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Keywords: Kalman Filter, Inequality, Prices, Neighborhood, Panel

JEL Code: O12, D12, D31

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1 Introduction

In this paper we look at the prices prevailing in the food grain market in Uttar-Pradesh, India, through the lens of inequality. The issue of increase in inequality in India is one that has been increasingly scrutinized over the past several years. This is primarily because India like many other regions in the world has experienced some increase in the level of inequality[1]. Apart from ethical reasons, increase in income inequality is a concern because its prevalence has lead to inequality in other dimensions like education, health etc.[2] Even more worrisome is the fact that it has marginalised people who are already poor because of its affect on how market functions. Thus inequality not only has a social phenomenon but also has an economic dimension attached to it. The question is whether inequality pushes poor people futher to the fringes as they are priced out? Or are poor people better-off as presence of rich implies higher purchasing power which attracts more firms and competition which brings down the price? These are the kind of questions which we seek to answer in this paper.

Moving around different regions of a country like India, where there is so much variation with respect to income one can see the way markets respond to peoples demands. Down the street from a road in a city which is surrounded by large sparse of poor neighborhood are all kinds of retail shops and at a distance of a few kilometers is a mall. This reflects that what people demand in certain ways depends on their income but what they eventually receive depends on the way they are geographically organised. Where malls have shied away due to high rentals and low-income population, these small shops have kept their costs low by building small capacities at a price point that provides value in such markets. From the firms perspective the criteria always has been profitability which depends on the paying capacity of the end user. People no longer need to travel few kilometers to these malls to buy goods. This however comes at the cost of quality. The story is very different for the people with the same level of income, residing in a relatively rich locality some distance from this poor neighborhood. Even though the availability of goods and services is guaranteed, the high price makes them unaffordable. Hence, the role played by the economic ghettos in explaining an individuals well-being could be striking. This very much explains how the kind of neighborhood a person stays in affects their buying potential and quality of life.

[1]There is strong empirical evidence showing that there has been increase inequality in the recent past; see, for example, Azam and Shariff (2011), Daumal (2010), Chikte (2011).

[2]Rowlingson (2011) summarises the impact of inequality on health.

The aim of the paper is to focus on the functional inequality by examining the relationship between inequality and price. So far, the literature on the relationship between income inequality and its cost to poor has focused on two main research topics: on one side it has looked at the increase in cost to poor because of their income constraint[3] and the other side has looked at the relative increase in the cost to poor because of their different preference structure relative to rich [4]. The focus of our paper is to look at the impact of inequality directly on the prices [5]. In this paper, we look at the impact of inequality in small neighborhoods on the prices. As the data on individual Gini coefficient is missing, all evidence collected by literature related to inequality is based on Gini coefficient across different nations. This represents a major shortcoming as researchers are not able to investigate the role of local inequality. Infact, the national level data obscures the impact of inequality in the confined neighborhood[6]. Thus the main aim of this research is to improve upon the existing literature on two aspects. First, we use data on regional Gini coefficient over the period of more than 20 years for three regions of Uttar Pradesh. This helps us to investigate how the Gini coefficient evolves over the period of time. Second, our analysis is based on the actual price data and is not inferred on the basis of expenditure[7]. This also helps us to control for the quality.

For this reason we try to see how the price of food grains respond to inequality in the three districts in Uttar Pradesh over the period of time[8]. In this study we are interested in measuring the consequences of the income distribution on the price of food grains. We use wholesale wheat prices on Dara quality compiled and maintained by Department of Economics and Statistics of the Ministry of Agriculture, Government of India (DES-MOA, GOI) for the purpose of our analysis. This is weekly data and is available for the period 2006-2010. Data on income distribution comes from different rounds of National Sample Surveys (NSS) collected for different state regions of India from the period 1983 to 2012. We use Kalman

[3]Frankel and Gould (2000) summarizes the main reasons for the increase in price with increase in inequality. These reasons could be lack of storage capacity, limited budget etc.

[4]Chakrabarty, Majumder and Ray (2012)

[5]Broda and Romalis(2009) and Bergh and Nilsson (2012) have looked at the impact on inequality on the prices of products poor people buy.

[6]For instance major studies like Daumal(2010), Sperling and Hansen(2012) which look at the impact of inequality on various dimensions work at either at state level or national level and that too is limited to cross-sectional analysis.

[7]Unlike in the paper by Mishra and Ray(2011)

[8]As reported in Majumder, Ray and Sinha (2012), there are large and significant spatial differences in the individual's level of income in India, implying that there may lot of regional variations in inequality.

filter to convert the annual series to monthly series.

It is interesting to speculate how the distribution of income affects market prices. The link between inequality and prices is perhaps more robust in poorer countries. We find an inverted-U shape relationship between price and income inequality: if we compare a cross-section of societies, then initially price level increases as income gap widens but then it tapers off. The rationale is as follows; a rise in income of people raises the demand upward, and also increases the willingness to pay leading to a price rise as supply cannot respond instantaneously. Rising prices typically induce either people to shift to consumption of other varieties or increases the supply of new varieties. The supply of new varieties or other sources of consumption will make prices resettle at a new equilibrium. Thus, there are price corrections over time.

The rest of the paper is organized as follows. Section 2 presents an overview of the literature on the relationship between Gini coefficient and prices. Section 3 describes the the data which underlie the empirical results from panel regression and reports the main descriptive statistics. It also discusses the use of Kalman Filter to predict missing values for Gini coefficient. Section 4 presents the methodology and results based on panel regression and attempts to explore the relationship between price and inequality. Conclusions and policy discussions are presented in section 5.

2 Literature Review

There are both theoretical and empirical studies to understand market behaviour in case of income inequality. Broda and Romalis (2009) show that much of the increase in income inequality in the US has been offset by a relative decline in the prices of products that poorer consumers buy. Muellbauer (2012) has shown that relative consumer price changes in the United Kingdom since 1964 have had an inequality increasing bias. He calculated constant cost-of-living indices, where preference parameters are calculated from Linear Expenditure System of demand equations. He found that cost-of-living for the poor increases more rapidly than for the rich. Bergh and Nilsson (2012) argue that higher income inequality will often imply higher demand for products targeted towards the poor. This will increase supply of these goods and this will mitigate adverse effects of higher income inequality by its impact on the distribution of purchasing power.

Most of the theoretical literature focuses on transaction costs and shows that they are the main barriers to market integration, even for homogenous goods. In the presence of transaction costs, its the local factors like the demand and supply conditions which become more prominent in determining the prices. For instance the model by Enke (1951) which was later developed by Samuelson (1952) is elegant in explaining the systematic changes in prices of homogeneous goods across regions when they are spatially separated. Samuelson's paper also shows that the prices of homogenous goods across regions will behave according to aggregate demand and supply and in a systematic and expected pattern, subject to transportation costs. Paper by Gulati and Ray (2012) studies analytically the impact of rising inequality on the welfare of the poor. They have demonstrated striking differences in the prices of same quality product in different regions varying with their level of inequality. Mechanism through which it works is explained as follows - as income rises, individual's marginal ability to pay also increases. Firms with aim of making higher profits respond to this change by increasing prices. Transportation cost introduces horizontal differentiation, making the local demand conditions more important. As increase in income is not uniform across the society, there are some sections (depending upon where they stay), which end up paying higher prices, without participating in growth process.

This explains how the kind of neighborhood a person stays in affects their buying potential and quality of life. What individuals demand and are willing to pay in certain ways depends on their income but what people actually end up paying depends on how they are geographically organized. Thus, the rising inequality has an externality that has feed back effect on the consumption of the poor. There have been many works like Muellbauer (1974), Ray (1985), Banks, Blundell and Lewbel (1997), Pendakur (2002), Pendakur (2009), Nicholas, Ray and Valenzuela (2010), Mishra and Ray (2011) which have established close links between different specifications of consumer preferences which is the function of their income level and distributive consequences of inflation. However, these papers do not indicate how the differential rates of inflation for different consumption baskets itself could be the function of inequality.

3 Data and Descriptive Statistics

In this study, we will focus our attention on microeconomic aspects, in particular the demand side factors like income and its distribution, in explaining the differences in price after controlling for the supply side factors [9]. For the purposes of our study, we concentrate on the state of Uttar Pradesh. Located in northern India, Uttar Pradesh is the fifth largest and the most densely populated state in India. Agriculture is the mainstay of majority of the population. It employs about two-thirds of the workforce and contributes about one-third to the state income[10]. The key question that we seek to answer here is how does wheat price change with income inequality. For the purpose of our analysis we identify 3 districts in Uttar Pradesh which are Kanpur in Central Uttar-Pradesh, Varanasi in South Uttar-Pradesh and Jhanshi in Western Uttar-Pradesh [11]. The choice of the districts for analysis is restricted to those areas where people consume same quality of wheat. Idea is that the variation in price should not be governed by the difference in the level of quality. It also merits a mention that Uttar Pradesh is a major wheat consuming state in India, justifying looking at the wheat prices. The data used for the purpose of analysis is discussed below in detail.

3.1 Data on Gini coefficient

Uttar Pradesh like other parts of India, has reported significant growth in income over the past decade. This has been complemented with rise in income inequality captured by Gini coefficient [12]. Inequality measure is constructed on the basis of monthly per capita expenditure of the household as the data on the consumer's income is not available. We use consumption data collected using 30-day recall period from 22 rounds of the NSS conducted by the Government of India (GoI) for the period 1983 and 2012. It warrants a mention that this is an annually representative data. The consumption rounds of the NSS were not collected for the years 1984, 1985, 1986, 1988, 1989, 1990, 1991, 2009 and 2011. Hence, we use the Kalman filter to estimate missing values for the years mentioned and for converting the data into monthly inequality estimates. This is justified as the change in Gini coefficient is slow relative to change in the prices. As the price is much more volatile so we use monthly

[9]It warrants a mention that in India, government fixes minimum support price which seeks to ensure remunerative prices to growers for their produce. This minimum support price is also uniform across the country; Agriculture produce pricing policy, August(2013)

[10]Source: *http://www.undp.org*

[11]See appendix for the map of the three districts.

[12]Paper by Pathak, 2010 indicates an increasing trend in the inequality in Uttar Pradesh between 1993-94 and 2004-05.

estimate of price and adjust the Gini coefficient data to match the frequency.

It is important to mention here that inequality measure constructed on the basis of expenditure is biased downward as compared to the one based on income, this implies that the rise in inequality is much more than shown by these statistics[13]. However, in the absence of regular data on inequality, the Gini coefficients and other measures of interest have been frequently calculated based on the expenditure data from the NSS rounds. Many studies, for instance Himanshu (2007) and National Human Development Report (2001) have used consumption expenditure data from the NSS to evaluate the extent of increase in inequality.

To estimate the values of the missing observations, we first use association rule that identifies the relationship between observed values of annual Gini coefficient given by $Gini_t^A$ and the missing monthly values of Gini coefficient given by $Gini_t^M$. We start by studying the properties of individual series to asses the model which best describes the evolution of Gini coefficient over time. The presence of unit root under the assumption that the error terms are correlated overtime is tested using the Augmented Dickey Fuller (ADF) test. In particular the following model was specified for the test:

$$Gini_t = \alpha_0 + \rho Gini_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta Gini_{t-i} \tag{1}$$

The lag terms on the differenced Gini coefficient series was determined using the BIC criteria. The results of the unit root test are presented in Appendix (tabe 3). The tests illustrate that the series are non-stationary [14]t 5% level of significance.

In order to estimate the missing annual values and convert annual series into monthly series, we use the linear state space model and kalman filtering technique. The basic assumption of the model is that the observed time series, y_t is a function of an underlying state or process, that has all the information contained from the past. The simplest model to assume is that the observed series is a linear combination of the unobserved series or what we call the state vector denoted by $[\alpha_t^1, ..., \alpha_t^d]$.

[13]Drez and Sen, (2013)

[14]a

Thus, we have the first of the equations of the model called measurement equation to be defined as

$$y_t \;=\; Z^T \alpha_t + \epsilon_t, \quad \epsilon_t \;\sim\; i.i.d\, N(0, H_t) \tag{2}$$

where Z^T is a d-dimensional parameter vector. The equation showing the evolution of the state variable is called the transition equation and is given by

$$\alpha_t \;=\; T_t\, \alpha_{t-1} + R_t\, \eta_t, \quad \eta_t \;\sim\; i.i.d\, N(0, W_t) \tag{3}$$

where T is a dXd matrix of parameters. The random noise terms that are at the end of both equation provide flexibility to the model [15]. Here we also assume that η_t and ϵ_t are uncorrelated[16].

The Kalman filter provides a method to estimate and update the state vector α_t given the observed series. The whole intention of the process is to estimate the values of the state vector. To describe the filter, the minimum mean square estimator of α_t, defined by $\hat{\alpha}_{t|t-1}$ and its variance defined by $P_{t|t-1}$ are given by

$$\hat{\alpha}_{t|t-1} = T_t \hat{\alpha}_{t-1} \tag{4}$$

$$P_{t|t-1} = T_t P_{t-1} T_t^T + R W_t R^T \tag{5}$$

where $\hat{\alpha}_{t-1}$ is the least square estimator of α_{t-1} and $P_{t|t-1}$ is the Mean Square Error matrix associated with $\hat{\alpha}_{t|t-1}$.

From the measurement equation (eq 2), the prediction error is given by, $\epsilon_t = y_t - Z^T \hat{\alpha}_{t|t-1}$. Using this, the update equation along with updated standard errors can be written as

$$\hat{\alpha}_t = \hat{\alpha}_{t-1} + R_t \epsilon_t \tag{6}$$

$$P_t = P_{t|t-1} - R_t Z^T P_{t|t-1} \tag{7}$$

[15] Harvey and Phillips (1979) were able to derive the exact maximum likelihood estimator for an ARIMA process

[16] Koopman et al. (1999) has derived likelihood in the absence of this assumption.

where $R_t = P_{t|t-1}Z_t/[Z^T P_{t|t-1}Z_t + W_t]$ or known as the Kalman Gain [17]. The recursive nature of calculations in the Kalman filter allows estimates to take into account all previous information available. Thus, the moment a new information is available on the series, the filter is able to update the estimates of the future value of the state variable.

In the presence of missing values at a time point t, the prediction equation is calculated as usual but the updating equation does not have a new value addition. Thus, the updates are simply replaced by

$$\hat{\alpha}_t = \hat{\alpha}_{t|t-1} \; and \; P_t = P_{t|t-1}$$

If there is a consecutive missing value, the prediction equation converts to

$$\begin{aligned} \hat{\alpha}_{t+1|t} &= T_t\hat{\alpha}_t = T_t^2\hat{\alpha}_t, \\ & \text{and} \\ P_{t+1|t} &= T_t P_t T_t^T + RW_tR^T \\ &= T_t P_{t|t-1} T_t^T + RW_tR^T \\ &= G(T_t P_{t-1} T_t^T)G^T + RW_tR^T \end{aligned}$$

Naturally, the process can be repeated innumerable times as its is a recursive process[18] as long as there is an initial starting value[19].

The ADF test ran earlier indicates non-stationarity in all three annual series (also the observed variable in the model). The same inferences are extended to the state variable (the monthly series). So the State-Space formulation that we use to predict the missing values of the Gini coefficient is given by:

$$Gini_t^A = TGini_t^M + v_t \tag{8}$$

$$Gini_t^M = \delta_t + Gini_{t-1}^M + \epsilon_t \tag{9}$$

Here equation 8, is the measurement equation that relates the observed value of annual Gini coefficient to unobserved value of monthly Gini coefficient. Equation 5, describes the

[17] Janaceck and Swift, 1992

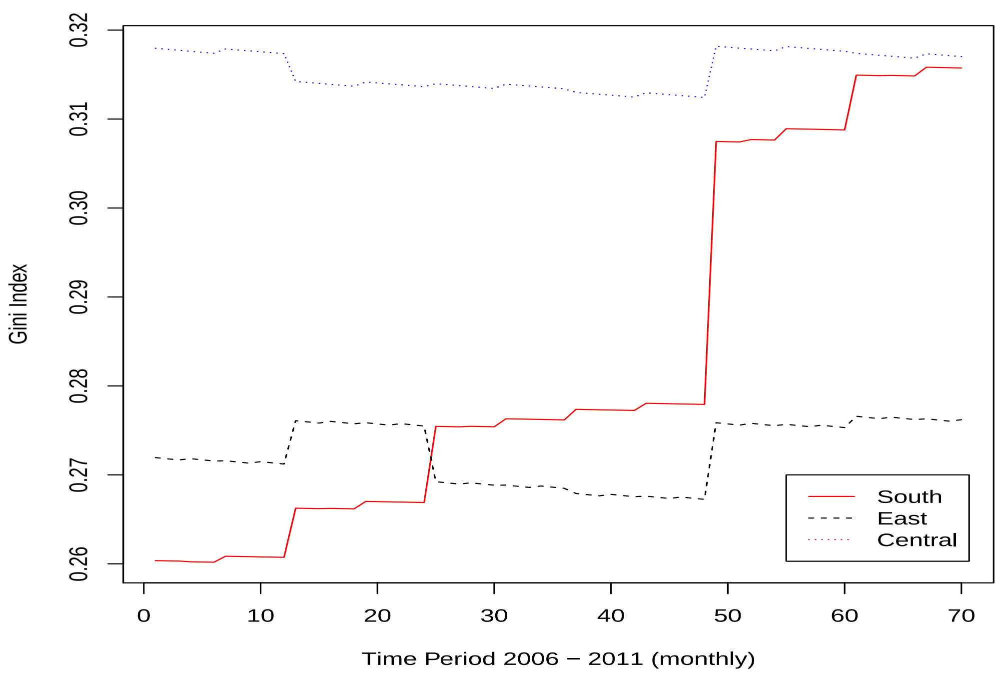
[18] Chatfield, 1994

[19] For information on Kalman Filtering and state space models see Hamilton, (1994) and Harvey (2006)

evolution of monthly Gini coefficient over time. Equations 4 and 5 combined to form the state equation. υ_t and ϵ_t are the random variables that represent the process and measurement noise respectively. They are assumed to be independent of each other, white noise, and with normal probability distributions. In principle Kalman filter predicts the unobserved value for monthly Gini coefficient conditional on the observed value of annual Gini coefficient.

Figure 3.1 provides the evolution of the estimated monthly time series between 2006-2011. There seems to be a general increase in the inequality measure for all three districts. Although, there may be a number of factors affecting inequality, it is not the main interest of this paper to speculate on what might these factors be. What is important is that the data provides enough variation across time and districts to be able to test its effects on prices of food grains.

Figure 1: *Evolution of Gini Coefficient between 2006 - 2011*



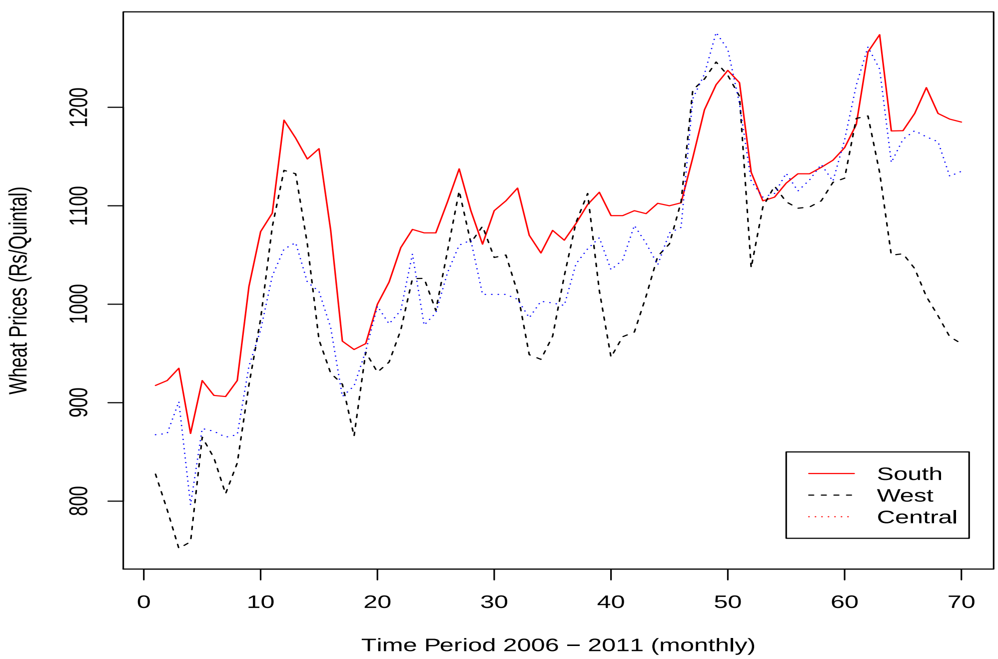
It is evident from the plot above that there is lot variation in the Gini coefficient across time and over different regions. In Central Uttar-Pradesh, initial Gini coefficient is high and it continues to remain so for all the time periods. However in the Southern Uttar-Pradesh, Gini coefficient registers a consistent increase over the period of time.

3.2 Price

We use data on wholesale price of Dara quality of wheat from the Department of Economics and Statistics of the Ministry of Agriculture, Government of India (DES-MOA, GOI) for the period Jan 06, 2006 to Oct 14, 2011. The DES collects and compiles wholesale and retail prices, international prices and market arrivals of essential commodities on weekly/monthly basis from 700 centres and 87 centres respectively spread all over the country.

Figure 23.2 provide a fair idea of the pattern of variation in monthly price of wheat in Varanasi, Etawah and Kanpur districts of Uttar Pradesh for the period Jan 06, 2006 to Oct 14, 2011.

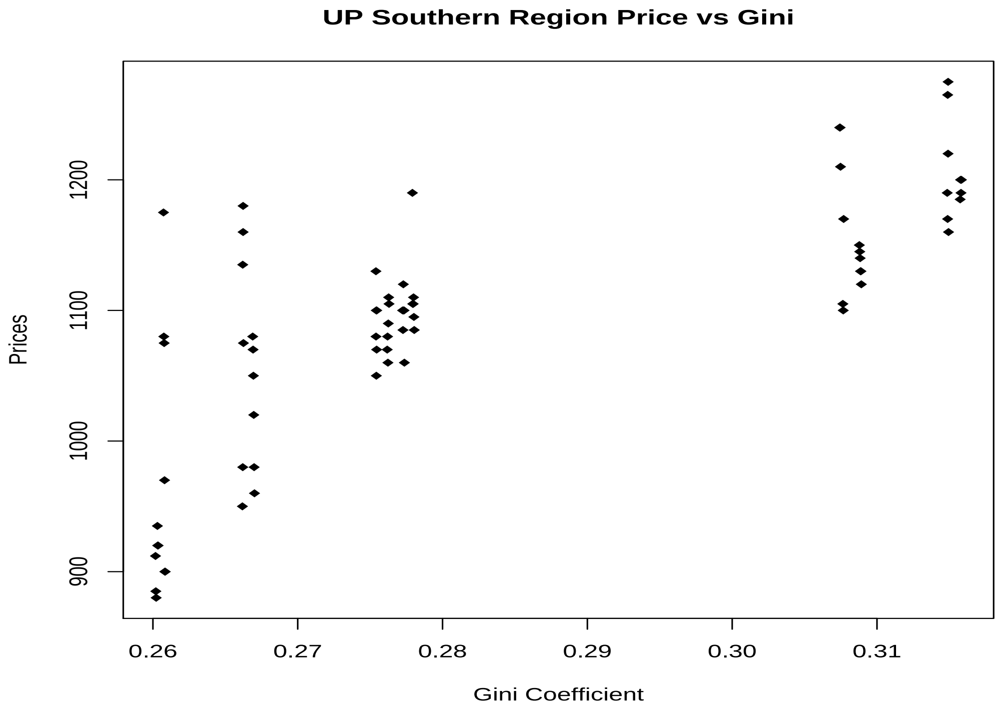
Figure 2: *Evolution of Gini Coefficient between 2006 - 2011*



It is evident from the plot that there is a lot of variation in price over time and across districts. We observe that prices have markedly increased over the period of time in all the three regions. It also warrants a mention that prices are highest in Southern region which experienced maximum increase in inequality.

Figure 3 provides some information on the relationship between price and inequality based on the monthly data on Gini coefficient and price from 2006 to 2011 for Southern UP. More specifically it shows that even though initially price increases with rise in Gini coefficient but this relationship is not linear.

Figure 3: *Evolution of monthly prices and Gini coefficients - Southern Region*



3.3 Other variables in Panel Regression

Table 1 provides the summary statistics for the rest of the variables used as control for the panel regression. The variables given below will control for both demand side and supply side factors that are different in different regions so that any price affect other than inequality are accounted for.

Area is the total farm area in the district on which wheat is being cultivated. It includes land that is cultivated each year excluding land kept fallow during production. The annual level data is available from Directorate of Wheat Development, Ministry of Agriculture, Government of India (DWD-MoA, GOI).

Production is the total quantity of wheat that is cultivated annually from the districts. This variable acts as a control for the supply of wheat, assuming that the quantity of wheat is traded outside only once internal consumption needs of the district are met. The production level in the regions are also at annual levels avaialable from DWD-MoA.

Yield is the production of wheat per unit of land cultivated. Yield provides the proxy for natural resource endowment and soil fertility that affects production costs. The yield is annual level also avaliable from DWD-MoA.

Rainfall measures the precipitation in each district on a monthly basis. In the absence of irrigation and because of water shortages majority of Indian agriculture and thus wheat production depend on rainfall for water needs. Thus this once again denotes the supply side factors. The rainfall in at a monthly frequency available obtained from the Indian Metrological Department

Net Domestic Product (NDP) Agriculture, Net District Domestic Product (NDDP) and Per capita Income (PCI) and Population are all quantifiers of demand in each district in terms of income level and number of people. A combination of these variables would control for the major demand pattern shifts due to migration and other demographic related effects. The production stats are all annual statistics available from the Directorate of Economics and Statistics, Government of India.

4 Methodology

In this section we report the results of the empirical analysis we have carried out. The regression analysis qualifies the relation between price and inequality shown earlier. The use of data on the three state regions together, helps us to elegantly explore and illustrate the causality from Gini coefficient to price. To this end, we use panel data framework to estimate the strength of the relationship between Gini coefficient and price for the three regions from the period 2006-2011. So the equation that we are interested in estimating is given by

$$p_{it} = \alpha_i + \beta x_{it} + \epsilon_{it}, \tag{10}$$

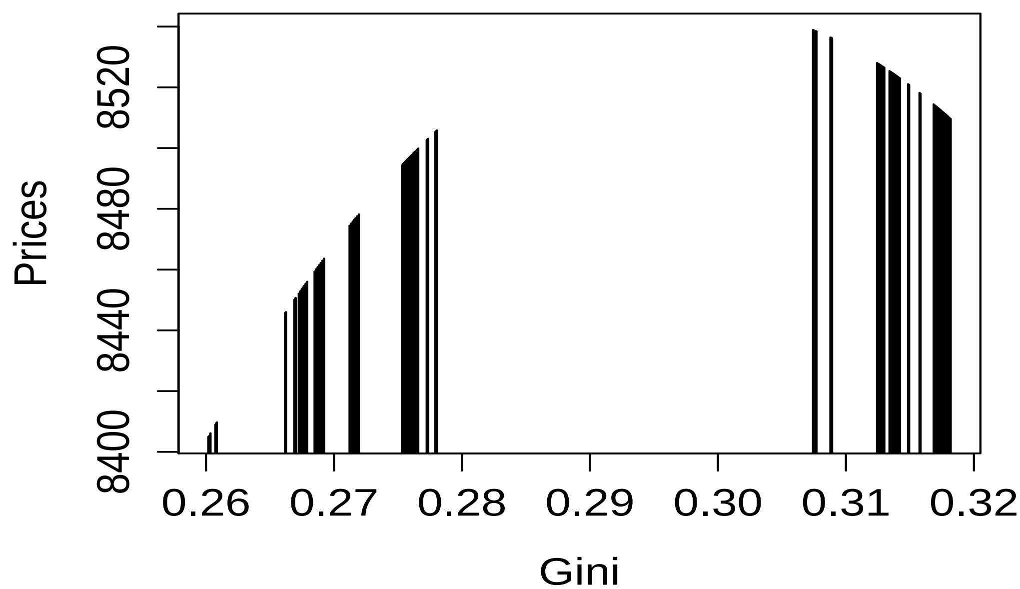
where, p_{it} is vector of prices which varies across different regions and over time, x_{it} is the vector of controls, α_i represents the unit effect and captures the variables that affect p_{it} other than x_{it} and ϵ_{it} is error variable. If we assume that the unit effects are all equivalent and are uncorrelated then with $x's$ then equation 6 reduces to the pooled model. If the unit effects α_j are associated with x_{it} then the variation in α_j must be modeled in order to avoid wrong inference about the coefficient of x_{it}. In the literature there are two standard approaches for modeling variation in α_j: fixed effects and random effects. In the case of fixed effects it is assumed that the unobserved heterogeneity is uncorrelated with x_{it}. In the random effects model, α_i are assumed to follow a probability distribution with the parameters to be estimated from the data. Even though fixed effects model will produce unbiased estimates of β, their variancea are very high. The random effect model may introduce bias in the estimates of β, but can greatly constrain the variance of those estimates.

We believe that higher variance is a greater problem than the bias so we prefer random effects than fixed effects. While using random effect we implicitly assume that heterogenous features of the cross sections are uncorrelated to the error terms in the model. Table 2 reports the coefficients of Gini coefficient obtained from random effect regressions for the panel data of three regions.

To evaluate the impact of income distribution on price we regress price on different moments of income distribution. We use population and per capita income to control for demand and purchasing power. To control for supply side factors we have yield and farm area for each district. Finally, we also use rainfall as it is a major source of irrigation in India.

Looking at model 1, for the sample, the coefficient of Gini coefficient is statistically significant (at 1%), thus suggesting that increase in income inequality leads to a rise in prices. This means that people in the lower echelons of income would seem at a disadvantage of staying in neigborhoods where income inequality is high. The subsequent models provide even more interesting information. We use Gini coefficient and Gini coefficient square to allow for the non-linear relation between inequality and price. It is important to note that though the sign Gini coefficient is still positive but the sign of coefficient of squared Gini coefficient is negative. Both the coefficients are significant at 5% level. This suggests that with the increase in income inequality, the cost of common household consumption items such as wheat rises, but it decreases after a point. This translates to an inverted-U shaped relationship between income inequality and prices. The intuition for the initial increase and then decline in the price is as follows; in the first stage price increases due increase in income[20]. But it decreases after a point due to increase in the supply of differentiated goods, as suggested by Bergh and Nilsson (2012). Figure 4 shows the relationship between predicted value of price on the basis of the above regression and the Gini coefficient.

Figure 4: *Estimated inverted-U shaped relationship*



5 Conclusion

In this paper we have investigated the statistical association between income inequality and and wholesale wheat prices in Uttar-Pradesh, India. As apposed to earlier work on this topic, we have been able to take care of the existing country heterogeneity in the small neighborhood by looking at the Gini-coefficient at the state-regional level. In the first part of the

[20]The rise in state and state-regional GDP over time indicates that the rise in inequality is becuase of the increase in income at the upper end and not because of a decline at the lower end.

paper we have used Kalman filter to make the frequency of Gini-coefficient consistent with price and other data. Regression produced evidence of initially positive and then negative statistical significant relationship between inequality and price. We get similar results using random effects model. These results are partly in line with the basic intuition that initial increase in income leads to higher price but after a point competition from different varieties reduces price. Thus we investigate how as money looms larger in societies, affluence and its absence matters more. If the main advantage of affluence were the ability to afford fancy vacations, inequality would matter less than it does today. But as money comes to affect prices of essential commodities especially food, it affects the life of those with modest means. We show that the marketization initially sharpens the sting of inequality as it exasperates the existing level of inequality by further increasing the prices initially. Later on price tapers-off as inequality increases. This implies that the role played by the economic ghettos in explaining an individual's well-being could be striking. The policy implication of such change is profound. It requires a fiscal policy that focuses not only on efficiency, but also on equity. Targeted distribution of accumulated fiscal surpluses to needy households is clearly needed. In the light of above results it will be interesting to approach the debate that India has been facing recently on the distribution of basic food items like rice, wheat and course grain. One of the ironies that India faces is in food grain sector - it has large stocks of food grains which are not being utilized and on the other hand there is large size of population which is malnourished. And all this is against the backdrop of obstinately high consumer prices, which rose 9.64% in July from a year earlier. But this increase in prices is not uniform in all the regions and significantly depends on the level of inequality. So there is curious paradox on display where one people shine is glare for others!

Appendix

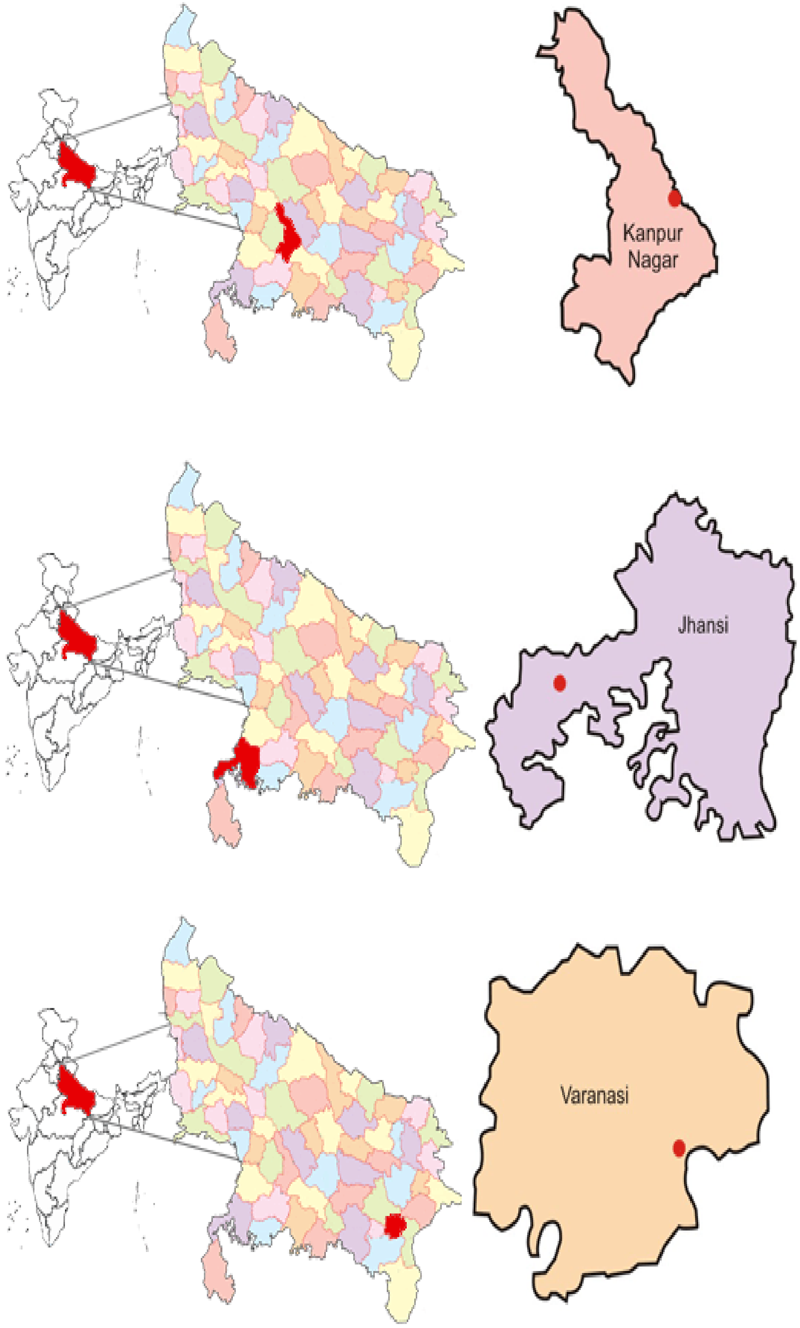


Figure 5: *District Maps*

Table 1: *Summary Statistics for South Region, 2006-2011*

	Mean	Std. Dev	Minimum	Maximum
Gini	0.28	0.02	0.26	0.31
Prices (Rs per quintal)	1,094	91.87	868.75	1,256
Area (hec)	71,150	2,488	69,323	76,433
Production (tonnes)	18,16,84	17,377	1,48,663	1,98,007
Yield (tonnes per hec)	2.55	0.22	2.14	2.82
Rainfall (mm)	71	112	0	474
NDP Agriculture (Rs crore)	461	46	406	540
Per Capita Income (Rs)	13,210	1,671	11,592	16,077
Net District Domestic Product (Rs Crors)	4769	738	3990	6050
Population	35,02,658	1,28,798	33,51,640	37,63,176

Table 2: *Results from Panel Regression*

	model 1	*model 2*	*model 3*	*model 4*	*model 5*
$Intercept$	278.31^{**}	-7441^{*}	-6618.2^{*}	-6698.6^{*}	-6656.9^{*}
$Gini$	1331.1^{**}	57242.5^{*}	50093^{*}	50338^{*}	50065^{*}
$Gini^2$		-95850.7^{*}	-82426^{*}	-84795^{*}	-84306^{*}
$Population$	0.00004^{**}		0.00005^{**}	0.00005^{**}	0.00005^{**}
$Yield$	84.42^{**}			76.648^{*}	75.679^{*}
$Rainfall$					-0.055321
$PerCap.Inc.$	0.026^{**}				
$FarmArea$	-0.0037^{**}				

'*' denotes 5% and '**' denotes 1% level of significance

Table 3: *ADF test for Gini*

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
Central Uttar Pradesh Series				
(Intercept)	0.32	0.11	2.93	0.00
z.lag.1	-1.00	0.34	-2.91	0.01
z.diff.lag	0.10	0.25	0.41	0.68
Value of test-statistic is: -2.91 and 4.29				
Southern Uttar Pradesh Series				
(Intercept)	0.27	0.10	2.52	0.02
z.lag.1	-0.94	0.37	-2.50	0.02
z.diff.lag	-0.01	0.28	-0.02	0.97
Value of test-statistic is: -2.50 and 3.17				
Western Uttar Pradesh Series				
(Intercept)	0.26	0.09	2.73	0.01
z.lag.1	-0.87	0.31	-2.78	0.01
z.diff.lag	0.07	0.24	0.31	0.75
Value of test-statistic is: -2.78 and 3.88				
Critical values for ADF test				
	1pct	5pct	10pct	
tau2	-3.51	-2.89	-2.58	
phi1	6.7	4.71	3.86	

Table 4: *ADF test for Prices*

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
Central Uttar Pradesh Series				
(Intercept)	101.23	47.73	2.12	0.03
z.lag.1	-0.09	0.04	-2.05	0.04
z.diff.lag	0.09	0.12	0.80	0.42
Value of test-statistic is: -2.05 and 2.40				
Southern Uttar Pradesh Series				
(Intercept)	143.72	53.43	2.69	0.01
z.lag.1	-0.12	0.04	-2.64	0.01
z.diff.lag	0.28	0.11	2.49	0.01
Value of test-statistic is: -2.64 and 3.72				
Western Uttar Pradesh Series				
(Intercept)	166.82	54.08	3.08	0.01
z.lag.1	-0.16	0.05	-3.06	0.01
z.diff.lag	0.30	0.11	2.66	0.01
Value of test-statistic is: -3.06 and 4.75				
Critical values for ADF test				
	1pct	5pct	10pct	
tau2	-3.51	-2.89	-2.58	
phi1	6.7	4.71	3.86	

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