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Abstract

This paper empirically analyzes sources of extreme economic distress in rural India. We use district-level data on farmers' suicides in two major states during the years 1998 to 2004 to estimate the effects of transitory economic shocks and structural change in agriculture on the incidence of suicides in farm households. To elicit the causal effect of transitory economic shocks on suicides, we use rainfall conditions as an instrumental variable. For the state of Karnataka, where rainfall and poverty were especially variable around the turn of the millennium, we find that transitory spikes in poverty caused by a lack of rainfall increase suicides among male and decrease suicides among female members of farm households. According to our point estimates, a poverty increase of one percent increases male suicide mortality by 0.57 and decreases female suicide mortality by 1.05 percent. Given that suicides among male farmers are four times as frequent as among females on average, the combined causal effect of a poverty shock on suicides in farm households is positive. We also find that a shift from subsistence crops to cash crops, especially cotton, is associated with a decrease in male suicides.

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1 Introduction

Although poverty has been declining substantially over the last twenty years in many regions of the developing world (Ravallion et al., 2007), there is an intense public debate on continuing immizerization in many low-income countries. In particular, rural areas often do not benefit proportionally from aggregate economic growth (World Bank, 2007). In India, rural poverty remains significantly higher than its urban counterpart. According to Ravallion et al. (2007), 29 percent of rural inhabitants lived under the national Indian poverty line in 2005 compared to 25 percent in urban areas, and this wedge has not narrowed since the acceleration of India's economic growth around the early 1990s.

Perhaps more than India's success in rural poverty reduction, suicides by farmers in India's rural areas have received an immense global and domestic media attention over the last ten years.[1] Increasing agrarian distress in the form of economic liberalization, shift from subsistence to cash crops, and depleted environmental resources has been held responsible for this phenomenon and also been a central issue in recent national election campaigns in India.[2]

In this paper, we empirically investigate the interrelationship between risk, structural change in agriculture, and suicides by farmers in India. In line with existing theoretical work on suicides by economists (e.g. Hamermesh and Soss, 1974), we view farmer suicides as an expression of extreme self-perceived misery. Moreover, in the largely agrarian economy that we study here, we regard suicides by farmers as an important aspect of rural welfare and rural immizerization that goes beyond conventional consumption-based poverty. In our view, India since the 1990s is a particularly relevant case for such an analysis because structural change in agriculture has been proceeding at a rapid pace, in particular in the form of technological change (Matuschke, Mishra, and Qaim, 2007; Subramanian and Qaim, 2009) and market liberalization (e.g., Topalova, 2007), with important implications for rural livelihoods.

[1] In 2007, The New York Times titled "In India, Farmers in Debt Reach the Depth of Despair" and The Economist wrote "The great unravelling - Is globalisation killing India's cotton farmers?". The issue of farmer suicides in India has been featured in virtually all major North-American and European newspapers including the Daily Telegraph, Globe and Mail, Le Monde, and Der Spiegel to mention only a few. In The Times of India alone, we have counted more than 250 related articles since 2000. *Economic and Political Weekly*, an influential Indian economic policy magazine, published a special issue on farmer suicides in 2006.

[2] N. N. (2009), India's Election - Singh When You're Winning, *The Economist*, May 21, http://www.economist.com/node/13692955

Adiga, A. (2004), The Face of Reform, *TIME*, May 31, http://content.time.com/time/world/article/0,8599,2047365,00.html

Furthermore, exposure to risk in agriculture continues to be immense and mostly uninsured (Cole et al., 2013).

Our analysis is based on district-level data on suicides from police records covering 62 districts in South-India, where roughly ten percent of India's rural population lives, for the years 1998 to 2004. We combine these suicide data with district-wise information on rainfall, cropping patterns, irrigation, and a conventional consumption-based measure of poverty calculated from National Sample Survey household-level data. With this district panel, we empirically identify determinants of farmer suicides. A particular focus of our econometric analysis is on disentangling the effects of transitory economic shocks and medium-term structural change on farmer suicides.

To assess the effect of structural change in agriculture on farmer suicides we employ fixed effects estimation. Our results are as follows. We find that adoption of major cash-crops, in particular cotton and to a lesser extent oilseed, is associated with a decrease in suicides by male farmers. Our point estimate implies an elasticity of roughly minus one, that is an increase in a district's agricultural area dedicated to cotton by one percent is associated with a decrease in the suicide rate among male farmers by one percent. On the other hand, none of the indicators of structural change in agriculture is a significant predictor of female suicides.

To identify the causal effect of transitory fluctuations in poverty on suicides, we conduct instrumental variables estimations, where rainfall serves as an instrument for consumption-based poverty. We find that, in the state of Karnataka, where rainfall and poverty were especially variable over the period covered by our data, transitory spikes in poverty caused by a lack of rainfall have increased suicides among male farmers. According to our point estimate, an increase in the poverty headcount ratio by one percent causes an increase in male suicide mortality by 0.57 percent. In contrast, we find that the same increase in transitory poverty decreases female suicides by roughly one percent. Given that suicides among male farmers are four times as frequent as among females on average, the combined effect of a poverty shock on suicides in farm households is positive.

For suicides of male farmers, our findings document that adverse aggregate economic shocks lead to an exacerbation of extreme self-perceived misery. This pattern is broadly in accordance with previous qualitative case studies carried out in Southern India that have identified lack of rainfall and the resulting deterioration in a household's economic situation as a risk factor for suicide (Deshpande, 2002; Mishra, 2006). It is also in line with studies using longitudinal data from high-income countries. In this connection, for Finland, Viren (2005) documents an inverse relationship between aggregate economic activity over the business cycle and suicide rates, and Classen and Dunn (2012) find that increases in local unemployment drive up local suicide rates in the United States. For females, our findings are more intriguing. If suicide is a response to overwhelming psychological distress whose causes can be economic or non-economic (as elaborated in the classical work of Durkheim, 1951, Book II, Chapter 5), our finding on poverty shocks and female suicides is consistent with a scenario where, first, non-economic stress factors play a more dominant role for suicides of females than males, and, second, such stress exacerbates in economically better years. For India, the former of these circumstances is supported by aggregate data on causes of female suicides according to which female suicides are relatively more often due to problems surrounding relationship, marriage, family and reproduction than male suicides.

This paper makes contributions to three strands of literature. The first one is the literature on rural welfare beyond consumption. In this regard, Deaton and Drèze (2009) and Maitra et al. (2010) document a declining calorie intake among India's rural population and deteriorating anthropometric achievements among children since the 1970s. Concerning the effect of long-term poverty reduction, Balhotra (2012) finds that different paces of poverty reduction across Indian states explain more than half of the reduction in rural infant mortality between the 1970s and 1990s. Regarding economic reforms and structural change in the process of development, Atkin (2013) estimates a negative effect of India's ongoing trade liberalization on nutritional achievements of rural households. Gruère and Sengupta (2011) find no systematic effect of the adoption of genetically modified cotton on farmer suicides in panel data from Indian states covering the years 2002 to 2007. Finally, concerning vulnerability to shocks, Burgess et al. (2011) find that excessively hot days as well as deficient rainfall during the agricultural growing season increase subsequent mortality in rural India, and Rose (1999) documents that female infants' survival is more sensitive to rainfall shocks than that of males. Within this strand of literature, our study is the first one to consider suicides as an important aspect of rural welfare by means of a rigorous econometric analysis.

Second, we make a contribution to intra-household economics and the intra-household distribution of welfare in low-income economies. A large body of literature has documented welfare asymmetries between men and women in low-income environments (see Duflo, 2012, for a survey). In this connection, several authors have established that economic shocks to a household can have important effects on intra-household consumption allocations (e.g., Bobonis, 2009; Villa et al., 2011). In addition, Duflo and Udry (2004) and Robinson (2012) suggest that insurance between spouses in response to such shocks may be far from complete. Within this literature, two recent papers are related to ours in terms of the outcomes that are considered. Using data from Indian Crime Records Bureaus similar to ours, albeit aggregated at the state rather than the district-level, Anderson and Genicot (2014) show that legislative reforms toward improved property rights for women increase both male and female suicide rates. Sekhri and Storeygard (2013) use an all-India district panel data set on crime against women and find that dowry murders increase in years of drought. Our contribution to this literature is that we document important differential effects of economic shocks and structural change on male and female suicides.

Finally, we inform a global public debate on farmer suicides in India by quantitatively identifying determinants of farmer suicides. Hence, we are able to assess various claims on the causes of surging agrarian suicides made in the popular press in India and elsewhere by econometric methods. Our major findings in this connection are twofold. First, contrary to claims in the press, we find that a shift in cropping patterns from subsistence to cash crops tends to reduce male suicides rather than increase them. Second, while most press articles have focused on only male farmers, we find important effects of economic shocks on female suicides, too.

The remainder of this paper is structured as follows. Section 2 describes our data in detail. In section 3, we outline our econometric approach and present the empirical results. The final section concludes.

2 Data

We combine data from various sources into a panel covering 62 districts in the states of Karnataka and Maharashtra for seven consecutive years, from 1998 to 2004. Our dataset includes suicide statistics from police records, consumption from household surveys, rainfall data from meteorological stations, and land use statistics from agricultural surveys. We exclude thirteen coastal districts with an average annual precipitation of more than 1,500 millimeters. This focus on the largely semi-arid interior regions of Southern India allows us to study economic stress factors in agriculture on a fairly homogeneous agro-climatic background. Hence, the sample used in our estimations comprises 49 districts. A map of the two states depicting district boundaries and long-term average rainfall is reproduced in Figure 1, and Table 10 in the appendix lists all districts included in our estimations.[3]

Data on the incidence of suicides by sex, district and year were provided by the State Crime Records Bureaus of Karnataka and Maharashtra. We restrict our attention to suicides where the profession of the victim is coded as "self-employed in farming or agriculture". We normalize the suicides recorded for a given sex, district and year by the respective number of rural inhabitants (in millions), which we calculate from the 1991, 2001 and 2011 censuses through linear interpolation.[4] We will refer to the resulting figures as "normalized female suicides" and "normalized male suicides", respectively. Sample means and standard deviations by state are set out in Table 1. Figure 2 depicts normalized male and female suicides averaged over districts for each of the two states. Suicides among male farmers are markedly more frequent than among females over the whole period covered by our data. The time series of female suicides exhibits more volatility than its male counterpart during the first four years covered by our sample. Over the same time period, female suicides were almost twice as frequent in Karnataka as in Maharashtra. In 2001, female suicides in Karnataka dropped to the Maharashtra level, followed by a gradual decline in both states.[5]

To assess the relative frequency of suicides among farmers relative to other segments of the population, we compare the share of farmer suicides in total suicides to the share of farmers in the total population. According to National Crime Records Bureau (2004) data, in 2004, there were 1,963 and 4,147 suicides among farmers, and 11,937 and 14,729 suicides in total in Karnataka and Maharashtra, respectively, which implies a share of farmer suicides in total suicides of 16.4 and 28.2 percent, respectively. According to the consumption expenditure module of the Indian National Sample Survey's 61st round, canvassed between July 2004 and June 2005, the relative frequency of being self-employed in farming as primary occupation figured at 26.1 and 20.3 percent, respectively. Hence, farmer suicides were about fifty percent more frequent among farmers than among the entire population of Maharashtra, while suicide mortality among Karnataka's farmers was smaller than among the whole state's population. According to our calculations, this latter

[3] As farmer suicides in the semi-arid areas of India's Deccan plateau, which extends over the states of Andhra Pradesh, Karnataka and Maharashtra, have received most of the media attention on this issue, we had the intention to also include Andhra Pradesh in our study. We did not succeed in obtaining district-wise suicide figures for that state, however.

[4] We would have preferred to normalize by the number of self-employed farmers. This figure is not available in India's Census, however.

[5] A detailed discussion of state-wise and all-India suicide mortality rates can be found in Gruère and Sengupta (2011).

statement also holds for earlier years covered by our data when farmer suicides were up to forty percent more frequent than in 2004. In this connection it is worth noting that Karnataka has traditionally had one of the highest total suicide mortality rates in India, ranking the state fifth among India's 35 states and Union Territories in 2004.

We now address potential concerns regarding the quality of the suicide data that we use. Regarding the issue of measurement error, Mayer (2011) argues that, due to well-specified legal stipulations governing the process of the official recording of suicides, there are no reasons to expect systematic differences in reporting across districts within a state, which implies that any remaining potential measurement errors are non-systematic. A second concern, specific to farmer suicides, is that both the inclination to commit suicide and the probability by which suicides are recorded correctly are systematically affected by government relief measures. These measures include waivers on loans and ex-gratia payments to the families of victims (Sarangi, 2010). Yet, since all such measures that we are aware of have applied uniformly to all districts of a given state, this should not bias our estimates of interest since we include state-year fixed effects in all our subsequent estimations.

Turning to suicide risk factors, our first predictor of suicides among farmers is a measure of transitory economic shocks. Toward this, we calculate consumption-based poverty statistics from the National Sample Survey Organisation's (NSSO) Consumer Expenditure Surveys. These household surveys are conducted roughly annually. Figure 4 in the Appendix depicts the timing of the canvassing periods relevant for our analysis. We use the rural sub-sample's household-level data from eight different survey rounds to calculate the poverty headcount ratio at the district level. In line with common practice (Deaton, 2008), we use the 2004 state-wise poverty lines published by India's National Planning Commission and inflate them using the consumer price index for agricultural laborers (Ministry of Labour and Employment, 1998-2004). Sample means are set out in Table 1 and Figure 3 depicts the evolution of poverty averaged over districts. Across the two states, poverty has moved roughly in parallel with the headcount ratio being about 10 percentage points lower in Karnataka over the whole period. Between 1999 and 2003, poverty remained roughly constant in both states. In 2004, subsequent to a drought and crop failure, poverty increased by about 12 percentage points. At this point, we need to discuss the extreme drop in rural poverty from 1998 to 1999 implied by the NSSO's consumption data. First, the 54th NSS round, canvassed in 1998, covered only the six months of the agricultural lean season, January to June, which are generally characterized by lower consumption levels. Second, subsequent to the NSSO's 54th survey round, there has been a change in methodology in the Consumer Expenditure Survey. In the 55th round, a different recall period for certain items was introduced, which likely resulted in higher recorded consumption expenditures - even if actual expenditures remained constant (Deaton and Kozel, 2005). In our subsequent econometric analysis, we address these complications in three ways. First, we use state-year fixed effects, which eliminates any estimation bias due to systematically higher poverty common to all districts within a state in 1998. Second, we instrument headcount poverty by rainfall, which eliminates any potential estimation biases due to non-systematic measurement error. Third, we have conducted robustness checks without the year 1998 that do not yield any qualitatively different results.

In our econometric analysis, we use rainfall as an instrumental variable for poverty. In line with common practice (e.g. Duflo and Pande, 2007), for each district and each year, we use the fractional deviation from the district's long-term average rainfall. We calculate this variable from meteorological information at the district level on annual actual and long-term average rainfall released by the Directorates of Economics and Statistics of Karnataka and Maharashtra (Directorate of Economics and Statistics, 1997-2004). Long-term average rainfall is calculated from data spanning the years 1870 to 2010. In the sequel, we will refer to this variable simply as "rain". In our sample, this variable varies between -0.65 and 1.11. According to Table 1, the mean value of rain is negative for both states and slightly smaller for Maharashtra than for Karnataka. Some districts experienced rainfall conditions below average in all years between 1997 and 2004. Rain is negative for 54 percent of the observations in Karnataka and 64 percent in Maharashtra. Hence our analysis covers a spell of deficient rainfall. Figure 3 depicts rain averaged over districts for each of the two states. While rainfall was below average in Maharashtra during most of the years covered by our data, it never fell short by more than sixteen percent relative to its long-term average. In Karnataka, the distribution of dry and wet years is more balanced, but there were two consecutive severe droughts in 2002 and 2003, where rainfall fell short by more than 25 percent.

In our econometric analysis, additional economic predictors of suicides are cropping patterns and irrigation. We have collected information on land use from India's federal Directorate of Economics and Statistics (Directorate of Economics and Statistics, 1998-2004). We use the total cropped area to calculate the share of area under different crops and the percentage of area irrigated. We pay particular attention to the area under major cash crops, especially cotton, as the movement from subsistence farming to commercial farming has been repeatedly cited as a major source of agrarian distress in the context of farmer suicides (Gruère and Sengupta, 2011). For the state of Karnataka, no land use statistics are available for the year 1999. In Maharashtra, the most common cash crops are cotton, oilseed and sugarcane. In addition to these three, tobacco is common in Karnataka. Sample means and standard deviations by state are set out in Table 1. The most important cash crop in Karnataka has been oilseed followed by cotton. The cultivation of both crops exhibits considerable variation. Whereas the area under cotton varied between four and almost nine percent over the seven years covered by our data, the share of area under oilseed dropped from 27 percent in 1998 to 20 percent in 2000, reaching again 27 percent in 2004. In Maharashtra, cotton and oilseed were equally common and the fraction of the area under each of these two crops remained relatively stable over time, at around 15 to 20 percent. Regional disparities are large, however. For example, averaged over all years, 47 percent of the cultivated area has been devoted to cotton in the eleven North Eastern districts of the Vidarbha region. The areas devoted to sugarcane and, in the case of Karnataka, tobacco have been substantially smaller. In relative terms, the area under sugarcane has been about twice as large in Karnataka than in Maharashtra. While it remained mostly stable in Maharashtra, it varied between 3.3 and 5.3 percent in Karnataka. Tobacco has mostly been cultivated in four districts of Karnataka, where it occupied a little more than nine percent of the agricultural area on average. Irrigation has been substantially more wide-spread in Karnataka than in Maharashtra. Starting at 25 percent in 1998, it rose to over 30 percent in 2004. In Maharashtra, the share of irrigated area has been relatively stable, at around fifteen percent, between 1998 and 2002. We lack information on irrigation for Maharashtra for the years 2003 and 2004. An overview of missing data is provided in Table 10 of the appendix.

Turning to the matching of the different variables, some of our data sources adhere to the Indian financial year (April to March), whereas others follow the calendar year. Figure 4 in the appendix provides an overview. The same figure also summarizes the timing of major events in agriculture. The most important crops sown are so-called *kharif* crops; meaning they are harvested in autumn. The success of the *kharif* harvest largely depends on the preceding southwest summer monsoon rains. Therefore, the timing underlying our matching of the different data sources is driven by the motive that all variables refer to the same agricultural cycle. In the subsequent statistical analysis, we also experimented with alternative matching schemes without obtaining substantially different results.

3 Econometric Analysis

3.1 Empirical Approach

To assess the effect of transitory poverty shocks and structural changes in agriculture on suicides of farmers, our main econometric specification is

$$y_{sit} = \alpha_{si} + \theta_{st} + \beta Poverty_{sit} + \delta X_{sit} + \varepsilon_{sit}, \tag{1}$$

where y_{sit} is the outcome of interest, that is, either normalized male or normalized female suicides in district i of state s during year t. The variable $Poverty$ denotes the poverty headcount ratio, X is a vector including cropping intensities and irrigation, and ε is a stochastic error term. The coefficients α_{si} and θ_{st} are district fixed effects and state-year interaction effects, respectively. We estimate (1) both by ordinary least squares and instrumental variables, where we use contemporary and lagged rainfall, and the interaction of these two as instruments for $Poverty$. When estimated by instrumental variables, the coefficient β identifies the causal effect of transitory fluctuations in poverty due to rainfall on suicides. The exclusion restriction amounts to the assumption that rain does not affect suicides except through economic factors. When we speak of a causal effect of poverty on suicides here, we are aware that individual instances of suicides have more particular causes than a shortfall in consumption, e.g. distress sales of land and associated loss in social status. Accordingly, we view fluctuations in consumption-based poverty due to rainfall shocks as a meaningful proxy for an economic shock to the lower part of the rural consumption distribution. We also estimate (1) for each of the two states separately. The exact estimation equation for this latter exercise is obtained from (1) by omitting the subscript s throughout.

We also assess the possibility that poverty shocks and structural change in agriculture have heterogeneous effects on male and female suicides. Specifically, we estimate the following regression equation, in which male and female suicides are explained jointly,

$$y_{sigt} = \alpha_{sig} + \theta_{sgt} + \beta Poverty_{sit} + \xi \mathbb{I}_{\{g=m\}} Poverty_{sit} + \delta X_{sit} + \eta \mathbb{I}_{\{g=m\}} X_{sit} + \varepsilon_{sigt}, \tag{2}$$

where the subscript g indicates the gender of the suicide victim and the indicator $\mathbb{I}_{\{g=m\}}$ equals one if the gender is male and zero otherwise. Hence, females are the reference category in this empirical specification.

3.2 Results

Table 2 presents the results of the first stage estimation, where poverty is regressed on rainfall and all other variables that are included in X in the second stage. As expected, a shortfall in precipitation, both contemporary and lagged, increases poverty. The estimated effects are large. For example, our point estimate for contemporaneous rainfall in the pooled sample of -0.118 is much larger than the -0.041 estimated by Duflo and Pande (2007) for 374 districts from all over India during the years 1973 to 1999. The point estimate of -0.263 for lagged rain in the pooled sample implies that a drought with a precipitation shortfall of twenty percentage points increases poverty by 5.2 percentage points a year later. Moreover, at least for Karnataka, the negative coefficient for the interaction term suggests that two consecutive years of drought have an even more severe effect on poverty than implied by the sum of the contemporaneous and lagged linear effects. Given the sample mean of 24 percent, the associated implied elasticity of poverty with regards to lagged rain equals about minus one. It is of some importance for the subsequent empirical analysis of suicides that, in our data, rural poverty is more dependent on the rains in the state of Karnataka than in Maharashtra, an issue which we will revisit later.

Results for (1) with male suicides as the dependent variable are set out in Table 3. According to the first three columns, in which results from ordinary least squares regressions are reproduced, the estimated effects of poverty on suicides by male farmers are positive but far from statistically significant at conventional levels. This is remarkably different for the state of Karnataka in the instrumental variables specification in column 5. According to the point estimate of 232.5, an increase in the headcount ratio of ten percent, that is 1.8 percentage points, increases the suicide rate among male farmers by 5.7 percent. This effect is significant at the ten percent significance level. We find a similar result neither for the state of Maharashtra nor for the pooled sample. Regarding structural changes in agriculture, the most robust finding we obtain from the instrumental variables estimations is a negative effect of an expansion of the area under cotton on suicides. According to the point estimate in column 4, an increase in the area under cotton of one percent is associated with a decrease in suicides of 0.65 percent.

Table 4 displays the results for estimations of (1) with normalized female suicides as the dependent variable. According to column 2, in which the results from an ordinary least squares regression for the state of Karnataka are reproduced, there is a negative effect of poverty on female suicides, which is statistically significant at the ten percent level. The sign of this effect is confirmed by the instrumental variable specification in column 5. The sign of the point estimate of -102.2 is opposite to the one estimated for males and much smaller in absolute magnitude. The implied elasticity is -1.05. Regarding structural changes in agriculture, we find no effects for any of the major crops. For tobacco, which is a minor crop and published only for the state of Karnataka, we find an implied elasticity of 0.18. We have also carried out estimations with total normalized suicides in farm households, whose results we do not report in this article for considerations of space. As expected, the pattern of results in terms of the signs of estimated effects resembles those of male suicides, where we have found much larger point estimates previously. In particular, according to an instrumental-variables estimation for the state of Karnataka, an increase in the poverty headcount ratio by one percentage point increases total normalized suicides by 68.6. With a standard error of 72.6, this effect is not statistically significant, however. For cotton in Maharashtra, from an instrumental-variables estimation we obtain a point estimate of -236.9 (standard error 126.1), which is significant at the ten percent level.

In our view, the most interesting findings of the preceding analysis are the effects of transitory poverty shocks on suicides of male and female farmers. To summarize, we have found opposite effects of similar relative magnitude, whose direction is as expected for males and opposite for females. To assess whether the difference between the male and female effects is statistically significant, we estimate (2) by instrumental variables. The results are reported in Table 5. Notice that females are the reference group in the parameterization implicit in (2). According to the results for the state of Karnataka (column 2), the difference of 334.7 is statistically significant at the one percent significance level. Moreover, the point estimate for females of -102.2 is significant at the five percent significance level in this specification.

In addition to the differences between males and females, the difference in effects across the two states in our sample, in particular with respect to transitory economic shocks, is remarkable. In this connection, it is important that the variability of rainfall and poverty differed systematically across these two states during the time period covered by our data. Given that our state-wise sub-samples are small, the resulting differences in power for a test of the hypothesis $\beta = 0$ are likely substantial. To investigate this phenomenon in more detail, for each state, we regress rain on district and year dummies. The root mean squared error of this regression, which is a measure of the "within-variation" of rainfall, is set out in Table 6. According to this measure, rainfall has been 38 percent more variable in Karnataka than in Maharashtra (columns 2 and 3). A second issue of importance is to what extent these rainfall fluctuations have systematically translated into poverty fluctuations. In this context, it is remarkable that the effects of contemporaneous and lagged rainfall on poverty are twice as large for Karnataka as for Maharashtra (Table 2, columns 2 and 3). This implies that Maharashtra's poor were substantially better protected from the economic consequences of droughts. While our analysis cannot elicit the channels, the government of this state has been an active proponent of social protection policies, of which the best-known is probably the Maharashtra Employment Guarantee Scheme (Datt and Ravallion, 1994). Similar to India's current National Rural Employment Guarantee Act, the scheme has provided flexible work opportunities on public construction sites since 1979. In 1997 alone, under this scheme over ninety million person days of work were performed by Maharashtra's rural inhabitants (Gaiha and Imai, 2005), which corresponds to a little less than two person-work-days per rural inhabitant.

In line with the just-discussed findings on rainfall variability and the sensitivity of poverty to rainfall fluctuations, we also find that the within-variation of the headcount ratio is noticeably smaller for Maharashtra, 0.49 compared to 0.63 in Karnataka (columns 2 and 3 of Table 6). If we take into account the higher average level of poverty in Maharashtra, 28% compared to 18%, we arrive at a coefficient of variation which is only half of that obtained for Karnataka. Taken together, these patterns are likely one driver of the differences in the first stage results set out in Table 2, where the F-statistic for Karnataka is twice as large as for Maharashtra. This is despite the fact that the latter state has forty percent more districts in our estimations. To summarize, our findings on state-specific differences regarding the variability of poverty and the responsiveness of suicide rates to transitory poverty shocks are compatible with a scenario where social protection policies for rural inhabitants were more effective in Maharashtra than in Karnataka.

Our finding that male suicides increase in years of economic distress is in line with the case-study based evidence in Mishra (2006), Sridhar (2006), and Mohanakumar and Sharma (2006). Similar patterns have also been documented in studies of suicides in high-income countries. For Finland, Viren (2005) documents an inverse relationship between aggregate economic activity over the business cycle and suicide rates. For the United States, Classen and Dunn (2012) find that increases in local unemployment tend to increase local suicide rates. Perhaps because of lower incidence rates, development researchers have paid less attention to female suicides in rural India. Although our reduced-form empirical approach does not allow us to shed light on the particular mechanisms that drive up female suicides in economically better years, in our view a plausible explanation for this pattern is that, first, suicides of women in farm households are, to an important extent, driven by psychological distress which is not immediately economic and, second, that such distress exacerbates in economically better years. While we were not able to find empirical evidence on the relationship implicit in the second statement, there is evidence for the first in the context of India in general and the state of Karnataka in particular. According to the 2012 Report on Accidental Deaths and Suicides in India (National Crime Records Bureau, 2013), which lists causes of suicides by sex of the victim, the Karnataka police recorded 8,596 and 4,157 suicides by males and females in total. Among males, the cause can be classified economic or related to social status in nine percent of all cases, which compares to only five percent among females.[6] On the other hand, causes surrounding love, marriage and reproduction account for 7.9 percent of female and only 3.5 percent of male suicides.[7]

Our empirical finding for female suicides is interesting to compare to that of Sekhri and Storeygard (2013), who use a panel comprising all districts in India and find that droughts increase dowry murders committed against women. While female suicide and dowry violence may be related, we view suicide as an expression of self-perceived distress and dowry violence as stress produced by a woman's immediate environment. Moreover, female suicides in our sample are five times as frequent as dowry deaths in Sekhri and Storeygard's (2013) data set.

We conclude our main empirical analysis with simple cross-sectional regressions of the form

$$\overline{y}_{si} = \alpha_s + \beta \overline{Poverty}_{si} + \delta \overline{X}_{si} + \epsilon_{si}, \tag{3}$$

where $\overline{Z}_{si}$ denotes the average of the variable z_{sit} over all values of t for which observations are available. In the language of panel data econometrics (Wooldridge, 2010), (1) and (3) yield within and across-estimators, respectively, of the coefficients β and δ. According to Table 9, the only marginally significant conditional cross-sectional correlation is the one between poverty and male suicides in the pooled sample, which is negative. In other words, suicides among male farmers are relatively less frequent in poorer districts. This empirical relationship mirrors Jungeilges and Kirchgässner's (2002) finding that per-capita GDP and middle-age suicides are positively correlated in a cross-section of thirty high and middle-income countries. In our view, the second interesting, albeit insignificant correlation, is between cotton and male

[6] We classified the following causes in this category: Bankruptcy or Sudden Change in Economic Status, Fall in Social Reputation, Poverty, Professional Problems, Property Dispute, Unemployment.

[7] We classified the following causes in this category: Illicit Relation, Not Having Children, Death of Dear Person, Dowry Dispute, Divorcee, Illegitimate Pregnancy, Love Affairs.

suicides. According to the point estimate in column 1, when an additional one percent of the cultivated area is dedicated to cotton, male suicides are 1.4 percent more frequent on average. This finding is in line with existing writings on cotton cultivation and farmer suicides, where higher suicide rates in cotton-growing locations have been taken as an indication for the immizerizing effect of this crop on rural livelihoods (e.g. Mishra, 2006). In contrast, our within-estimation result on cotton and suicides of male farmers suggests that an expansion of the area under cotton comes together with fewer suicides suggesting that the positive cross-sectional correlation is driven by time-invariant factors other than, but correlated with, cotton cultivation.

3.3 Robustness Checks and Extensions

3.3.1 Instrumental-Variables Approach

The F-statistics in our first-stage regressions are low, 3.3 for Karnataka and only 1.6 for Maharashtra (Table 2, columns 2 and 3). Evidently, this is primarily due to the small number of observations since, according to the first-stage results in Table 2, rainfall, both contemporaneous and lagged, is an important and significant predictor of poverty. Since inference based on instrumental-variables estimations is exact only in large samples and known to suffer from sometimes severe biases in small samples, in this subsection we assess the sensitivity of our instrumental-variables results to changes in the econometric specification. As suggested by Angrist and Pischke (2009) when the F-statistic is smaller than ten, we first run a just-identified instrumental-variables regression. Using lagged rain as the only instrument, we obtain a first-stage F-statistic of 8.9 for the pooled sample and 5.4 for Karnataka.[8] The second stage results are qualitatively unchanged, albeit, for Karnataka the effect of poverty on male and female suicides is now statistically insignificant at conventional levels (the T-statistics equal 1.55 and -1.62 for males and females, respectively). Second, we conduct limited-information maximum likelihood estimations with the same set of instruments as in our main estimations. As with the just-identified instrumental variables estimation, the pattern of the second-stage results remains unaltered. Moreover, for Karnataka, the point estimates of the effect of the headcount ratio of 241.5 and -82.21 for males and females, respectively, are significant at the ten percent and five percent significance level, respectively. We take these findings as evidence for the robustness of our previous instrumental-variables results.

[8] For considerations of space, we do not report the full set of results in this article.

3.3.2 Missing Observations

Table 10 in the appendix shows that the data used in our main estimations are mostly from 2000 to 2004 for Karnataka and exclusively from 1998 to 2002 for Maharashtra. This is primarily due to missing data for cropping patterns and irrigation. In contrast, data on poverty, precipitation, and suicides are available for all seven years and almost all districts. We hence run ordinary least squares and instrumental-variables estimations of (1) without the vector of explanatory variables X. Turning to the results of this exercise, which we do not report in full in this article for considerations of space, compared to Table 3, the sign of β's point estimate is the same across all six subsamples in this parsimonious specification. Corresponding to the first entry in column 5 of Table 3 (instrumental-variables regression with male farmer suicides as dependent variable for Karnataka), we obtain a point estimate of 195.0 and a standard error of 187.7. Regarding female suicides in Karnataka, instead of -33.64 (second column of Table 4), the parsimonious specification yields -33.29 and a standard error of 15.79. When estimated with instrumental variables, we now obtain -74.0 and a standard error of 61.6 rather than -102.2 and 56.1 as reported in Table 4. With the parsimonious specification explored here, there are 99 and 166 observations for Karnataka and Maharashtra, respectively.

The parsimonious and our original specification yield results that are qualitatively identical and quantitatively similar. On the other hand, the former are characterized by noticeably larger standard errors when estimated by instrumental variables, which is likely due to the increase in unobserved heterogeneity arising from the omission of regressors. In summary, while the parsimonious specification does not replicate the statistical significance of the instrumental-variables results for Karnataka, we view the analysis of this subsection as a confirmation of our main results.

3.3.3 Alternative Measures of Economic Shocks

We also consider two alternative measures of economic shocks. In lieu of the poverty headcount ratio we use average monthly per capita consumption expenditures and average logarithmic monthly per capita consumption in an estimation of (1). The former is the mean of the distribution of consumption among the rural population while the latter can be viewed as a utilitarian welfare measure, which is relatively more sensitive to changes in the lower part of the distribution. The headcount ratio, in comparison, focuses exclusively on that distribution's left tail. The results of instrumental-variables regressions of (1) with average monthly per capita consumption expenditures substituted for

$Poverty_{sit}$ are set out in Table 7. Analogous to our previous findings, the estimate of β is negative for males and positive for females for the state of Karnataka. While the elasticities implied by the coefficient estimates, -0.742 and 0.276, are large and equal 4.8 and 7.6, these point estimates are imprecisely measured and fail to be statistically significant at conventional levels. According to Table 8, with average logarithmic monthly per capita consumption expenditures as explanatory variable, the T-statistics for the headcount ratio are a little larger but still not significant at conventional levels. In summary, we conclude that, as far as the effect of economic shocks on suicides is concerned, changes in the lower part of the consumption distribution, as captured by the poverty headcount ratio, have the greatest predictive power for the suicide risk among farmers when economic shocks are concerned.

3.3.4 Additional Predictors of Farmer Suicides

In addition to income shocks, cropping patterns and irrigation, we have considered further explanatory variables, including output prices and agricultural credit. With regards to the former, we were not able to collect a satisfying number of observations at the district level. With regards to the latter, for all our subsamples, we did not find any mentionable effect and have chosen not to report the results in detail here.

4 Concluding Remarks

Farmers around the globe have high suicide rates relative to other professions (Judd et al., 2006). High levels of economic stress due to various sources of risk in agriculture and the rapid pace of structural change have previously been stated as reasons for this phenomenon (World Bank, 2007). The fact that these two features are especially pervasive in the agricultural sector of low-income countries has motivated our econometric study of farmer suicides in India. In addition, this issue has received broad media attention around the globe, where it is often taken as a manifestation of the destitute situation of poor farmers in the wake of globalization.

In this study, we have analyzed novel, district-wise data on suicides in farm households in two major Indian states during the years 1998 to 2004. Our estimation results differ markedly across the two states. For the state of Karnataka, where rainfall and rural poverty were especially variable, we have found that transitory poverty shocks due to a lack of rainfall cause suicides among male farmers to rise sharply. For females, we have found an intriguing opposite, albeit quantitatively smaller, effect. We have found no such effects for the state of Maharashtra, for which our econometric findings suggest that rural social protection policies were more effective. On the other hand, mostly driven by the state of Maharashtra, we have found that an expansion of cotton cultivation, which is a much-debated cash crop in India's South, is associated with fewer suicides among male farmers, while the cross-sectional correlation between these two variables is positive.

Even though suicides are relatively rare events, in our view they are an essential facet in a comprehensive assessment of economic development and rural welfare for two reasons. First, the relative frequency of suicides is an objective quantitative measure of the prevalence of extreme individual distress. Second, unlike a transitory shock to household income, a suicide is irreversible. In this perspective, our study documents the vulnerability of India's rural populations at the beginning of the current millennium from a different than the usual consumption or income-based poverty angle and underscores the need for rural development policies that are geared towards protection against various sources of risk rather than just aggregate growth.

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Figure 1: Sample Districts and Long-term Average Rainfall (in millimeters)

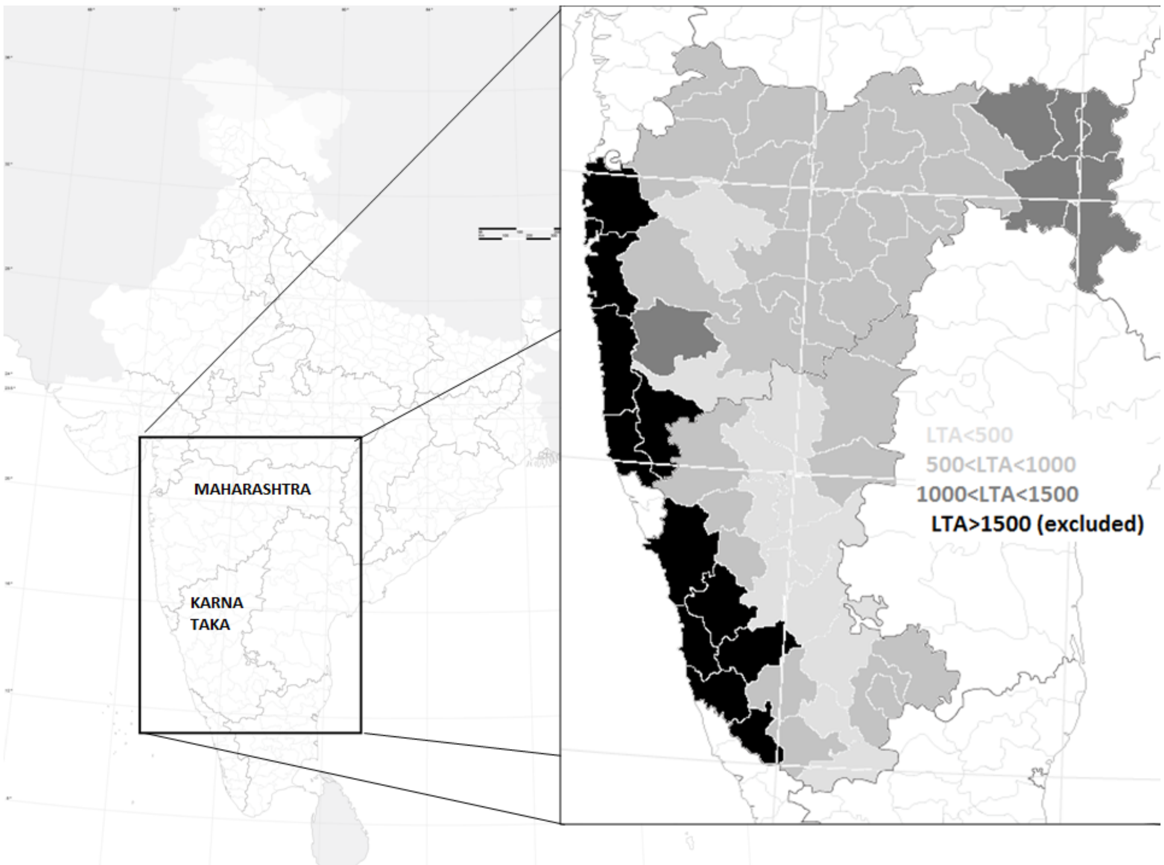

Figure 2: Normalized Suicides

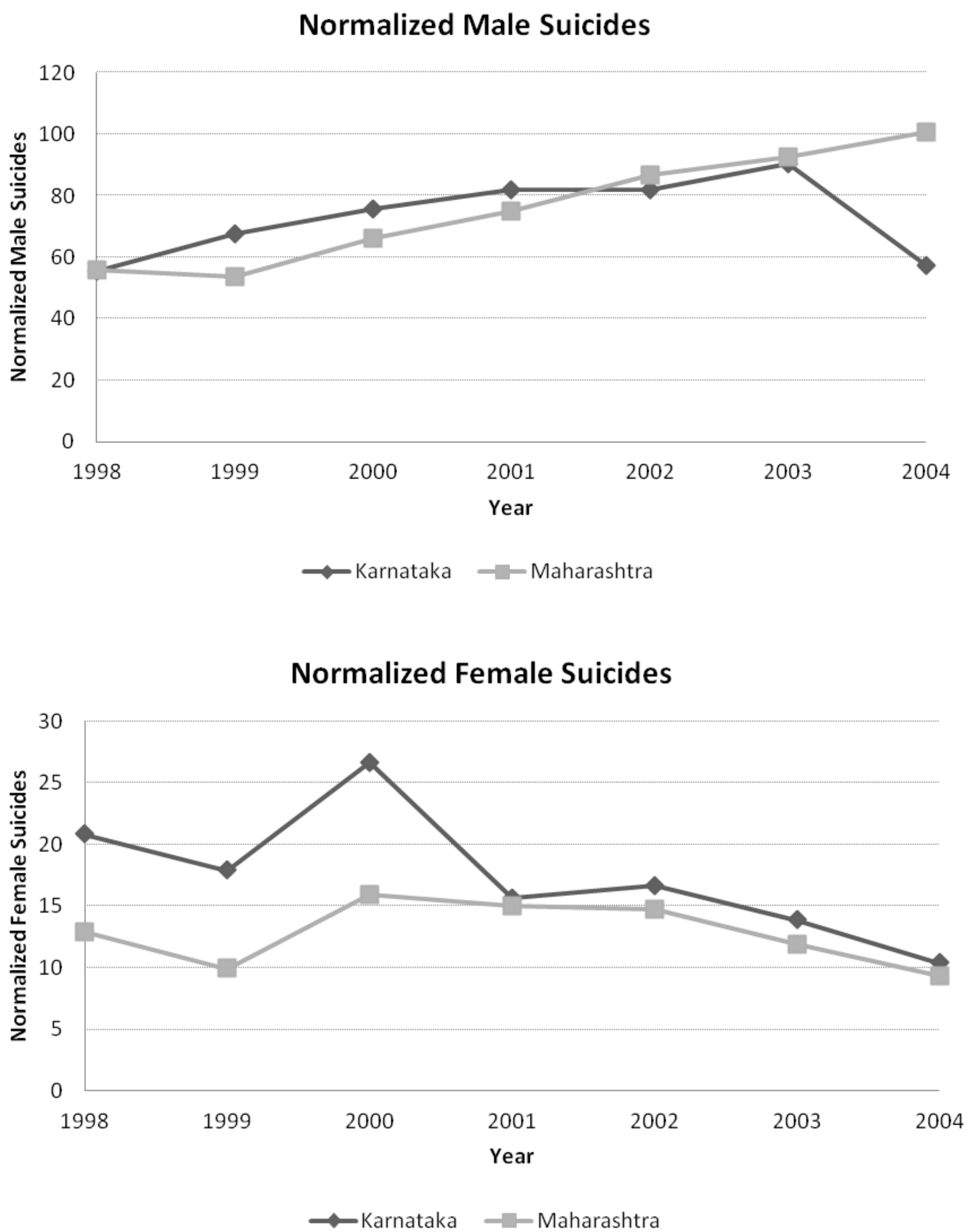

Figure 3: Poverty and Rainfall (State Averages)

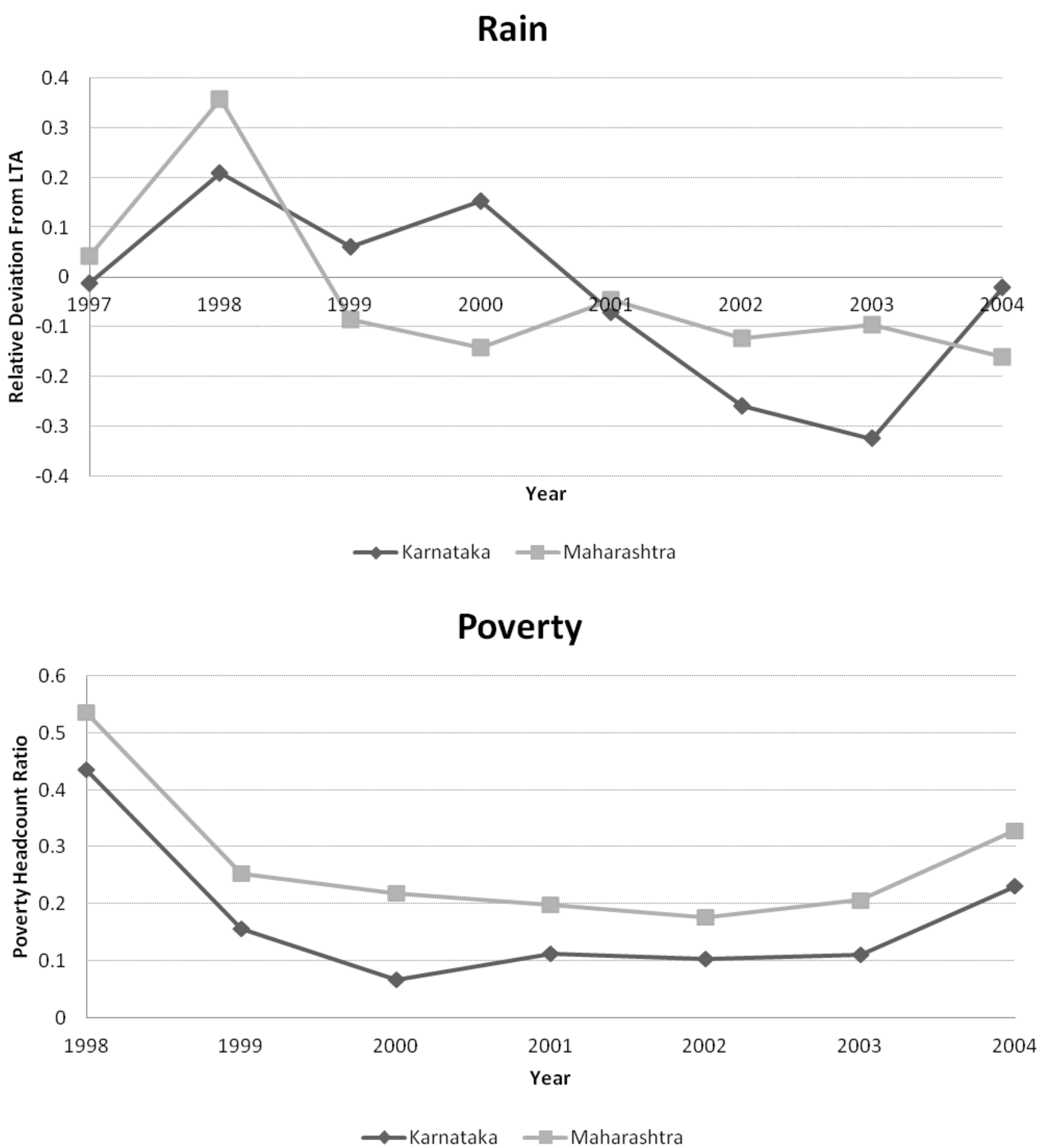

Table 1: Descriptive Statistics

Variable	*Full Sample*	*Karnataka*	*Maharashtra*
Suicides (normalized)	45.37	45.71	45.12
	(36.3)	(37.17)	(35.72)
Male Suicides (normalized)	74.56	72.93	75.78
	(59.22)	(55.66)	(61.87)
Female Suicides (normalized)	14.75	17.48	12.7
	(21.87)	(26.2)	(17.77)
Poverty Headcount Ratio	0.24	0.18	0.28
	(0.19)	(0.17)	(0.19)
Monthly Per-capita Consumption	483.03	477.28	486.48
Expenditure	(129.02)	(116.32)	(136.26)
Logarithmic Monthly Per-capita	6.14	6.14	6.15
Consumption Expenditure	(0.27)	(0.25)	(0.28)
Rain	-0.04	-0.03	-0.05
	(0.26)	(0.25)	(0.27)
Food Grains	0.65	0.64	0.65
	(0.16)	(0.15)	(0.16)
Oilseed	0.19	0.25	0.16
	(0.13)	(0.15)	(0.1)
Cotton	0.12	0.05	0.17
	(0.14)	(0.07)	(0.15)
Sugarcane	0.03	0.04	0.02
	(0.04)	(0.06)	(0.02)
Tobacco		0.01	
		(0.03)	
Irrigation	0.23	0.31	0.15
	(0.13)	(0.12)	(0.08)

Means, standard deviations in parentheses. Normalized male suicides and normalized female suicides are the share of male and female farmer suicides in 1,000,000 rural male and female inhabitants, respectively. Poverty headcount ratio is the share of the rural population with monthly per-capita consumption less than India's national poverty line. Rain is the fractional deviation from long-term average rainfall. Food grains, oilseed, cotton, sugarcane, tobacco, and irrigation are the shares of area under the respective crop or irrigation in total cultivated area, respectively. Data sources: State Crime Records Bureaus of Karnataka and Maharashtra for suicides; National Sample Survey (various years) for poverty headcount ratio; Planning Commission (2007) for poverty lines; Ministry of Labour and Employment (various issues) for CPIAL; Directorates of Economics and Statistics of Karnataka and Maharashtra (various issues) for rain; Directorate of Economics and Statistics (various issues) for food grains, oilseed, cotton, sugarcane, tobacco, and irrigation. Refer to Section 2 of the text for further details on data sources and variable construction.

Table 2: Predictors of Rural Poverty

Dependent Variable: Poverty Headcount Ratio			
	Full Sample	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)
Rain	-0.118	-0.240*	-0.126
	(0.0720)	(0.134)	(0.0870)
Rain (lag)	-0.263***	-0.359**	-0.170**
	(0.0836)	(0.134)	(0.0880)
Rain × Rain (lag)	-0.120	-0.248	0.00533
	(0.204)	(0.309)	(0.278)
Cotton	0.195	-0.662	0.00392
	(0.505)	(0.662)	(0.802)
Oilseed	0.418	0.733	-0.875
	(0.371)	(0.510)	(1.005)
Sugarcane	-2.238*	-1.781	-11.36***
	(1.384)	(1.344)	(3.750)
Tobacco		0.855**	
		(0.359)	
Irrigation	-0.130	-0.278	1.225
	(0.223)	(0.249)	(0.823)
Observations	186	71	106
F-Statistic for Joint Significance of Rain Terms	3.41	3.29	1.58

Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Specification 1 includes district and state-year fixed effects. Specifications 2 and 3 include district and year fixed effects.

Table 3: Regression Analysis of Suicides by Male Farmers

Dependent Variable: Normalized Male Suicides						
Estimation Method:	Ordinary Least Squares			Instrumental Variables		
	Full Sample	*Karnataka*	*Maharashtra*	*Full Sample*	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)	(4)	(5)	(6)
Poverty Headcount Ratio	-0.110	-33.92	-9.834	95.86	232.5*	-29.97
	(19.52)	(46.52)	(18.95)	(66.77)	(134.2)	(95.98)
Cotton	-339.9*	-53.82	-469.6*	-400.7**	-25.15	-466.6**
	(196.9)	(215.3)	(234.5)	(188.3)	(216.2)	(228.9)
Oilseed	-150.0*	-204.7**	189.4	-178.7	-337.6*	169.7
	(77.41)	(79.82)	(246.9)	(117.8)	(183.1)	(238.8)
Sugarcane	204.6	590.3*	-2599.4***	396.5	760.5*	-2853.3*
	(381.9)	(318.3)	(806.4)	(350.3)	(418.9)	(1547.3)
Tobacco		70.85			-134.4	
		(140.1)			(309.6)	
Irrigation	103.0	87.00	272.7*	101.6	104.6	301.3
	(99.22)	(126.2)	(157.1)	(84.03)	(99.37)	(202.7)
Observations	186	71	106	186	71	106

Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Specifications 1 and 4 include district and state-year fixed effects. Specifications 2, 3, 5 and 6 include district and year fixed effects. Instruments for Poverty Headcount Ratio are contemporaneous and lagged Rain as well as the interaction of those two.

Table 4: Regression Analysis of Suicides by Female Farmers

Dependent Variable: Normalized Female Suicides						
Estimation Method:	Ordinary Least Squares			Instrumental Variables		
	Full Sample	*Karnataka*	*Maharashtra*	*Full Sample*	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)	(4)	(5)	(6)
Poverty Headcount Ratio	-5.355	-33.64*	10.74	-12.05	-102.2*	35.46
	(9.653)	(17.45)	(10.61)	(26.44)	(56.09)	(48.60)
Cotton	32.49	10.99	10.46	36.73	3.613	6.736
	(57.86)	(62.72)	(97.31)	(59.19)	(79.38)	(76.10)
Oilseed	-6.776	11.44	27.75	-4.768	45.65	51.93
	(56.43)	(58.09)	(129.9)	(53.20)	(71.63)	(105.0)
Sugarcane	12.92	-89.68	287.3	-0.465	-133.5	599.0
	(106.7)	(109.6)	(567.5)	(105.2)	(149.2)	(791.6)
Tobacco		272.4***			325.2***	
		(72.20)			(104.5)	
Irrigation	5.138	-36.69	-18.82	5.230	-41.21	-53.93
	(40.60)	(30.61)	(99.43)	(36.85)	(36.96)	(116.4)
Observations	186	71	106	186	71	106

Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Specifications 1 and 4 include district and state-year fixed effects. Specifications 2, 3, 5 and 6 include district and year fixed effects. Instruments for Poverty Headcount Ratio are contemporaneous and lagged Rain as well as the interaction of those two.

Table 5: Joint Analysis of Suicides by Female and Male Farmers

Dependent Variable: Normalized Suicides			
Estimation Method: Instrumental Variables			
	Full Sample	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)
Poverty Headcount Ratio	-12.05	-102.2**	35.46
	(23.64)	(49.81)	(43.21)
Poverty Headcount Ratio× Male	107.8*	334.7***	-65.00
	(64.21)	(129.1)	(95.52)
Cotton	36.72	3.613	7.013
	(52.97)	(70.50)	(67.71)
Oilseed	-4.793	45.65	52.12
	(47.60)	(63.62)	(93.46)
Sugarcane	-0.600	-133.5	600.8
	(94.24)	(132.5)	(706.0)
Tobacco		325.2***	
		(92.80)	
Cotton × Male	-437.0**	-28.76	-474.3**
	(176.6)	(204.5)	(214.9)
Oilseed × Male	-173.8	-383.3**	117.6
	(115.7)	(174.6)	(232.0)
Sugarcane × Male	397.8	894.0**	-3452.3**
	(327.3)	(394.9)	(1548.9)
Tobacco × Male		-459.6	
		(290.2)	
Irrigation	5.128	-41.21	-54.25
	(32.96)	(32.82)	(103.4)
Irrigation × Male	96.74	145.8	355.4*
	(82.11)	(94.16)	(207.6)
Male	303.8***	117.8	351.3***
	(87.27)	(76.46)	(118.5)
Observations	372	142	212

Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Specification 1 includes district and state-year fixed effects. Specifications 2 and 3 include district and year fixed effects. Instruments for Poverty Headcount Ratio are contemporaneous and lagged Rain as well as the interaction of those two.

Table 6: Variability of Rainfall and Poverty

	Full Sample	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)
Rain			
Within-Variation	0.51	0.63	0.43
Poverty Headcount Ratio			
Within-Variation	0.54	0.63	0.49
Mean	0.24	0.18	0.28
Coefficient of Variation	2.25	3.50	1.75
Observations	339	145	194

In column 1, Within-Variation is the root-mean-squared error of a regression of the outcome variable (rain and the poverty headcount ratio, respectively) on district and state-year fixed effects, and on district and year fixed effects in columns 2 and 3. The coefficient of variation is calculated as Within-Variation devided by Mean.

Table 7: Regression Analysis of Suicides by Female and Male Farmers with Average District Consumption

Estimation Method: Instrumental Variables						
Dependent Variable:	Normalized Male Suicides			Normalized Female Suicides		
	Full Sample	*Karnataka*	*Maharashtra*	*Full Sample*	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)	(4)	(5)	(6)
Monthly Per-capita	-0.398	-0.742	0.376	0.0340	0.276	-0.0946
Consumption Expenditure	(0.781)	(0.760)	(0.912)	(0.225)	(0.281)	(0.305)
Cotton	-510.5	-147.9	-292.0	43.67	50.94	-32.99
	(380.7)	(357.2)	(515.9)	(109.9)	(148.6)	(162.6)
Oilseed	-147.3	-161.1	205.7	-8.615	-27.84	15.55
	(128.7)	(204.6)	(340.7)	(52.59)	(83.64)	(105.7)
Sugarcane	145.6	467.3	-2651.2**	28.69	-14.41	196.2
	(386.3)	(480.0)	(1203.9)	(90.73)	(161.6)	(462.7)
Tobacco		51.98			243.8	
		(404.4)			(185.9)	
Irrigation	100.2	102.5	322.7	5.299	-39.41	-19.67
	(97.79)	(158.6)	(249.3)	(36.95)	(51.58)	(93.99)
Observations	186	71	106	186	71	106

Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Specifications 1 and 4 include district and state-year fixed effects. Specifications 2, 3, 5 and 6 include district and year fixed effects. Instruments for Poverty Headcount Ratio are contemporaneous and lagged Rain as well as the interaction of those two.

Table 8: Regression Analysis of Suicides by Female and Male Farmers with Logarithmic Consumption

Estimation Method: Instrumental Variables						
Dependent Variable:	Normalized Male Suicides			Normalized Female Suicides		
	Full Sample	*Karnataka*	*Maharashtra*	*Full Sample*	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)	(4)	(5)	(6)
Logarithmic Monthly Per-capita	-218.0	-263.3	107.9	26.97	95.16	-32.42
Consumption Expenditure	(225.3)	(212.8)	(285.4)	(66.24)	(81.67)	(109.6)
Cotton	-539.3*	-116.7	-369.0	53.76	38.65	-18.63
	(286.3)	(279.5)	(324.7)	(85.00)	(117.1)	(119.8)
Oilseed	-181.9	-218.0	227.3	-4.436	-6.664	8.733
	(143.5)	(170.5)	(300.3)	(54.70)	(69.54)	(111.8)
Sugarcane	351.6	648.9	-3018.2*	5.474	-81.52	315.1
	(382.3)	(403.8)	(1822.8)	(101.6)	(123.9)	(744.2)
Tobacco		4.581			261.0*	
		(314.4)			(143.4)	
Irrigation	87.41	74.77	317.7	6.988	-29.24	-21.31
	(97.71)	(123.9)	(225.0)	(37.37)	(39.57)	(101.4)
Observations	186	71	106	186	71	106

Robust standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Specifications 1 and 4 include district and state-year fixed effects. Specifications 2, 3, 5 and 6 include district and year fixed effects. Instruments for Poverty Headcount Ratio are contemporaneous and lagged Rain as well as the interaction of those two.

Table 9: Cross-Sectional Correlations

Dependent Variable:	Normalized Male Suicides			Normalized Female Suicides		
	Full Sample	*Karnataka*	*Maharashtra*	*Full Sample*	*Karnataka*	*Maharashtra*
	(1)	(2)	(3)	(4)	(5)	(6)
Actual rainfall (log)	-29.76	4.917	-1.002	-8.502	58.64	-8.854
	(33.59)	(122.3)	(51.69)	(13.29)	(53.04)	(16.47)
Poverty Headcount Ratio	-168.4*	-130.0	-263.7	-25.59	-35.28	-54.58
	(96.00)	(194.8)	(151.0)	(38.00)	(84.51)	(48.09)
Cotton	107.6	-165.5	57.09	19.50	-80.58	8.070
	(74.89)	(234.3)	(146.8)	(29.64)	(101.6)	(46.77)
Oilseed	42.85	181.0	-142.0	0.958	95.07	-59.23
	(74.08)	(179.0)	(163.4)	(29.32)	(77.63)	(52.04)
Sugarcane	-44.18	-29.53	-709.7	-98.20	-101.0	-468.4
	(226.8)	(294.5)	(1053.0)	(89.75)	(127.7)	(335.4)
Tobacco		495.3			94.79	
		(412.0)			(178.7)	
Irrigation	-23.59	-4.159	-52.45	-26.89	-0.842	0.455
	(112.4)	(180.9)	(219.7)	(44.49)	(78.49)	(69.98)
Constant	279.5	9.504	194.2	89.09	-378.7	109.7
	(218.0)	(859.7)	(322.1)	(86.29)	(372.9)	(102.6)
Observations	186	71	106	186	71	106

Robust standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Specifications 1 and 4 include state fixed effects.

Appendix

Table 10: Data Availability

Year	1998	1999	2000	2001	2002	2003	2004
Karnataka							
Bagalkot							
Bangalore Rural			x	x		x	x
Bangalore Urban			x	x	x	x	x
Belgaum			x	x	x	x	x
Bellary			x	x	x	x	x
Bidar	x		x	x	x	x	x
Bijapur	x		x	x	x	x	x
Chamarajanagar							
Chitradurga			x	x	x	x	x
Davanagere							
Dharwad					x	x	x
Gadag							
Gulbarga	x		x	x	x	x	x
Hassan			x	x			
Haveri							
Kolar	x		x	x	x	x	x
Koppal							
Mandya	x		x	x		x	x
Mysore			x	x		x	x
Raichur				x	x	x	x
Tumkur			x	x	x	x	x
Total	5	0	13	14	11	14	14
Maharashtra							
Ahmednagar	x	x	x	x	x		
Akola	x	x	x	x	x		
Amravati	x	x	x	x	x		
Aurangabad	x	x	x	x	x		
Beed	x	x	x	x	x		
Bhandara							
Buldhana	x	x	x	x	x		
Chandrapur	x	x	x				
Dhule	x	x	x	x	x		
Gadchiroli							
Gondia							
Hingoli							
Jalgaon	x	x	x	x	x		
Jalna	x	x	x	x	x		
Latur	x	x	x	x	x		
Nagpur	x	x	x	x	x		
Nanded	x	x	x	x	x		
Nandurbar							
Nashik	x	x	x	x	x		
Osmanabad	x	x	x	x	x		
Parbhani	x	x	x	x	x		
Pune	x	x	x	x	x		
Sangli	x	x	x	x			
Satara	x	x	x	x			
Solapur	x	x	x	x	x		
Wardha	x	x	x	x	x		
Washim							
Yavatmal	x	x	x	x	x		
Total	22	22	22	21	19	0	0

"x" denotes data availability for all variables for a given year and district.

Figure 4: Data Matching