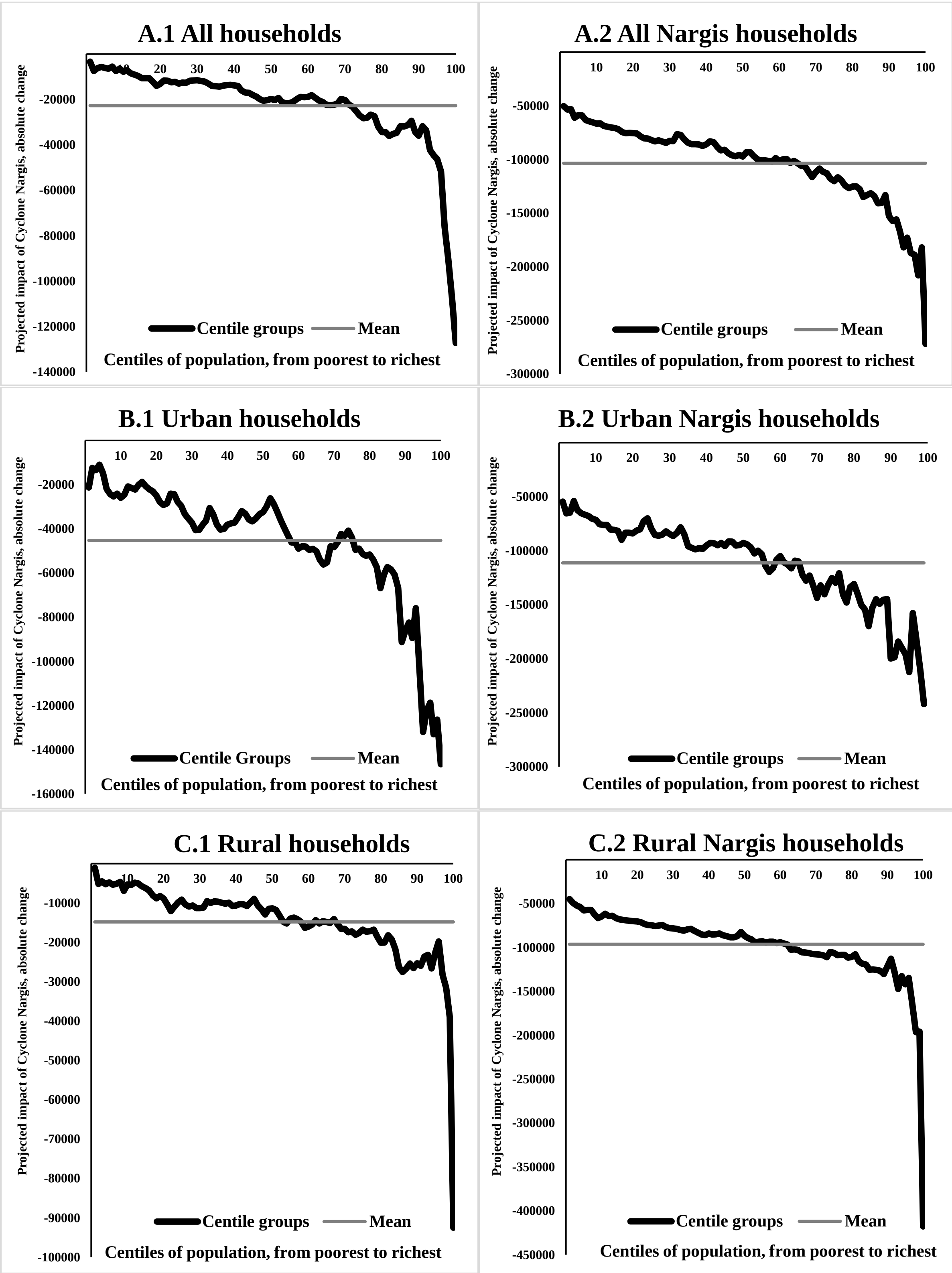
Source: Authors' calculations, using data from IDEA and IHLCA (2007a, b, c) and IHLCA (2011a, b, c).

Figure 1. Decomposition of change in poverty incidence



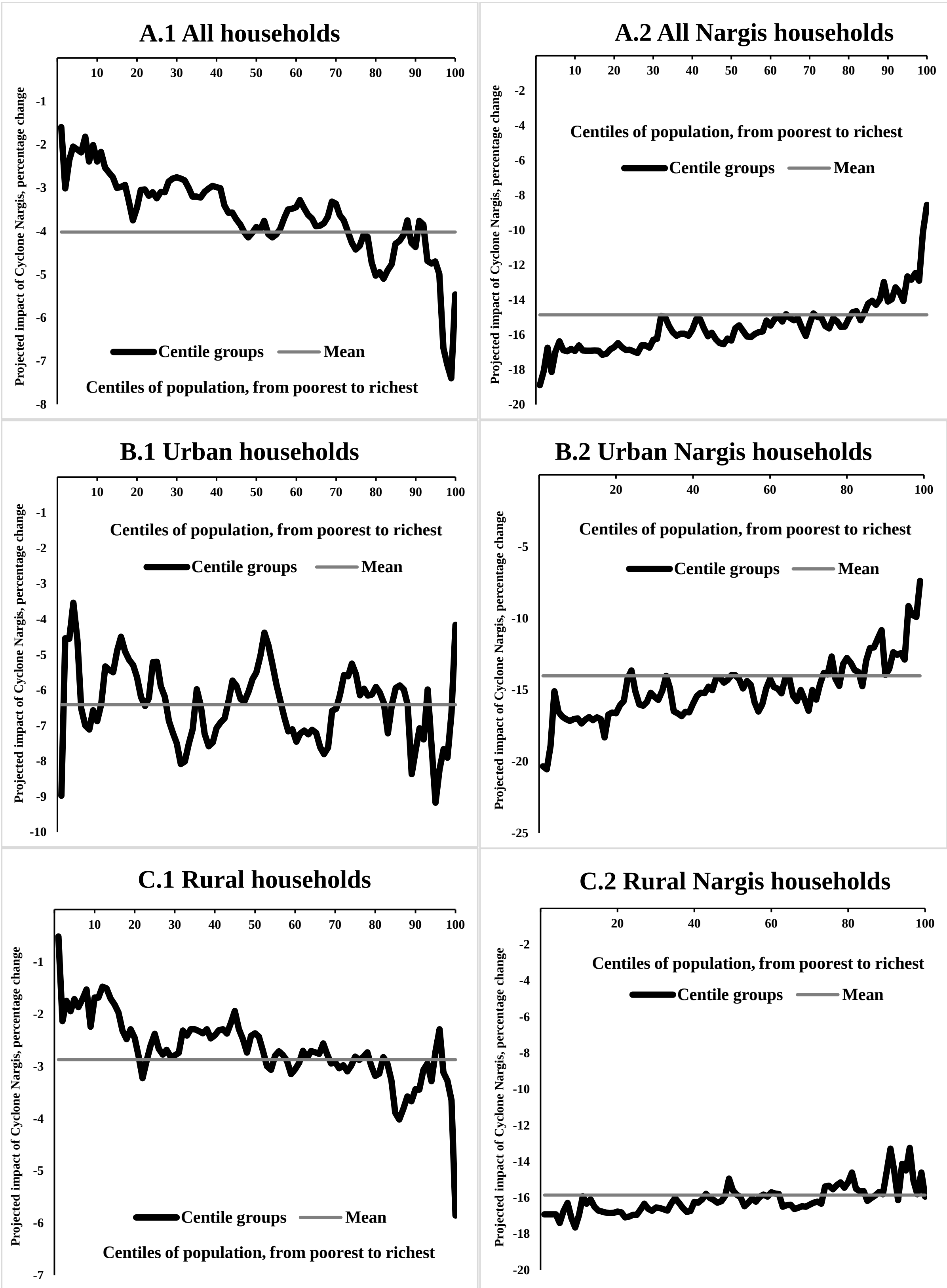
Source: Authors' calculations, as described in the text.

Figure 2. Estimated cyclone impact on real expenditure: Absolute change



Source: Authors' calculations, as described in the text.

Figure 3. Estimated cyclone impact on real expenditure: Proportional change



Source: Authors' calculations, as described in the text.