Technological Change and Political Mobilization: Evidence from India
(Job market paper)

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Abstract This paper empirically examines the role played by a technological change in Indian agriculture (adoption of High Yielding Variety [HYV] seeds) in the political mobilization of cultivators in Northern India in 1970s and 1980s. Using panel data from the state of Uttar Pradesh (UP) from 1962-1989, I find that the districts that had the largest impact of the green revolution also had the biggest increase in the vote share of the Janata party (a new rural party). This change is accompanied by a fall in political fractionalization, even as effective competition increased over the period. I hypothesize that technology adoption consolidates rural votes by aligning the policy preferences of previously disparate rural groups. I then look at public good provision to see if this substantive political change induced any policy changes. I examine the provision of schools as previous literature has documented the increasing returns to human capital with the advent of the new technology. I find that an increase in the vote share of the Janata party in a district is associated with an increased proportion of villages in that district that have a school (primary, middle and high schools).

The peasants have started to flex their muscles that their economic betterment has given them....In national terms [they] cannot claim [that] they have received a raw deal. Witness the manner in which agricultural inputs have been subsidized for the past two decades....But it is precisely because the farmers have been enabled to move beyond subsistence economy that they have acquired the capacity to launch the kind of sustained struggle that they have. (The Times of India, Editorial, Feb. 1988)

Introduction

The question of whether there is a causal link between economic development and democratization is of long standing interest in the social sciences. The existing literature [1] on this question uses cross country data to uncover evidence of a positive relationship between levels of economic development and presence of democratic institutions in a country. This literature suffers from two main drawbacks, first the nature of the data make it difficult to credibly establish a causal link from economic development to democratization (it could be that more democratic political institutions lead to higher levels of development) and secondly cross country data can provide limited evidence on channels through which development enhances levels of democracy in a polity.

This paper tries to address these two concerns by focusing on political developments within a country. Using an episode of mass scale technological introduction in Indian agriculture it tries to understand how economic changes can lead to political changes within a democracy and how economic development can lead to more representative democracies. Since the data that are used come from administrative units located within the same country and hence institutional setting, the results are not confounded by the reverse causality of the sort discussed above. Also the specificity of the institutional setting (India is a democracy with regular elections) allows us to uncover the channel through which, in this particular case, economic development effects political institutions.

The 1970's and 80's witnessed large scale political mobilization of cultivators and rural voters in India, at that time a young democracy which until then had been politically dominated by urban interests. This mobilization was reflected in the emergence of political organizations, both electoral and non electoral and in the increasing presence of politicians with an agricultural background in all political parties. Table 1 shows the background of legislators in the Indian parliament from 1952 - 89. The entries in the table are the proportion of legislators belonging to that particular occupational category. As the first row shows the proportion of politicians with a rural background has increased significantly over time. An

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[1]Acemoglu et al. (2008); Boix (2010) are recent contributions.

extensive literature in political science[2] has theorized about the role that a key innovation in Indian agriculture, namely the introduction of High Yielding Variety (HYV) seeds (popularly called the green revolution), played in this mobilization. This paper systematically studies the political developments in north India ushered in by the mass introduction of this new agricultural technology beginning in the mid 1960's. Using panel data from northern India I document the impact of the spread of the technology on the emergence of a new, rural interest based, political party (the Janata Party).

Indian politics for the first two decades after independence[3] was dominated by the Indian National Congress (henceforth Congress). The Congress won 72.07% of the seats in the first five parliaments. What was perhaps surprising was that its average vote share over these five elections was however only 44.4%[4]. Even these simple averages reflect the fragmentation in the opposition to the Congress. Voters turned out to vote against the Congress, but their votes got split between different smaller parties. This changed when starting in 1969, with the formation of the Janata party[5], the cultivators and rural voters started mobilizing against the mostly urban Congress.

In this paper I argue that part of the reason for that mobilization can be traced to the introduction of new HYV seeds that were rolled out on a massive scale in the wheat growing regions of northern India, starting in 1965-67. I use a panel of 48 districts from the state of Uttar Pradesh (UP) that I observe over 7 elections from 1962-89. Owing to differences in historical institutions and geographical features different districts adopted the new seeds at different rates. This between district variation over time allows me to use a generalized difference-in-difference framework that controls for unobserved district and time effects to estimate the impact of the spread of HYV technology on the emergence of the Janata party. I find that a 10 percentage point (p.p) increase in the proportion of wheat area in a district planted under HYV seeds results in a 1.5 p.p. increase in the vote share of the Janata party and a 2.5 p.p increase in its seat share. This increase is accompanied by a *fall* in political fractionalization[6] but there is *no* change in voter turnout or Congress vote share. Together these results confirm that a consolidated opposition to the Congress party emerged, in the form of the Janata party, following the introduction of new agricultural technology.

The results are robust to the inclusion of various controls that allow me to discount possible alternative explanations and restricting the estimation to various sub-samples. I also use log of average wheat yield in a district as an alternative measure of the effect of HYV

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[2]See for example Varshney (1998); Weiner (1978, 1983); Duncan (1988, 1997)

[3]India gained independence from British colonial rule on Aug 15, 1947

[4]These are numbers for India, the numbers from my sample of states are very similar.

[5]The construction of party labels is discussed in detail in a later section.

[6]Fractionalization in district $i = 1 - \sum_j Voteshare_{ij}^2$, where j indexes candidate or political party.

seeds and find a similar pattern of results. The results from the fixed effects estimation are consistent only if there is no third variable driving the trends in both HYV adoption and political changes. Including various controls increases confidence in the proposed explanation, it however does not completely resolve the issue. Thus to address concerns about omitted variables and reverse causality, I instrument for adoption of technology using the proportion of irrigated land in that district in 1931 interacted with a dummy which is 0 pre HYV introduction (i.e before 1965) and 1 post HYV introduction. The IV results confirm the pattern of results obtained from the fixed effects OLS estimatations.

I construct a falsification test using the electoral outcomes of the communist parties as a dependent variable. The communist party's support comes mostly from urban industrial workers and should not have been systematically affected by the green revolution. Regression estimates confirm this, there is no effect of the spread of HYV seeds on communist party vote or seat share.

I then propose an explanation for the effect of HYV adoption on political mobilization. The new technology increased the level of commercialization in Indian agriculture. As more cultivators became engaged in commercial farming (as opposed to subsistence farming that was practiced previously), they were unified by a policy demand for higher output prices[7]. Also the new technology depended more heavily on market obtained inputs compared to traditional farming practices; a demand for more input subsidies and availability of subsidized credit was another key demand of the Janata party[8].

The green revolution thus aligned the policy preferences of previously disparate groups of rural voters. I employ a novel empirical strategy to provide evidence for the above channel. Using caste data from the census of 1931 I construct district level caste fragmentation. I then find that similar levels of HYV adoption have **larger** impacts on Janata party vote share in less fragmented districts as compared to more fragmented districts. This is consistent with the above story as it is more difficult to align preferences in more fragmented districts. The new technology also had larger impact on cultivators with larger landholdings. Using within district inequality and using the same empirical strategy as with caste fragmentation I find that the impact of HYV technology on Janata vote share was **larger** in more unequal districts. In this respect the results of this paper relate to an emerging literature that looks at how diversity in policy preferences of a majority can allow a minority to govern (Bandiera and Levy (2010)) and how changes in economic environment can result in political changes by aligning these preferences (Jha (2008)).

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[7]Agricultural prices in India are heavily influenced by government policy as the government sets a price floor for agricultural output.

[8]This channel is based on the extensive literature on the emergence of the Janata party, see Varshney (1998); Weiner (1978, 1983).

The final empirical section of the paper investigates whether there were any policy changes that resulted from the substantive political changes discussed above. First I document that changes in macro development policy were consistent with the rise of the Janata party and mass rural mobilization. The emergence of a rural party was also reflected in changing policy stands of *all* political parties. Secondly, I look at changes in provision of public goods at district level between 1971 and 1991. Using a diff-in-diff strategy I find that a 10 p.p increase in Janata vote share in a district resulted in about a 1 p.p increase in proportion of villages in the district that had a primary or middle school and a 0.1 p.p increase in the proportion of villages with a high school. I focus on schools as the literature has previously documented the increasing returns to schooling with advent of the green revolution (Foster and Rosenzweig (1996)).

The idea that as individuals and groups prosper they desire more control over their political fortunes goes at least as far back as Tocqueville's "Democracy in America" ((De Tocqueville, 1863, p. 3))[9]. This paper is related to different strands of literature that investigate the role of changes in economic circumstances on political institutions. There is a substantial literature that looks at the effect of atlantic trade on the development of political institutions in Western Europe (Acemoglu et al. (2002, 2005); North and Thomas (1973); North and Weingast (1989)). However, to the best of my knowledge this is the first paper that systematically conducts this exercise in developing country democratic setting.

The role that economic development plays in emergence and stability of democracies has been investigated by an extensive literature, since Lipset (1959). Most of this literature is cross country in nature (Acemoglu and Robinson (2006); Acemoglu et al. (2008); Boix (2003, 2010); Huntington (1991)). This paper, by focusing attention to within a country, provides some insight into the channels through which economic development can bring about a more representative democracy. There is also a recent literature that looks at the link between human capital and political participation or mobilization Campante and Chor (2011b,a). This paper provides evidence on an alternative channel that can lead to political mobilization, namely, alignment in preferences brought about by a technological innovation.

Finally there is extensive work in political science on the political developments in India in the 1960's and 1970's (Weiner (1978, 1983); Frankel (1972); Brass (1980a,b); Duncan

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> *Whilst the kings were ruining themselves by their great enterprises, and the nobles exhausting their resources by private wars, the lower orders were enriching themselves by commerce. The influence of money began to be perceptible in state affairs. The transactions of business opened a new road to power, and the financier rose to a station of political influence in which he was at once flattered and despised.*
> *-Alexis de Tocqueville ("Democracy in America")*

(1988, 1997); Baxter (1975); Frankel (1977)). The present paper is much narrower in focus, it looks at economic change caused by new technology and documents its effect on the political environment (a point which I believe does not receive adequate attention in the above work[10]). Also unlike this literature I systematically quantify the effect of technology adoption on political change. This paper thus complements the above literature.

The rest of the paper is organized as follows. Section 1 discusses the political background of the study in some detail, section 2 describes the setting of the study, section 3 describes the data and construction of variables, section 4 presents the empirical framework, estimation results and discussion, section 5 provides concluding comments.

1   Background

1.1   Political Background

For the first two decades after independence from colonial rule in 1947, politics in India was dominated by the Congress party and its stalwart leader Jawaharlal Nehru, India's first prime minister. Political scientists have called the Congress an "umbrella" party, containing in its folds many disparate caste, class and religious groups. In the context of this paper, there is one feature of the Congress of the 1950's and 1960's that is of particular interest. This was the tussle between the urban and rural sections of the party to wrest control of policy making.

The central leadership of the party, along with Nehru, was very much urban, elite and left leaning ideologically. They were socialists in outlook and promoted heavy industrialization through state controlled industries as the means to development and growth. The role of agriculture was to provide food for the newly industrializing country, thus the food prices had to be kept low which resulted in anti producer policies[11]. Agricultural output could

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[10]Duncan (1997); Baxter (1975); Frankel (1977) are notable exceptions, but these studies rely on broad correlations to draw their conclusions

[11]The role of the state in determining the input and output prices for agriculture was and remains big. On the input side because of the heavy subsidies that it provides. On the output side because it promises to buy for the PDS any quantity of grain at a pre set procurement price. This effectively sets a price floor. The argument of this group can be summed up in this quote by A.P Jain, food minister between 1953-57 ((Varshney, 1998, p. 34)):

> There is...a school of thought in this country consisting of economists and persons confined to their rooms. They think that you can finance the Plan by depressing the agricultural prices. Some of them go to the length of saying:"fix the price of wheat (at a very low level) and the price of rice and other agricultural commodities compulsorily in the market and that will solve the problem of prices. Wages will not go up and the plan will progress smoothly." These people seem to forget that there is some such thing as agricultural sector in our economy and it all forms part of the Plan....If we adopt any policy of low prices for agriculture, it is a regressive

be increased, not through price incentives, but increase in efficiency through institutional reforms such as land reforms and more secure land tenure for cultivators, farm and service co-operatives and local self government at the village level.

Their power was countered by the so called "state bosses", mostly right leaning local political leaders from different states and regions who were more in touch with the realities on the ground, so to say. They were mostly rural leaders themselves and were very aware of the difficulties in implementing the institutional reforms because of existing entrenched interests. Also the interests they represented were the landed classes in the rural areas, thus they argued for more producer friendly agricultural prices. However as long as Nehru was alive India's development policy firmly remained pro urban and pro industrialization[12]

The death of Nehru in 1964, and exogenous shocks to the Indian economy (these are discussed in the next section in more detail) prompted a shift in agricultural policy, and it became increasingly producer friendly. An agricultural prices commission (APC) was set up to decide the minimum procurement price so that the producers would not suffer in the event of a plentiful crop. Along with the price incentives new agricultural technology was also introduced (in the form of HYV seeds) and the agricultural extension services were extended to greater parts of India (this meant more investment in agriculture, particularly in imports of seeds and fertilizers and setting up fertilizer plants, rather than industry which would not have been possible under Nehru's policies.).

The increased prosperity of cultivators following this shift in policy was soon reflected in politics. Five years after the death of Nehru fissures began to appear in the Congress. Prominent among the leaders who split from the party was Charan Singh, a peasant leader of the *jat* agricultural caste from western UP, who in 1969 formed a party called the Bhartiya Lok Dal (BLD). The BLD was a party with powerful following among the peasants in the wheat growing regions of North India, and was the chief constituent of the Janata party which came to power in 1977 with Charan Singh as the home minister.

Charan Singh was a powerful agrarian ideologue, with a strong opposition to heavy industrialization and belief in the defense of peasant proprietorship in agriculture[13]. The

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policy. If our policy does not give incentive to the farmer, he is not going to produce and if the Plan fails it will wreck on the policy of depressing agricultural prices.

[12]The present literature says that this had more to do with Nehru's political stature and charismatic leadership than anything else. (Varshney, 1998, p. 30) calls him the "supreme leader of the masses", and the the state bosses required "Nehru's national stature and supreme popularity" to win national elections. But as the results of this paper show that it may partly have to do with the difficulty of the leaders to mobilize rural classes at the time, which later became easier with the introduction of HYV.

[13]The following taken from Charan Singh's writing reflects his political ideology:"Political power lies in the hands of the urbanites to whom urban interests naturally come first." "To the town dweller he," he added "the farmer was a mere grist in the mill of economic progress on whose bones the structure of heavy industry

BLD was organized around a demand for higher producer prices from the APC, changing the composition of the APC to include more agriculturalists (politicians with rural backgrounds) rather than technocrats, cheaper agricultural inputs through more subsidies, cheaper credit and larger allocation of public resources to villages (roads, schools, drinking water facilities).

When the Janata came to power in 1977 with the BLD as its biggest component, these views were very clearly reflected in its policy. "The relative neglect of the rural sector has created a dangerous imbalance in the economy. The farmer has been consistently denied reasonable and fair prices for what he produces. Allocations for agriculture and related development have been grossly inadequate and the need for improving conditions in the villages has received scarce attention." ((Varshney, 1998, p. 104)) The Janata government did not survive long, but by 1980 peasants had been mobilized and the political environment had changed substantially to accomadate them. As (Varshney, 1998, p. 138) shows all political parties began to adjust their policy stands to reflect the increasing power of rural India. The Congress party manifesto in 1971 and 1977 did not contain any references to agricultural prices. The 1980 election manifest promised that "greater attention [will be] paid to the farmer's cost structure" and "input cost indexation of support prices will be instituted so as to safeguard the farmer's income from inflationary trends."

1.2 The Green Revolution

This section expands on the policy discussions surrounding the change in India's agricultural policy in the mid 1960's, with the aim of understanding the reasons for the change in policy and the factors which influenced the rolling out of the new HYV seeds. This is important to understand the empirical framework used later and interpret the results.

By the beginning of the 1960's Indian agriculture was in a dire state. Lack of infrastructure; scarcity of inputs like improved seeds, fertilizers, pesticides and equipment and a confused agricultural policy had resulted in stagnated output in the face of an increasing population. This had made the country more dependent on imported wheat than ever before (Varshney (1998); Frankel (1972))[14].

Indian agricultural policy at the time was committed to two irreconcilable aims: to achieve maximum increases in agricultural output and reduce regional disparities. The emphasis on reducing disparities between regions (and sometimes within regions) meant that the scarce inputs were not applied to their most productive uses[15]. The selection of methods

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was to be reared." ((Varshney, 1998, p. 103))

[14]This section borrows heavily from Frankel and Varshney; two excellent sources on the political economy of Indian agricultural policy at that time.

[15]As this would have meant providing them in regions with good irrigation and institutions (Frankel (1972)). The first Community Projects in 1952 were allocated only to districts with assured water from

for agricultural development was also influenced by the social aim of reducing disparities. Secondary importance was given to the introduction of costly modern inputs as a means of increasing agricultural productivity. Instead priority was to be given to achieving large scale institutional change: implementation of land reforms, including security of tenure, lower rents, transfer of ownership rights to tenants, and redistribution of land[16]. The pace of these reforms was understandably slow as the legislature and the executive arms were both dominated by the landowning classes.

By the late 1950's and early 60's stagnant growth rates in agriculture had become a serious limiting factor on the overall rate of economic growth. The situation was not helped by two severe droughts which led to famine like conditions(*more details*). The country had become increasing reliant on cheap grains imported from the U.S, the continuation of which was in jeopardy in light of an imminent government change in that country[17].

By the early 1960's the planners were convinced that the continuing shortfalls in agricultural production had the potential to jeopardize the program of industrial development. In 1964, they announced "a fresh consideration of the assumptions, methods, and techniques as well as the machinery of planning and plan implementation in the field of agriculture". Policy was changed in two important ways. First, development efforts were to be concentrated in cultivated areas with an assured supply of water which created "fair prospects of achieving rapid increases in production", and second there would be a "systematic effort to extend the application of science and technology" including the "adoption of better implements and more scientific methods" to raise yields[18].

In 1961, 15 districts across the country[19] had been taken up under a pilot scheme, the Intensive Agricultural Development Program (IADP) (Desai (1969)). Pioneered by the Ford foundation[20] IADP placed emphasis on providing the farmer a complete package of inputs to increase yields, including credit, modern inputs, price incentives, marketing facilities, and

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rainfall or irrigation. This program however soon ran into difficulties because objections were raised to the practice of "picking out the best and most favourable spots". Within a year the principle of selective and intensive development was abandoned. Instead the Planning Commission announced a program for rapid all India coverage under the National Extension Service and Community Development Program.

[16]According to the father of Indian planning P.C Mahalanobis, planners devised programs based on "intensive cultivation of land by hand-and improving conditions of living in rural areas through community projects, land reforms, consolidation of holdings, etc."

[17]Wheat was being imported under agreement PL-480 concluded under Kennedy. This agreement was to run out in June, 1965 and its continuation was suspect as President Johnson had reservations about it. Eventually Johnson did continue the wheat exports, but they were put on a "short tether" and wheat was released on a month-to-month basis rather than year-to-year.(Varshney (1998))

[18]See Varshney (1998) for the detailed political mechanics behind this decision

[19]The districts were Thanjuvar (Madras), West Godavary (Andhra Pradesh), Shahabad (Bihar), Aligarh (Uttar Pradesh), Ludhiana (Punjab), Pali (Rajasthan), Alleppy and Palghat (Kerala), Mandya (Mysore), Surat (Gujarat), Sambalpur (Orissa), Burdwan (West Bengal), Bhandera (Mahrashtra) and Cachar (Assam).

[20]Ford foundation was also instrumental in beginning the initial HYVs to India.

technical advice. In October 1965, the program was extended to 114 districts (out of 325) under the name Intensive Agricultural Areas Program (IAAP).

The attempt to improve yields through this change in policy was bolstered through an almost simultaneous technological breakthrough. This was the development of improved varieties of paddy and wheat reported from Taiwan and Mexico. The new varieties were more resistant to plant diseases and more responsive to fertilizers and chemical inputs. Two initial varieties of wheat imported from Mexico, Sonora 64 and Lerma Rojo 64A were found to be particularly well suited to Indian conditions. They were crossed with local varieties and released for mass distribution in 1967. The new seeds needed the kind of package of inputs that was already being provided in the IAAP districts, hence these varieties were phased in starting with these districts using the same extension concepts embodied in the earlier project.

The above discussion shows that the timing of the introduction of the HYVs is plausibly exogenous. It was constrained by the availability of technology, which was imported into India. The change in policy that resulted in the rather quick adoption of the new technology was necessitated by the worsening economic condition in the country. The regional disparities in the timing and extent of adoption had to do with the existing institutional and natural endowment differences, with more productive regions getting the technology first, rather than political considerations. I discuss this point further in the next section where I discuss the geographical setting of the study.

2   Setting of the Study

Politics in India is very regional, with dissimilar trends for different states and regions in the country. Leading political scientists who have worked on India have stressed the importance of looking at sub-regional data to find meaningful results[21]. In this paper I look at UP(fig 4). This is guided by several reasons; UP shows regional variation in the adoption and use of the new technology, but more importantly it was the also the birthplace of the Janata Party, the new rural party that emerged in north India. It was the first serious challenge to the hegemony of the Congress

UP comprises almost half of the northern Indian Gangetic plain. Wheat and rice are the major food crops grown in the state. Wheat is planted in all districts whereas rice is planted mostly in the eastern part of the state. Along with Punjab and Haryana, western districts

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[21] "*National* correlations for India rarely produce any interesting findings. Strong correlations are procured only for smaller units-either the state or a region of the state...Local factors often play such an important role in voting that neither aggregate election data nor national surveys convey a satisfactory picture of why and how Indians vote as they do."(Weiner (1983))

of UP, being the most productive wheat growing region, were chosen for the initial phase of introduction of the new HYV seeds, however the technology eventually spread to the other parts of the state. The increases in agricultural yields obtained through the adoption of the new technology were as impressive in UP as elsewhere in India. Figure 5 plots wheat yield (in tons/ha) in a given district in a given year against the proportion of wheat area in that district that is planted under HYV wheat. There is a strong positive correlation between the two variables and this is robust to inclusion of a time trend.

Due in part but not entirely to it's sheer size, UP sends 85 out of the 540 elected members to the Lok Sabha, UP has had great political value both really and symbolically. It is the core of what is referred to as the north Indian 'Hindi heartland'(Jeffery and Lerche (2003)) and has played a central role in the political developments in the country. The demise of the Congress, the formation of modern farmers and peasants into a political force from the late 1960's, the emergence of the Hindu Nationalist *Bhartiya Janta Party* and the latest low caste movement spearheaded by the *Bahujan Samaj Party* were all taken seriously at the national level only after gaining importance in UP.

Despite the relative homogeneity of the state[22], the modern state boundaries are a recent creation by the British and encompass regions which were under different administrative and institutional setups historically. The effect of these institutional differences can still be seen in the economic performance of the various regions of UP.

Geographically UP shows substantial north-south differences with the mountains in the north giving way to the fertile alluvial plains in the centre and then the dry plateau in the south. From the east to the west the differences are man made in nature, with historical institutions specially those concerning land tenure resulting in lasting economic differences[23].

The advent of the green revolution made these differences more apparent[24] with the already more productive districts in the west being better able to take advantage of the new technology[25]. Figures 6 and 7 show the process of adoption of HYV wheat and the wheat yields in different regions of UP. The adoption rates over the 20 year period show considerable differences, with the rates being highest in the west and lowest in the plateau Bundelkhand region. However the the proportion devoted to HYV in the 3 regions of the

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[22]The state reorganization commission of 1955 decided that no changes were needed to the boundaries of UP as "UP forms the citadel of Indian civilization, that UP is homogeneous, and that a large size will lead to economy in administration"

[23]The different land tenure systems arose from the different British revenue settlements in the two regions. These in turn depended a lot on when British took control of the region. The eastern parts, districts surrounding Varanasi, came under British control a little earlier than the west.

[24]Also while these regional differences may have been some cause of concern during Colonial times, such regional differences were an anathema to the planners in modern India which made them prominent topics in policy discussions.

[25]This has been documented in the literature before, see Banerjee and Iyer (2005)

fertile alluvial plains is very similar with about 85% of the cultivated area being under the improved varieties by the end of the period of study. It is in productivity (Figure 7) however that the differences really start showing up. The yields in the western districts are easily much higher than in the rest of the state throughout the 30 year period. Towards 1985-86, when the data end, the yields are about 1 ton/ha higher in the west than in the central or eastern districts, which given that the yield is about 2 tons/ha in the east and central region is about 50% more. Also what is clear from the graph is that districts which were more productive *before* the green revolution were also better able to take advantage of the new technology[26]. Even the central region which was marginally better off than the east to start with remains marginally better off right upto the end of the period. Lastly, not only is the west more productive than the rest it is *even* more productive than it was before green revolution. The increase for the west is steeper than it was for the rest.

The earlier theories about the relative prosperity of western UP stressed the role of demographic pressures and land holding size, but evidence does not support this hypothesis(Sharma and Poleman (1993)). The now widely accepted arguments stress the role of the prevailing land tenure system and the development of canal irrigation in the west and not in the east (Stokes (1978); Stone (1984)).

The lasting impact of historical land tenure systems in India is well established (Banerjee and Iyer (2005)). The eastern part of the state which came under British control earlier than the wast experienced the Permanent Zamindari Settlement, while the western districts mostly experienced the *Bhaichara* system. The Zamindari settlement involved rentier landlords and several strata of tenants and sub-tenants, almost completely alienating the cultivators from the land. Sub tenants were frequently traders and moneylenders who acted as middlemen forcing cultivators to sell their produce at a lower than market rate on account of indebtedness (Sharma and Poleman (1993)).

More secure tenancy rights encourage more investment in agriculture, both private and public. The differences were noticed at that time as well; one canal engineer remarked upon the "rapid estension of irrigation in the villages owned by the *Bhaichara* communities [while] where the land belongs to large *zamindar* the increase if any is slight. Apparently cultivators in *zamindari* villages were afraid that landlords would use the advent of canal irrigation to enhance their rents and deprive them of *maurusi*[27] rights" (Stone (1984)).

Most of the public investment in irrigation in the 19th century was in western UP. The economic impact of the spread of irrigation was perhaps more indirect rather than direct.

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[26]This is not very surprising, since the two technologies the old and the new are very similar in terms of inputs they need. A very crude way of putting it is that the new technology just needs those inputs more intensively.

[27]*Maurusi* means occupancy status.

Increasing yields from canal irrigation resulted in increasing commercialization of agriculture and the development of specialized non-agricultural support services like carting, milling and draft cattle rearing. Thus the agricultural setup in the western districts was already much better adopted to handle commercial agriculture than the rest of the state at the turn of the century.

Another important impact of the commercialization of agriculture was development of good market facilities in the western districts. The rest of the state which had low marketable surplus was served by periodic village markets (*painths*) and by small market yards. They lacked the large scale market yards (*mandis*) that developed in the western districts. These larger markets with standardized markets were more efficient and less costly to cultivators (Sharma and Poleman (1993); Stone (1984)).

3   Data

3.1   Economic and Demographic data

The primary source of the data used, is the India Agriculture and Climate Data Set prepared by Sanghi et al. for the World Bank. These data build on an initial data set compiled by James McKinsey and Robert Evenson at Yale. The data set contains information on a number of variables for agricultural productivity and investment for 217 districts of India (which cover 13 major states) for the agricultural years 1957/58 through 1987/87. This paper only uses data for the 48 districts from the state of UP. Panel A of Table 2 shows the summary statistics for the economic and demographic variables used in the paper.

As previously discussed wheat is the major crop planted in UP, with only a few eastern districts growing rice. Thus the proportion of wheat area under HYVs grows rapidly to about 45% within 5 years of the introduction of the technology and to 80% within 15 years. A majority of agriculturally important districts (those lying in the central plains) have all their area under HYVs. As a contrast the proportion of rice area under HYVs is only about 15% after 15 years. This reflects two things, first in only 14 districts in eastern UP is rice a major crop (although all districts grow some rice, the acerage in most districts is very low). This can be seen in row 4 of the table which shows the average proportion of rice growing area under HYV conditional on the district having a non zero proportion. The average value of the proportion goes up significantly, but is still substabtially less than the wheat area under HYV growing to about 50% by 1981. This leads to the second point, that while initial improved varities of wheat were robust to Indian growing conditions and had higher yields the new varieites of rice were not. They were sensitive to soil conditions and farmer inptuts,

which delayed adoption of rice varieties by growers (Munshi (2004)). Thus in this paper I use adoption of new wheat varieties as my explanatory variable.

On a whole all these variables show clear upward time trends. The increase in wheat yields is a lot more impressive than that in rice yields. Wages increase almost 400% over this period. The instrumental variable used in the paper requires information on proportion of irrigated land in each district in 1931. I constructed this variable using the 1931 census of India.

3.2 Political data and Variables

The election data are taken from the detailed election reports published after every election by the Election Commission of India[28]. This paper uses 7 election years covering all elections held between and including 1962 and 1989 (parliamentary elections held in 1962, 1967, 1971, 1976, 1981, 1984 and 1989). The published reports contain detailed election results for each of the 85 parliamentary constituencies in UP (86 for 1962 elections). The reports have information on candidates; their party affiliations, vote share of each candidate, the total number of electors in the constituency and the voter turnout.

I use two complementary sets of political outcome variables to make my case. First, I use the vote and seat shares of the relevant parties, i.e the dominant Congress party and the new rural based Janata party to look at the performance of these parties to see if these systematically relate to the spread of HYV seeds. Second, I use standard measures to sum up the distribution of votes, to understand the political change in terms of party fragmentation.

Congress and **Janata** are used as broad labels here and do not represent the same party over the period of the study. The Congress party split in 1980 into Congress(I) and Congress(O). Congress(I) was the successor of the legacy of the united Congress party (Weiner (1983)) and it is the vote share of this party that I use as the Congress vote share after 1977[29]. The Janata party includes vote shares of the Swatantra party for the 1962 and 1967 elections, the BLD and Swatantra party for the 1971 elections, the BLD in 1977, 1980 and 1984 (the two parties merged in 1974) (see Weiner (1978, 1983) for more details) and Janata party in 1989. These were not the only parties contesting elections in UP during this period, but the Congress was the dominant party and the party that all opposition was aimed at. The Janata party represented the middle peasants and cultivators[30], the protagonists in

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[28]Downloaded from `http://eci.nic.in/eci_main/StatisticalReports/ElectionStatistics.asp`

[29]Congress(O) perished soon after while the other Congress is still very much active in Indian politics

[30]The notable absentees here are the Jansangh a right wing Hindu nationalist party and the Communist party of India (CPI). The Jansangh represented mostly urban middle class interests and the CPI had some support from rural landless wage workers but was mostly an urban trade union party. None of these two groups are of direct concern to this paper.

this story. Thus I look at the vote shares of these two to document the political changes.

Using the vote shares of different parties I construct the party fractionalization index,

$$1 - \sum_j Voteshare_{ij}^2$$

where i indexes political constituency and j the candidate (or political party). The fractionalization index is a widely used measure of political competition (Banerjee and Somanathan (2007)). In fact, most of the commonly used measures of political competition are Herfindahl index based measures, see for e.g Chandra (2004). In the case of multi-party competition the above index is a very intuitive way of measuring competition as it gives a direct measure of how fragmented a polity is. An increase in the index means a more fragmented political setup. To increase confidence in the results I also use

$$1 - max_j(Voteshare_{ij})$$

where as before i indexes political constituency and j the candidate, as an additional measure of political competition[31] The less dominant the winning party, the higher is this measure. Voter turnout in a constituency is used as a measure of political participation.

Political constituency(PC) boundaries and administrative districts do not always coincide in India. During the period of study there were 51 districts in UP but 85 PCs. I match the PCs to the respective districts they fall in and then aggregate the political variables to the district level. Additional details about the construction of the data are contained in the appendix. Some previous work using both political and administrative boundaries has taken an alternative route, (see Banerjee and Somanathan (2007)) by disaggregating district level data onto the constituency level. The introduction of HYV seeds was administered at the district level, hence I believe a district is the appropriate level of analysis when adoption of technology is the explanatory variable. Another advantage of using districts as units of observation is that district boundaries did not change much during the period of the study, as discussed below.

Panel B of Table 2 contains summary statistics on the political variables. All these variables except fractionalization, which is of course an index, are expressed as proportions. There is no clear discernible time trend in these unconditional means, except the vote share

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[31]I have used other measures of competition; plurality, which is the difference between the highest and the second highest vote shares in a constituency. Plurality thus measures the closeness of political competition. Higher the value of plurality, less close is the political race. Besley et al. (2010) use $-|voteshare_d - 0.5|$ as their measure of political competition, where $voteshare_d$ is the vote share of the winning party. In a two party system like the US this is exactly half of plurality. The results are not reported in the main body of the text for clarity of presentation. They are discussed as footnotes in the relevant section.

of the *Janata* party[32] which increases over time.

An important caveat about interpreting the results in this paper is that while district boundaries do not change over the course of the period studied in this paper, PCs were reorganized twice during the period of the study. They were re-organized in 1965, which affected the 1967 and 1971 election cycles and then again in 1976, which boundaries remained in effect for the rest of the period. The changes in the composition of a district in terms of the PCs it encompasses are not major with the core of each district remaining the same over time. The reason that political and administrative boundaries don't match is of course the difference in the sizes of the districts. PC boundaries are drawn up to minimize variation in the number of electors across PCs, hence bigger districts incorporate more PCs. If the growth rates of population were the same across districts then there would be no need for political re-districting. If the initial PC map[33] is optimal (in that it minimizes variance in population across PCs) then the same growth rate in population would imply that the same map is still the optimum. A need for redistricting implies differential growth rates across districts. All the results presented later in the paper are robust to including population density as a measure of population change.

A bigger problem is manipulation of PC boundaries to favor particular parties. Defining boundaries of political constituencies in India is the responsibility of a Delimitation Commission, an autonomous body expressly setup for this purpose[34]. Recent work, using the latest round of redistricting in 2008, (Iyer and Sharma(2011?)) has found no evidence of gerrymandering in India. They find that the commission achieves its aim of equalizing populations across constituencies and that there is no advantage to the incumbent party.

4   Empirical estimation and results

4.1   Framework

I am interested in estimating the effect of spread of HYV seeds on politics. The adoption of the new agricultural technology is non-random and very likely depends on unobservable district and time characteristics, that are not orthogonal to political outcomes. The panel nature of the data allows me to use a fixed effects framework to account for the non time variant district and time characteristics. Thus the following equation is my benchmark regression;

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[32]As discussed above these are labels and do not the represent the vote share of the same party over time.

[33]A map here is the composition of a district in terms of PCs.

[34]The commission consists of members of the judiciary, and ex members of the Election Commission which are appointed by the Central government. However to limit the power of the Central government it also has associate members who are drawn from the different state legislatures.

under the assumption of absence of time varying omitted variables and $cov(yield_{it}, \epsilon_{it}) = 0$ the following estimates the coefficient of interest β consistently.

$$Y_{it} = \alpha_t + \beta.yield_{it} + \gamma.X_{it} + \theta_i + \epsilon_{it} \tag{1}$$

where t is the election year and i indexes districts. Y_{it} is the political outcome variable (vote share, seat share or political competition), $yield_{it}$ is the wheat yield in that particular district in that election year. In this equation the effect of HYV expansion on politics is constrained to be the same across all periods. X_{it} are additional control variables that vary with time across districts. The district fixed effects, θ_i, account for differences in district characteristics such as culture and geography. I allow the intercept to vary with time to account for state or nation wide political events (like the 'emergency' implemented by Mrs. Gandhi or her assassination in 1984 as discussed previously).

I also estimate eqn. 1 with an alternative explanatory variable, the proportion of area in a district that is planted under HYV seeds. This is a better measure of marginal productivity than average yield in a district. Using the two independent variables increases confidence in the results.

The baseline regressions provide useful benchmarks, but a strong assumption is needed to consistently estimate β in eqn. 1, namely $cov(yield_{it}, \epsilon_{it}|X_{it}, \theta_i) = 0$. It is plausible that the omitted variable varies with time for each district (and is not captured in X_{it}. In this case the estimating equation can be rewritten as

$$Y_{it} = \alpha_t + \beta.yield_{it} + \gamma.X_{it} + \eta_i + \phi_{it} \tag{2}$$
$$\phi_{it} = \theta_{it} + \epsilon_{it}$$

where θ_{it} is not orthogonal to $yield_{it}$. If 2 is estimated with district fixed effects the estimate of β will be inconsistent, as clearly, because of the term θ_{it}, $cov(yield_{it}, \phi_{it}) \neq 0$. This could happen because of two possible reasons

1. The unobservable district characteristics that effect both the HYV technology and politics evolve over time, rather than being constant. Consider for example, institutions of collective action or social organization; differences in these across districts could effect both how new technology is adopted and how successful it is and could also effect politics. These institutions however could also evolve differently for different districts and hence have the form θ_{it}.

2. Another concern with the basic regression is that of reverse causality. The incumbent has incentive to manipulate (through policy) the spread of the new technology so as

to favor herself. This would bias the point estimates in the basic regression. Given that I am assuming that the technology was made available in an efficient way, any manipulation would result in lower adoption rates and less changes in politics, thus biasing the point estimates downwards.

To address these issues I instrument for $yield_{it}$ with $X_{i0}.f(t)$, where X_{i0} is the proportion of land in district i that was irrigated in 1931 and $f(t)$ is a step function that is 0 pre-HYV introduction (i.e for election year 1962) and 1 post-HYV introduction. I discuss the validity of the instrument in some detail in later sections, but it would be useful to summarize the main reasons here. Irrigation status of a district in 1931 is correlated to the contemprory level of irrigation in the district. HYV seeds are much more sensitive to irrigation and timely supply of water than traditional seeds and hence proportion of land irrigated in 1931 is correlated to the success of the new technology. The fact that the political environment in pre independence India in 1931 was completely different from the post independence one in 1962-89 means that it is unlikely that contemporary politics affected the irrigation in 1931. The identifying assumption thus is that irrigation in 1931 only affect contemporary politics through its effect on agricultural yields.

4.2   Basic results

The results from estimating eqn. 1 are presented in table 3. Cols (1)-(4) report results on party outcomes for the Janata and Congress parties, cols (5)-(7) report results using fractionalization, party dominance and plurality as dependant variables and col (8) for voter turnout. Panel A does not include any demographic controls, while panel B includes population density and literacy in the district as controls.

The point estimate for Janata vote share and seat share is positive and significant. An increase in yield over time implies an increase in the Janata party vote share and it's probability of winning seats. The point estimates suggest that a 1 standard deviation change in yield results in a 0.14 standard deviation change in the Janata vote share. The congress vote share on the other hand is unrelated to the increase in wheat yields. The seat share of the Congress party falls, however the point estimates are not statistically significant in some specifications[35]. Point estimates show that fractionalization falls and party dominance increases (as 1-max(vote share$_{ij}$) falls) with increase in yield. The spread of HYV over time in a district as measured by wheat yield results in a consolidation of the opposition to the Congress party and a fall in political fractionalization. The main opposition party to emerge

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[35]They are significant in the IV estimates presented later.

is the Janata party[36] The last column reports estimates with voter turnout as the dependant variable. These point estimates are indistinguishable from 0. Thus the increase in the vote share of the Janata party does indeed come from a consolidation of a fractured opposition rather than an increase in voter participation in favor of the new rural party.

4.3 Subsample results and robustness checks

4.3.1 General specification

As a robustness check I estimate a more general specification where I allow the effect of HYVs to vary with time.

$$Y_{it} = \alpha_t + \beta.yield_{it} + \sum_{dc} \beta_{dc}.yield_{it}.d_{dc} + \gamma.X_{it} + \theta_i + \epsilon_{it} \tag{3}$$

This is similar to the eqn. 1, except the β coefficients are now allowed to vary with time, more specifically with decade, i.e d_{dc} are decadal dummies. d_{72-80} is 1 if $t = 1977, 1980$ and d_{81-89} is 1 if $t = 1984, 1989$. Thus the estimates for the first decade are just β while for the next two decades it is $\beta + \beta_{dc}$ where dc is the relevant decade. The results are presented in table 4.

Expectedly the results are being driven by the 2 later decades. The HYV seeds were only mass introduced in 1967 hence it is not very surprising that there is no effect in the first decade. The pattern of results also helps explain why some of the results are not statistically significant in the basic specification. The congress seat share falls significantly in the second decade but not in the other 2, hence on an average it's negative but not significant. However, the overall pattern that emerges from the basic regression holds consistently over time. The results are not being driven by one election or time period.

4.3.2 Subsample results

The pace of technology adoption slowed down considerably after 1980 primarily because most of the districts already had large proportions of wheat growing area under HYV. Also the Janata party formed the central government in 1977, and this changed the political environment in the country considerably. Hence I estimate the regression with only the first 5 elections. The results are presented in panel A of table 5. The results display the same pattern as the full sample.

In a previous section I discussed the differences between western and eastern districts of UP in terms of economic development. The reasons for this can be traced to early

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[36]The main constituent of Janata party was the Bhartiya Lok Dal (BLD).

introduction of canal irrigation by the British, and historically more secure land tenures for cultivators. These districts were also better able to take advantage of post independence land reforms (Jeffery and Lerche (2003)). When HYVs were introduced, these districts along with the other northern Indian states of Punjab and Haryana saw the largest increase in rural capital investment. Most previous studies, including Stokes (1978), Stone (1984) and Sharma and Poleman (1993) have commented on the difference between these districts and the rest of UP[37] . These districts also had the roots of the BLD (Bhartiya Lok Dal) the main constituent of the Janata Party in UP (Weiner (1983))[38]. To ensure that my regression estimates are not just picking up the effect for these districts I run all the regressions on a reduced sample which excludes these districts[39]. The results are presented in panel B of table 5. The estimates are very similar to those obtained with the full sample, and the same pattern emerges. Thus the results are not being driven by a handful of districts and the political change is obtained across the state[40].

Mrs. Gandhi, then Prime minister, declared a state of 'emergency' in India in 1975. 1977 were the first elections held after the lifting of the 'emergency' and there was a huge backlash against the Congress. The 1984 elections were held after Mrs. Gandhi was assassinated that year. To make sure I am not picking up just the effect of these extraordinary political events, I estimate the regression with the full sample of districts but I drop the election years 1977 and 1984. The results reported in panel C of table 5 are again very similar to the other sets of results.

4.3.3 Alternative explanatory variable

Table 6 reports estimates when eqn. 1 is estimated with Proportion HYV as an explanatory variable instead of yield. The estimates are qualitatively the same as the ones obtained with yield as the regressor. The same pattern emerges. An increase in proportion of wheat area under HYV leads to the strengthening of the Janata party but it does not effect the Congress vote share. This increase in Janata vote share results from a fall in fractionalization and consolidation of the opposition.

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[37]Neither is this knowledge of the relative prosperity new, it has been commented upon by British officials since the 19th century see Stone (1984)

[38]The party had its roots in the *jats* an agricultural caste in the western region. *Charan Singh* the leader of the BLD was based in and contested elections from *Baghpat* parliamentary constituency in *Meerut*.

[39]The districts included in North West UP and excluded from the sample are *Meerut, Moradabad, Bulandshahr, Bijnor, Muzaffarnagar, Saharanpur and Rampur.*

[40]As fig 6 shows the hill districts and Bundelkhand seem to significantly fall behind the other parts of the state in HYV adoption. To see if the regressions are picking up the differences between these two regions and the rest of the state I run the above specifications without these regions. The results (not reported) are very similar to the results for the whole state.

4.3.4   Alternative mechanisms

Another possible reason for the observed effect could be demographic changes resulting from migration. The new agricultural technology widened the gulf between the already rich and poor districts and demand for agricultural labour and increased non farm employment may have caused migration within the state; and the resulting demographic changes may have resulted in a change in the composition of the electorate. This mechanism however is is not very plausible for migration rates in India are very low, most of it being women moving for the purpose of marriage. Also all the regression results that I presented before included population density as a control and the results were very robust to the inclusion of that variable.

4.4   Identification

4.4.1   Concerns about reverse causality

The differences in the spread of the technology have been widely studied in the literature. These studies have pointed out to economic and institutional factors as giving rise to differences in adoption. Following the discussion in the preceding sections it is not very surprising that size of land holdings and lack of irrigation facilities have been mentioned as the main reasons for the variations in productivity across UP (Sharma and Coutinho (1989); Sharma and Poleman (1993)). Studies have also discussed human capital differences as one possible cause for differences in productivity from the green revolution (Nair (1979)). However none of this literature or the literature on politics in India during that time (discussed above) mentions political intervention or manipulation as a possible cause for some regions lagging behind. In fact political intervention was made to reduce some of these differences (Sharma and Poleman (1993)).

I try to address the question question of reverse causality in two ways. First, I look at whether the introduction of the technology is politically manipulated or whether the adoption is explained by initial productivity. There is not much variation in the timing of the initial introduction of HYV seeds, most districts have some non-zero area under HYV wheat in 1966 (very small land areas, mostly experimental farms) and by 1967 all districts have a non zero area under HYV. So I use the initial proportion of wheat growing area under HYV (so Prop. HYV in 1966) as a dependant variable. As explanatory variables I use the average yield pre 1965 in the district and political variables (plurality, share of dominant party and whether Congress won the seat or not in 1962). The results (not reported) are very stark, the coefficient on initial productivity is positive and significant, while the point estimates on the political variables are close to zero and statistically insignificant. Thus the

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adoption is explained, as expected, by initial productivity in the district.

4.4.2 IV estimates

I use $X_{i0}.f(t)$, where X_{i0} is the proportion of land in district i that was irrigated in 1931 and $f(t)$ is a function that is 0 pre HYV introduction and 1 post HYV introduction, to instrument for $yield_{it}$ (and $proportionHYV_{it}$ in some specifications). An ideal instrument in this case would be a variable that only affects HYV technology and not traditional technology and of course does not affect politics directly. This ensures that the variable could not have contributed to differential institutional and economic development of different districts and hence satisfies the exclusion restriction; it only affects politics through agricultural yields. In the next paragraphs I argue for why the above is a good candidate.

As discussed in a previous section the contemporary differences in irrigation across different districts of UP are historical in nature. The western region of UP received a large amount of public investment in irrigation in the nineteenth century while the eastern region received hardly any at all. The eastern Yamuna, the Upper and Lower Ganga, and the Agra canal, all in western UP, were built between 1830 and 1880 while the first canal serving the central and eastern districts, the Sarda canal was completed in 1926. The difference in the spread of irrigation arose because of both natural and institutional reasons. The eastern region is more prone to water logging and flooding with almost annual floods that effect large tracts of the region. Proper irrigation requires a complex system of drainage, and the major rivers this far downstream are difficult to harness. This however does not mean that these difficulties could not have been overcome earlier than they were. A proposal to build a canal serving the central and eastern regions was first mooted in the 1870's when it was opposed by the *taluqdars*[41] of *Oudh* (Central UP) who wanted to maintain status quo. They only relented when the droughts and famines of the late 19th century threatened to result in large scale agrarian unrest (Sharma and Poleman (1993); Whitcombe (1972)). These historical differences in canal irrigation have been used to explain contemporary economic differences between districts.

This suggests that historical irrigation status may not be a good instrument as it may affect politics through more than just contemporary agricultural yields. Fig 8 plots the average wheat yield (in tons/ha) over time for different quintiles of the distribution of 1931 irrigation. The effect of irrigation on yields is small pre-HYV and real differences only start showing after the introduction of the HYV seeds. To see how significant (in magnitude and

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[41] *Taluqdar* is a large landowner.

statistically) these differences are I run a simple regression of the form

$$Yield_{it} = \alpha_t + \beta_{1957-1966}.p\_irrigation1931+ \tag{4}$$

$$\beta_{1967-1986}.(p\_irrigation1931 \; X \; \mathbb{I}(year > 1967)) + \gamma.X_{it} + \epsilon_{it}$$

Here $Yield_{it}$ is the wheat yield in district i in year t, α_t are time dummies, $p\_irrigation1931$ is the proportion of district i irrigated in 1931, $\mathbb{I}(year > 1967)$ is an indicator function which is 1 if the year is 1967 or greater (i.e post HYV) and X_{it} are additional controls. Thus the impact of irrigation in 1931 on contemporary yields is given by $\beta_{1957-1966}$ pre HYV and $\beta_{1957-1966} + \beta_{1967-1986}$ post HYV. The results are shown in table 5. It is clear that the impact of irrigation is much higher after the introduction of HYV seeds. In fact in the full specification with controls the impact of irrigation pre HYV is statistically indistinguishable from 0, while the impact post HYV is positive and very significant.

HYV seeds are very sensitive to the timing of application of water and hence availability of irrigation greatly affects the yield from HYV technology. The path dependence in irrigation in a district implies that irrigation in 1931 is correlated to contemporary irrigation in the district and hence its effect on yields. What is more puzzling is the fact that irrigation seems to have very little or no effect on traditional yields. This could be an outcome of the fact that HYV seeds are more sensitive to irrigation than traditional seeds (Sharma and Coutinho (1989)). Canal construction in the 1920's allowed the central and eastern districts to catch up with the western region in terms of irrigated area. Thus it closed down the gap in terms of irrigated area but over the next 30-35 years it did not significantly affect yields. Hence irrigation in 1931 is un-correlated with productivity from traditional technology but the sensitivity of the HYV seeds to irrigation means it is strongly co-related with HYV yields. This result increases confidence that the instrument does indeed only effect politics through contemporary yields.

Table 8 presents the IV estimates for different specifications. Each entry in Panel B is the point estimate on $yield_{it}$ from the second stage of an IV estimation of eqn. 1 with $p\_irrigation1931.f(t)$ as the instrument. The first stages for the various specifications are reported in Panel A. Col (1) reports the OLS estimates, while cols (2)-(5) are second stage IV results. The rows are the point estimates for different dependant variables.

The pattern of results that emerged from the basic fixed effects regression also holds for the IV estimates. An increase in wheat yield implies an increase in the vote share and seat share of the Janata party. The vote share of the Congress party is not related to the yield while it's seat share falls with an increase in yield in a district. Thus the result from the OLS estimation is robust to instrumenting for yield. An increase in yield in a district leads

to rise in the Janata vote share through a consolidation of the opposition to the Congress and fall in fractionalization.

The IV estimates are bigger than the OLS estimates and the Hausmann test can't reject the null that the OLS and IV estimates are different for most specifications. So the OLS estimates could be biased downwards because of reverse causality. However it is more likely that the OLS estimates suffer from an attenuation bias. Agricultural yield is a series that shows a lot of volatility around the trend and average yield for a district is likely measured with error. A fixed effects regression may exacerbate any measurement error in levels and hence bias the OLS estimates downwards.

4.5 Interpretation of the results

The previous section presented results on the the impact of the spread of the green revolution on changes in the political environment. To summarize, the spread of HYV technology within districts is associated with an increase in the vote share of the Janata party and the emergence of a consolidated opposition to the dominant Congress party. This section proposes an interpretation of these results.

The adoption of new technology changed the nature of Indian agriculture by increasing the level of commercialization in agriculture.

> Due to increase in farm yield, cultivators previously engaged in subsistence farming started selling their farm output on the market. This made the returns from agriculture more dependent on output prices than they previously were. Higher prices for agricultural output was one of the key demands of the Janata party.

> The new production technology also relied more heavily on market obtained inputs. It was more sensitive to the timing of application of water and hence irrigation became more important with the new technology. Application of fertilizers and other chemical inputs was also more important for the new technology than for traditional technology. Finally, the new technology was also more responsive to the application of capital inputs, hence availability of cheap credit assumed greater importance with the new technology. Another key demand of the new Janata party was lower input prices through increased subsidies on agricultural inputs including cheap credit.

Politically the impact of the above change was the alignment of policy preferences of previously disparate group of rural voters. Groups of voters that were divided over different dimensions of class and ethnicity, and who were therefore represented by several smaller

parties, were unified by a single policy demand and behind a single political party: Janata party.

I do not have data on market participation at the individual or aggregate level, however I use a novel empirical strategy to provide indirect evidence for the above claim. This strategy relies on exploiting differences across districts that are time invariant but which should matter for collective action.

Take caste fragmentation, for example, $cfrag_i$ in district i which is, defined as

$$cfrag_i = 1 - \sum_j caste_{ij}$$

where $caste_{ij}$ is the proportion of members of caste j in the total population of district i[42]. Now consider the following thought experiment, take two districts with different levels of caste fragmentation but similar levels of HYV adoption. Then if technology adoption effects political change through aligning policy preferences then the effect of HYV adoption should be lower in the more fragmented district as it will be more difficult to bring different voter groups together in a more fragmented society. I formalize this idea with a regression of the following kind

$$Y_{it} = \alpha_t + \beta.yield_{it} + \gamma.cfrag_i \ X \ yield_{it} + \theta_i + \eta_{it} \tag{5}$$

Here i indexes districts and t election year, Y_{it} is the vote and seat share of the Janata party, and $yield_{it}$ is the wheat yield in district i at time t. Following the above logic, once I control for $yield_{it}$ the coefficient on the interaction term should be negative, i.e, $\gamma < 0$.

As previously discussed in the paper, HYV technology was scale neutral (Sharma and Poleman (1993); Sharma and Coutinho (1989)). However for cultivators with very small landholdings of less than 1 Ha the increase in yield was not enough to allow them to engage in commercial agriculture. Also larger landholdings allow cultivators to adopt more capital intensive farming practices. Hence the class of cultivators that most benefited from HYV technology were medium farmers (2-6 Ha) (Varshney (1998)). We can now repeat the same exercise as above but this time using within district inequality. Again consider two districts with different gini coefficients (my measure of inequality) but similar levels of technology adoption. This time the effect of HYV adoption on political change should be higher in the more **unequal** district as this district has bigger farmers who are better set to take advantage of HYV and more likely to be united by a common policy preferences. The

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[42]These data are taken from the 1931 census of India.

following regression formalizes the idea

$$Y_{it} = \alpha_t + \beta.yield_{it} + \gamma.gini_i \ X \ yield_{it} + \theta_i + \eta_{it} \tag{6}$$

where $gini_i$ is the gini coefficient of landed HHs in district i. The prediction is that $\gamma > 0$.

The results are presented in tables 5 and 5. In table 5 col (2) shows the results of estimating eqn. 5 with Janata party vote share and col (4) with Janata seat share. Panel A uses prop. HYV as the explanatory variable and Panel B uses yield. Cols (1) and (3) present results from the simple fixed effects regression for comparison. As predicted the coefficient on the caste interaction is negative. The coefficient on the level (i.e Prop. HYV in Panel A or yield in Panel B) is the effect of HYV adoption on Janata vote share for a (hypothetical) district with a caste fragmentation of zero, i.e where everyone belongs to the same caste. As the point estimate shows this effect is really large, a 1 p.p change in proportion of land planted under HYV in a district results in a 3.62 p.p change in Janta vote share. However in the data $cfrag$ varies between 0.84 and 0.96, hence the effect in the least fragmented district is 1.14 times the effect in the most fragmented district.

Table 5 presents similar results for eqn 6. As predicted the point estimate on the interaction of gini coefficient and prop. HYV (in Panel A and gini and yield in Panel B) is positive. In this case the point estimate on the level is the effect of HYV adoption on Janata vote share in a (hypothetical) district with an equal land distribution (gini=0). This estimate is negative in all specifications. As the land distribution becomes more unequal (gini¿0) the effect increases. This is in line with the discussion presented above.

4.6   Public good provision

This section provides some evidence on the policy changes resulting from the broad political changes documented in the previous sections of the paper. The macro changes in policy making resulting from the rise of the Janata party have been discussed briefly elsewhere in the paper. Starting from the early 1970's Indian development policy became increasingly pro agriculture in nature. The structure of the Agricultural Prices commission was changed by including more agriculturalists (politicians with agricultural background) on the board and over time the procurement prices became increasingly producer friendly. As stated in the introduction the background of policy makers also changed. There was a steady rise in the number of legislators of agricultural background (see table 1, there is a steady increase in the number of legislators with an agricultural background).

However, whether these changes were in response to the increasing clout of the Janata party or independent developments is difficult to say. Therefore I look at changes in rural

public good provision to see if the effect of increase in Janata vote share in a district was reflected in changes in public good provision in the district.

From the 1971 and 1991 census of India I have data on the proportion of villages in a district that are provided with a particular public good (for example the proportion of villages with a primary school or middle school etc.). I run estimations of the following kind

$$S_{it} = \alpha_t + \beta.V_{it} + \gamma.X_{it} + \theta_i + \eta_{it} \tag{7}$$

where S_{it} is proportion of villages with a school in district i at time t and V_{it} is Janata Party vote share. X_{it} includes control variables, chief among which are agricultural yield and average agricultural wage in a district.

With two cross sections this is essentially a difference in difference estimate, and thus has the same identification assumption. In the absence of the technological change and the resulting rise of Janata party public good provision in all districts would have grown at the same rate.

In using the above estimation framework I am being purposefully agnostic about particular political economy models. It could be that districts with a higher change in vote share of Janata party are more likely to have spent time under Janata party incumbency and hence we expect to find more changes in rural public good provision in those districts. However, a positive β in the above model is also consistent with a swing voter kind of model where the consolidation of rural voters makes these voters pivotal and hence the districts where the change in Janata vote share are larger see more transfer from the incumbent.

I focus on provision of schools because the literature has previously documented the increase in returns to schooling because of the green revolution (Foster and Rosenzweig (1996)). Also there is literature in economic sociology that has documented the aspirations of the newly prosperous medium peasantry for upward mobility by securing white collar (particularly public sector) jobs (Jeffery and Lerche (2003)). This made increase in the number of schools a key demand of the Janata party.

Table 13 reports the estimates. Cols (1)-(3) report the results for primary, middle and high schools respectively. The 'treatment' here is of course the introduction of HYV seeds. This resulted in both yield increases and political changes. Thus all regressions control for yield and ln(wage). As the point estimates show an increase in Janata vote share results in a higher proportion of villages having access to schools at all levels. A 10 p.p increase in the vote share of the Janata party in a district results in a 1 p.p increase in the proportion of villages with primary and middle schools and 0.1 p.p increase in the proportion of villages with a high school. This is a fairly substantial effect given that on an average only about

0.7 percent of the villages in a district have a high school (see table 12).

5   Concluding comments

This paper studied the effect of a widespread technological change, namely the introduction of HYV seeds in northern India in the mid 1960's, on politics. It finds that the spread of the technology in a district resulted in the increase in the vote share and seat share of the Janata party, a new political party with its base in rural India. This was a result of the consolidation of the opposition to the Congress party, the dominant national party, and a fall in political fractionalization. Another key contribution of this paper is to provide empirical evidence for the hypothesis that technology adoption brings about political change by aligning the policy preferences of rural voters.

Although the analysis here is restricted to an episode of political change in one region in India, I believe the results have a relevance beyond just explaining political developments in India. In a democracy diversity in preferences in a majority group can be detrimental to its interests when faced with a unified minority group (Bandiera and Levy (2010)). As the results of this paper show an innovation that aligns these preferences can indeed result in substantial political changes and make governments more responsive to the interests of the majority. This locates the present research in a larger political economy literature that seeks to understand low political representation of large sections of society in developing countries (see for example Besley et al. (2005); Chattopadhyay and Duflo (2004); Clots-Figueras (2010); Duflo (2005); Olken (2010); Pande (2003)).

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Table 1: Occupational backgrounds of Lok Sabha Legislators

Occupation	1952	1957	1962	1967	1971	1977	1980	1984	1989
Agriculturalists	22.5	29.1	27.4	30.6	33.2	36	39.3	38.4	40.4
Social Workers	-	-	18.7	22.9	19	20	17.2	19	17
Lawyers	35.6	30.5	24.5	17.5	20.5	23.4	22.2	18	15.6
Traders/Industrialists	12	10.2	10.3	7.5	6.8	3.3	6.3	7.3	4.4
Educationaists	9.9	11.3	5.8	6.5	7.1	8.4	6.7	7.6	8.7
Writers/Journalists	10.4	10.3	5.8	4.8	6.3	2.1	2.7	1.3	3.7
Doctors/Engineers	4.9	3.5	3.9	4.2	2.9	2.8	3	5.2	-
Civil & Millitary service	3.7	4	0.9	3.2	3.4	1.7	0.9	1.6	-
Ex-princes	1.1	1.4	2.1	1.4	0.4	0.6	0.2	1.1	-

Notes: *Source:* Varshney (1994). Lok Sabha is the lower house of the Indian Parliament. Each entry in the table is the proportion of legislators for that year who belong to the particular occupational category.

Table 2: **Summary Statistics**

Variable	1962	1967	1971	1977	1981
Panel A: Economic and Demographic variables					
Prop. wheat area under HYV	0	.17	0.45	.82	.78
	(0)	(.1)	(.2)	(.18)	(.2)
Wheat yield (tons/Ha)	0.8	1.11	1.23	1.4	1.6
	(0.17)	(.25)	(.32)	(.31)	(.35)
Prop. rice area under HYV	0	.01	.08	.15	.15
	(0)	(.02)	(.13)	(.25)	(.25)
Prop. rice area under HYV (Conditional)	0	.03	.26	.49	.52
	(0)	(.01)	(.09)	(.19)	(.14)
Rice Yield (tons/Ha)	0.73	0.75	0.84	1.14	1.07
	(.11)	(.2)	(.23)	(.43)	(.4)
Daily agricultural wages	1.34	2.42	3.17	6.12	6.39
	(0.44)	(.57)	(.91)	(1.9)	(1.98)
Literacy rates	0.24	.26	.28	.32	.35
	(0.05)	(.06)	(.06)	(.07)	(.07)
Pop. density ('00/sq. Km)	2.76	3.21	3.57	4.12	4.39
	(0.99)	(1.12)	(1.23)	(1.4)	(1.51)
Panel B: Initial conditions (pre Green revolution)					
Average yield$_{1957-1964}$	.85				
	(.15)				
Prop. of district irrigated in 1931	.22				
	(.12)				
Gini coeffcient	.47				
	(.07)				
caste fragmentation	.91				
	(.03)				
Panel C: Political variables					
Fractionalization	0.71	0.73	0.62	0.47	0.70
	(.74)	(1.06)	(.57)	(.23)	(.35)
Plurality	.12	0.1	.26	.42	.13
	(.07)	(.6)	(.13)	(.1)	(.08)
1 - max($voteshare_i$)	0.59	0.61	.46	.32	.59
	(.07)	(.08)	(.09)	(.06)	(.05)
Voter turnout	0.51	.55	.47	.57	.5
	(.06)	(.06)	(.07)	(.06)	(.06)
Congress voteshare	0.38	.34	.49	.25	.37
	(.07)	(.08)	(.15)	(.05)	(.08)
Janata voteshare	0.05	.05	.11	.68	.28
	(.09)	(.09)	(.09)	(.06)	(.1)

Notes: Standard errors are reported in parantheses. Fractionalization is the measure of political fractionalization. gini coefficient is calculated for landed HHs. caste fragmentation is calculated using hindu caste groups from the 1931 census of India.

Table 3: Basic regression

	Janata voteshare	Janata seatshare	Congress voteshare	Congress seatshare	Fractionalization	1-max voteshare$_{ij}$	Plurality	Voter turnout
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Without control variables								
Yield	.06	.12	.02	-.07	-.05	-.05	.03	.006
	(.03)*	(.06)**	(.02)	(.07)	(.02)**	(.02)**	(.02)*	(.01)
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	336	336	336	336	336	336	336	336
R-squared	.85	.75	.64	.62	.68	.71	.63	.51
Panel B: With demographic controls								
Yield	.05	.12	.03	-.07	-.05	-.06	.04	.01
	(.02)**	(.06)**	(.02)	(.07)	(.02)**	(.02)**	(.02)*	(.01)
Pop. density	.03	.05	-.03	-.02	.01	.02	-.02	-.03
	(.03)	(.05)	(.02)*	(.05)	(.01)	(.02)	(.02)	(.01)***
Literacy	.85	2.25	-.10	-3.15	-.58	-.52	-.003	-.17
	(.63)	(1.06)**	(.22)	(.98)***	(.25)**	(.26)**	(.26)	(.12)
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	336	336	336	336	336	336	336	336
R-squared	.85	.76	.64	.64	.69	.72	.63	.55

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. All specifications include district and time fixed effects. The data include 7 election years between and including 1962 to 1989, for 48 districts in UP. Panel A reports estimates for the basic regression without any demographic controls. Panel B includes Population density and literacy rate in a district as controls. *Yield* is the wheat yield in the district in tons/ha. *Janata* is the label for new rural paries with the *Bhartiya Lok Dal (BLD)* as the main constituent , while *Congress* is the dominant party. Fractionalization is constructed as $1 - \sum_j Voteshare_{ij}^2$, while plurality is the difference between the highest and second highest voteshares in a district.

Table 4: General Specification

	Janata voteshare	Janata seatshare	Congress voteshare	Congress seatshare	Fractionalization	1-max voteshare$_{ij}$	Plurality	Voter turnout
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Yield	-.02	-.14	.01	.07	.003	-.02	.06	.03
	(.03)	(.07)**	(.04)	(.12)	(.03)	(.04)	(.04)	(.02)**
Yield$_{1972-80}$	.09	.41	-.02	-.36	-.09	-.07	.02	.003
	(.03)***	(.07)***	(.05)	(.14)***	(.03)***	(.03)**	(.04)	(.02)
Yield$_{1981-89}$	.09	.29	.02	-.11	-.05	-.03	-.05	-.05
	(.03)***	(.06)***	(.04)	(.12)	(.03)*	(.03)	(.04)	(.02)***
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	336	336	336	336	336	336	336	336
R-aquared	.85	.77	.64	.63	.69	.63	.72	.54

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. All specifications include district and time fixed effects. The data include 7 election years between and including 1962 to 1989 for 48 districts in UP. $Yield_{1972-81}$ reports the estimates of $\beta_{1972-81}$ in eqn. 3 and so on. *Janata* is the label for new rural paries with the *Bhartiya Lok Dal (BLD)* as the main constituent , while *Congress* is the dominant party. Fractionalization is constrcuted as $1 - \sum_j Voteshare_{ij}^2$, while plurality is the difference between the highest and second highest voteshares in a district.

Table 5: Subsample regression results

	Janata voteshare	Janata seatshare	Congress voteshare	Congress seatshare	Fractionalization	1-max voteshare$_{ij}$	Plurality	Voter turnout
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Full sample for 1962-1980								
Yield	.12	.16	.02	-.21	-.07	-.08	.07	.009
	(.04)***	(.09)*	(.03)	(.13)⁺	(.03)***	(.03)***	(.03)**	(.02)
Yield	.10	.12	.03	-.16	-.07	-.09	.08	.01
	(.03)***	(.08)⁺	(.03)	(.12)	(.03)***	(.03)***	(.03)***	(.02)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	240	240	240	240	240	240	240	240
Panel B: Excluding Western districts								
Yield	.07	.14	.04	-.09	-.09	-.09	.06	.02
	(.03)**	(.06)**	(.03)*	(.09)	(.02)***	(.03)***	(.03)**	(.01)
Yield	.06	.14	.05	-.09	-.09	-.10	.06	.02
	(.03)**	(.06)**	(.03)*	(.10)	(.02)***	(.02)***	(.03)***	(.01)*
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	287	287	287	287	287	287	287	287
Panel C: Excluding election years 1977 and 1984								
Yield	.13	.23	.04	-.14	-.08	-.09	.06	-.008
	(.05)***	(.11)**	(.03)*	(.12)	(.03)***	(.03)***	(.03)**	(.02)
Yield	.12	.21	.05	-.13	-.08	-.09	.07	.0009
	(.04)***	(.11)**	(.03)**	(.11)	(.02)***	(.03)***	(.03)**	(.02)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	240	240	240	240	240	240	240	240
Panel D: Including district specific time trends								
Yield	.07	-.13	-.005	-.18	-.04	-.07	.09	.003
	(.04)*	(.06)**	(.05)	(.19)	(.04)	(.04)	(.05)**	(.03)
Obs.	240	240	240	240	240	240	240	240

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. All specifications include district and time fixed effects. For Panel A the data include 5 election years between and including 1962 to 1980 for 48 districts in UP. For panel B the 7 western districts are excluded. The excluded districts are *Meerut, Moradabad, Bulandshahr, Bijnor, Muzaffarnagar, Saharanpur and Rampur*. For panel C the election years 1977 and 1984 are excluded. 1977 elections were held after the restoration of the parliament after the 'emergency', and the 1984 one after the assasination of Mrs. Gandhi. Controls include population density and literacy rate in a district. *Yield* is the wheat yield in the district in tons/ha. *Janata* is the label for new rural paries with the *Bhartiya Lok Dal (BLD)* as the main constituent , while *Congress* is the dominant party. Fractionalization is constructed as $1 - \sum_j Voteshare_{ij}^2$, while plurality is the difference between the highest and second highest voteshares in a district.

Table 6: Fixed effects regression with alternative explanatory variable

	Janata voteshare	Janata seatshare	Congress voteshare	Congress seatshare	Fractionalization	1-max voteshare$_{ij}$	Plurality	Voter turnout
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Without demographic controls								
Prop. HYV	.15	.25	.02	-.14	-.08	-.10	.11	-.01
	(.07)**	(.15)+	(.04)	(.16)	(.04)**	(.04)***	(.04)***	(.03)
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	336	336	336	336	336	336	336	336
R-squared	.85	.75	.64	.62	.68	.71	.63	.51
Panel B: With demographic controls								
Prop.HYV	.13	.19	.04	-.09	-.08	-.10	.12	.01
	(.06)**	(.15)	(.04)	(.15)	(.04)**	(.04)***	(.04)***	(.03)
Pop. density	.03	.06	-.03	-.03	.009	.02	-.02	-.03
	(.03)	(.05)	(.02)	(.05)	(.01)	(.02)	(.02)	(.01)***
Literacy	.80	2.16	-.12	-3.11	-.54	-.48	-.05	-.18
	(.63)	(1.10)**	(.23)	(.98)***	(.26)**	(.26)*	(.25)	(.11)
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	336	336	336	336	336	336	336	336
R-squared	.85	.76	.64	.64	.69	.72	.63	.55

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. $+, *, **, ***$ denote significance at 15%, 10%, 5%, and 1% levels respectively. All specifications include district and time fixed effects. The data include 7 election years between and including 1962 to 1989 for 48 districts in UP. Panel A reports estimates for the basic regression without any demographic controls. Panel B includes Population density and literacy rate in a district as controls. *Prop. HYV* is the proportion of wheat area in a district that is sown with HYV seeds. *Janata* is the label for new rural paries with the *Bhartiya Lok Dal (BLD)* as the main constituent , while *Congress* is the dominant party. Fractionalization is constrcuted as $1 - \sum_j Voteshare^2_{ij}$, while plurality is the difference between the highest and second highest voteshares in a district.

Table 7: Impact of irrigation in 1931 on yields

	Yield	Yield	Yield
	(1)	(2)	(3)
P_irrigation1931	1.37	.64	-.08
	(.20)***	(.16)***	(.24)
P_irrigation1931 X		1.01	.73
$\mathbb{1}(year > 1967)$		(.19)***	(.19)***
Controls	No	No	Yes
Obs.	1536	1536	1296
R-squared	.74	.75	.84

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. $*, **, ***$ denote significance at 10%, 5%, and 1% levels respectively. Dependant variable is wheat yield in tons/Ha for each district for each year from 1956-1987. Controls include altitude, latitude, longitude, distance from sea, average monthly temprature and rainfall, population density and literacy.

Table 8: Instrumental variable estimates (Instrumented variable $yield_{it}$)

	Full sample OLS	Full sample IV	Full sample IV 1962-80	IV excluding NW districts	IV excluding 1977,84
	(1)	(2)	(3)	(4)	(5)
Panel A: First stage					
Instrument		[.001]	[.001]	[0.000]	[.001]
F-statistics		35.44	25.10	40.61	32.98
Obs.	336	336	240	287	240
Panel B: Second stage					
Janata voteshare	.06	.46	.34	.29[1]	.50
	(.03)*	(.27)*	(.18)*	(.21)	(.26)*
Janata seatshare	.12	.99	1.12	.83	1.03
	(.06)**	(.66)*	(.51)**	(.22)***	(.25)***
Congress Voteshare	.02	.10	-.07	.05	.09
	(.02)	(.10)	(.11)	(.10)	(.11)
Congress seatshare	-.07	-1.01	-1.46	-.70	-1.2[2]
	(.07)	(.67)+	(.67)**	(.51)	(.71)**
Fractionalization	-.05	-.26	-.22	-.20	-.28
	(.02)**	(.14)*	(.10)**	(.10)*	(.13)**
1 - max(voteshare)	-.05	-.27	-.22	-.17	-.29
	(.02)**	(.15)*	(.10)**	(.11)+	(.16)*

Notes: Each entry in the above table is the point estimate on $yield_{it}$ from a fixed effects regression with $yield_{it}$ as the explanatory variable. Both stages include district and time fixed effects. Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. $+, *, **, ***$ denote significance at 15%, 10%, 5%, and 1% levels respectively. The data include 7 election years between and including 1962 to 1989 for 48 districts in UP. Panel A reports the first stage estimates. p-values on the instrument in the first stage are given in []. Panel B reports the second stage estimates. *Janata* is the label for new rural paries with the *Bhartiya Lok Dal (BLD)* as the main constituent , while *Congress* is the dominant party. Fractionalization is constrcuted as $1 - \sum_j Voteshare_{ij}^2$, while plurality is the difference between the highest and second highest voteshares in a district.

Table 9: Falsification test

| | OLS estimates | | | | IV estimates | |
	Voteshare	Seatshare	Voteshare	seatshare	voteshare	seatshare
	(1)	(2)	(3)	(4)	(5)	(6)
Yield	-.003	.005	.000	.02	-.09	-.12
	(.01)	(.03)	(.01)	(.03)	(.09)	(.14)
Controls	No	No	Yes	Yes		
Obs.	336	336	336	336	336	336
R-squared	.07	.06	.09	.08	.47	.28

Notes: Standard errors in parantheses are robust and clustered at district level to adjust for serial correlation. $*, **, ***$ denotes significance at 10%, 5% and 1% levels respectively. The dependant variable is communist party voteshare and seatshare. The first four cols present results from fixed effects OLS regressions while the last two columns present estimates from IV estimations.

Table 10: Interaction with caste fragmentation

	JP voteshare	JP voteshare	JP seatshare	JP seatshare
	(1)	(2)	(3)	(4)
Panel A				
cfrag X Prop. HYV		-3.55 (1.54)**		-6.41 (3.34)*
Prop. HYV	.43 (.17)**	3.62 (1.46)**	.78 (.34)**	6.53 (3.11)**
Obs.	322	322	322	322
R^2	.85	.85	.75	.76
Panel B				
cfrag X Yield		-1.58 (.60)***		-2.46 (1.42)*
Yield	.06 (.03)*	1.49 (.54)***	.12 (.07)*	2.35 (1.28)*
Obs.	322	322	322	322
R^2	.85	.85	.75	.76

Notes: Standard errors reported in parantheses are robust and clustered at district level to account for serial correlation. $*, **, ***$ denote significance at the 10%, 5% and 1% levels respectively. All the tables include district and time fixed effects. Data is missing for 2 disticts hence the number of observations in 322. *cfrag* is the caste fragmentation in the district. Panel A presents results using prop. of land in the district under HYV as the explanatory variable while Panel B uses wheat yield in the district.

Table 11: Interaction with gini coefficient

	JP voteshare	JP voteshare	JP seatshare	JP seatshare
	(1)	(2)	(3)	(4)
Panel A				
gini X Prop. HYV		1.46 (.63)**		2.45 (1.23)**
Prop. HYV	.43 (.17)**	-.21 (1.46)**	.78 (.34)**	-.30 (3.11)**
Obs.	322	322	322	322
R^2	.85	.85	.75	.76
Panel B				
gini X Yield		.38 (.22)*		.70 (.46)
Yield	.06 (.03)*	-.12 (.11)	.12 (.07)*	-.22 (.22)
Obs.	322	322	322	322
R^2	.85	.85	.75	.75

Notes: Standard errors reported in parantheses are robust and clustered at district level to account for serial correlation. $*, **, ***$ denote significance at the 10%, 5% and 1% levels respectively. All the tables include district and time fixed effects. Data is missing for 2 disticts hence the number of observations in 322. *gini* is the gini coefficient of landholdings for landed HHs only. Panel A presents results using prop. of land in the district under HYV as the explanatory variable while Panel B uses wheat yield in the district.

Table 12: Summary statistics on public good provision

	1971		1991		Overall	
	Mean	Std.dev	Mean	Std. Dev	Mean	Std. Dev
Primary	0.45	0.14	0.65	0.15	0.55	0.17
Middle	0.06	0.03	0.14	0.05	0.01	0.06
High	0.004	0.003	0.009	0.007	0.007	0.006

Notes: The dependent variable is the proportion of villages in a district which have the public good.

Table 13: Change in provision of schools 1971-1991

	Primary school	Middle school	High school
Janata voteshare	.10 (.06)	.11 (.03)***	.01 (.004)**
Fractionalization	.28 (.16)*	.16 (.07)**	.009 (.01)
Yield	.14 (.05)***	.07 (.02)***	.005 (.002)**
Pop. density	.04 (.03)	-.009 (.008)	-.001 (.001)
Obs.	88	88	88
R-squared	.86	.87	.72

Notes: Standard errors reported in parantheses are heteroskedasticity robust and clustered at district level. $*, **, * * *$ denote significance at 10%, 5%, and 1% levels respectively. All specifications include district fixed effects.
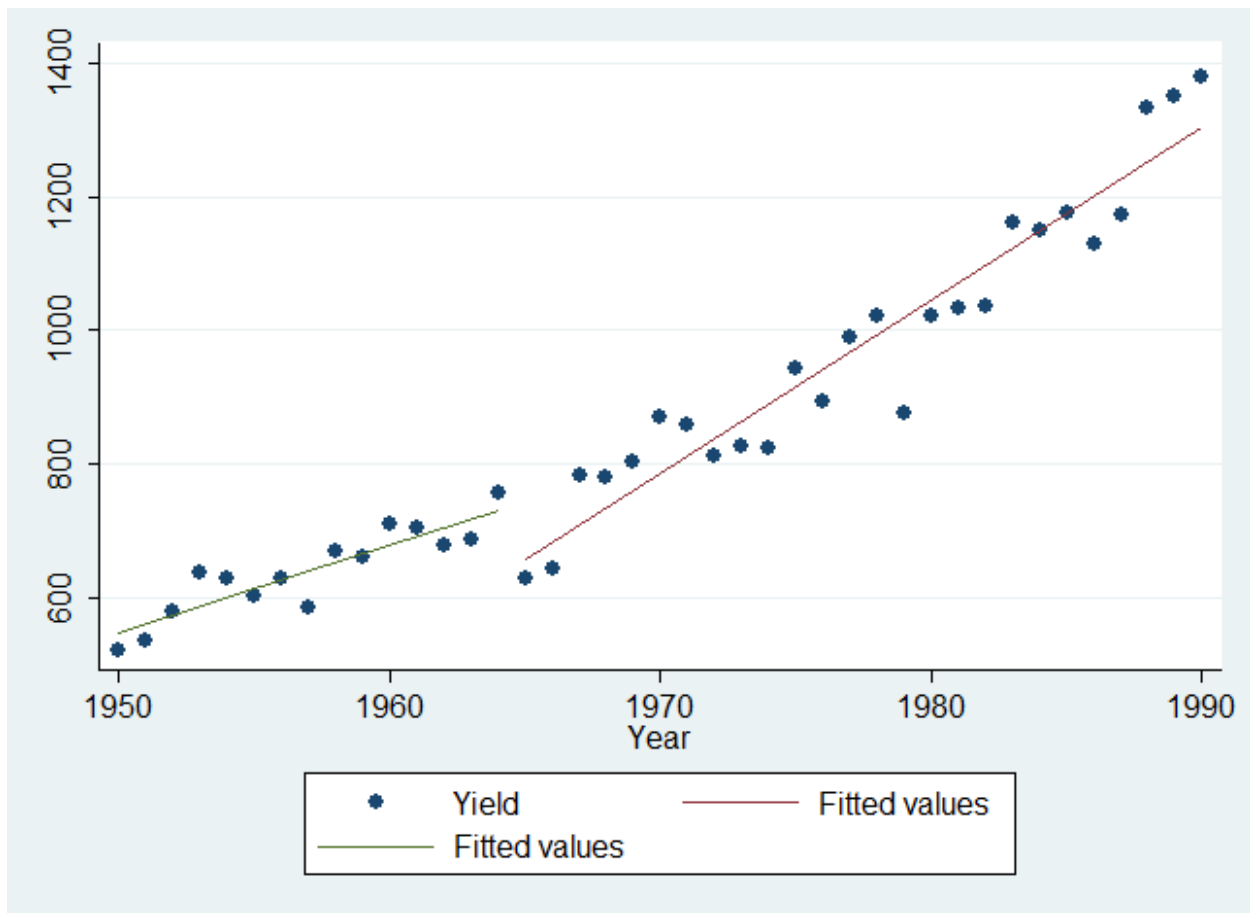
Figure 1: Agricultural yield in India, 1950-51 to 1990-91
Notes: I fit the time trends to the data from 1950-1965 and then 1965-1990. The trends are statistically different at the 5% level. *Source*: Data taken from Agricultural statistics at a glance(2003), Ministry of Agriculture India.
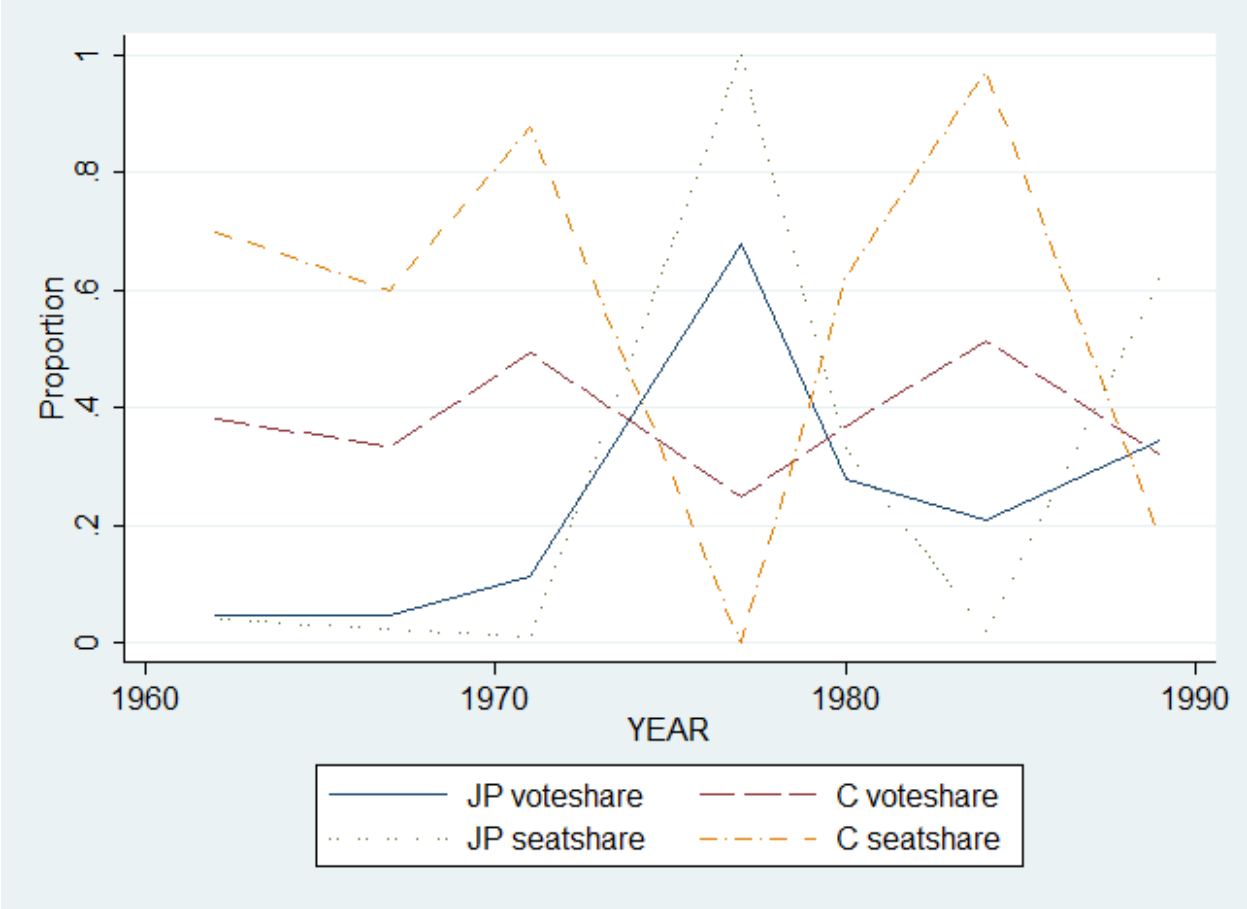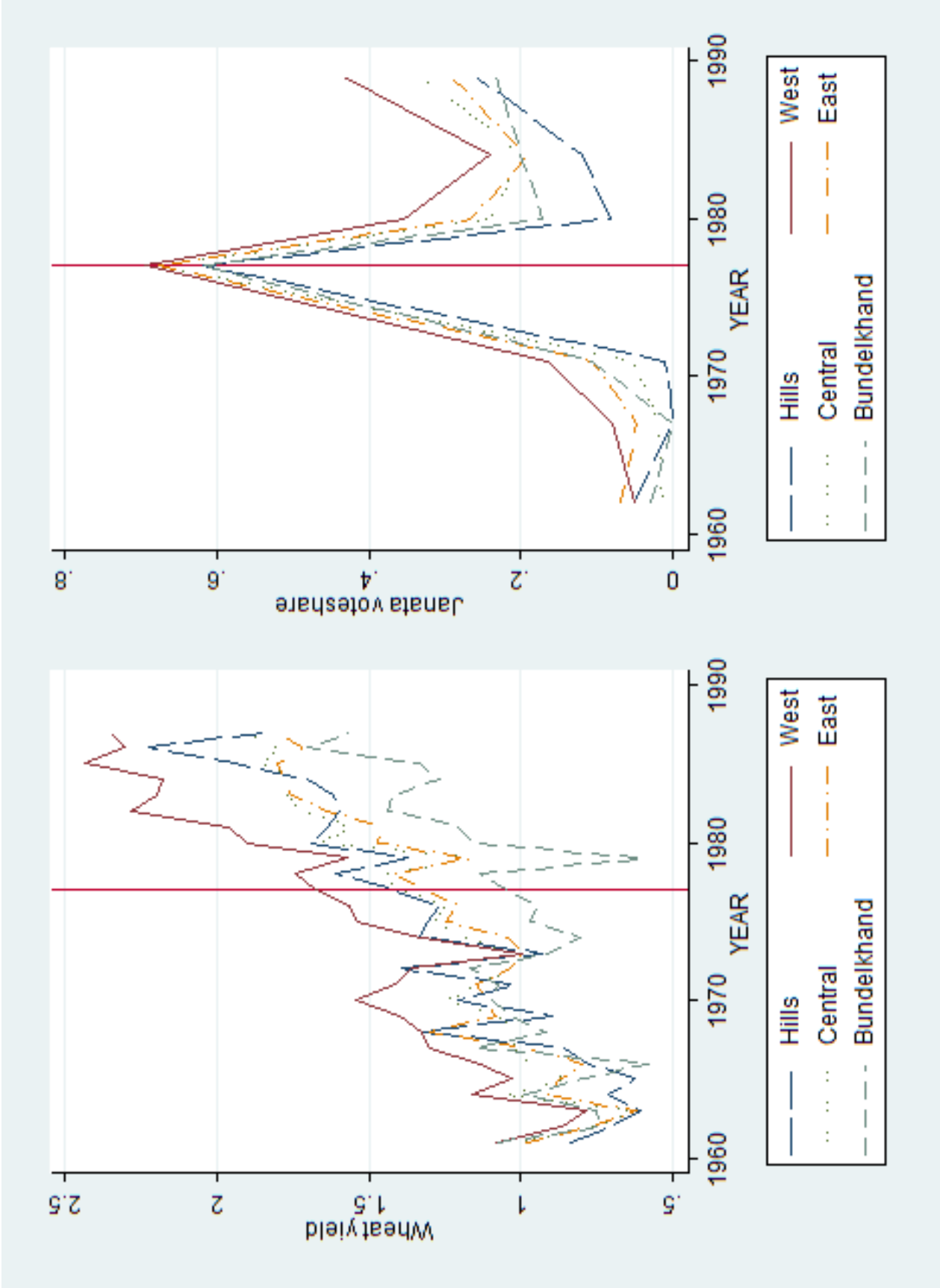
Figure 2: Time trends from UP Assembly Elections

Notes: The data for Janata Party(JP) include the sum of vote shares for parties representing the medium peasantry in each election. The data are taken from election commission reports.

Figure 3: Time trends from UP Assembly Elections
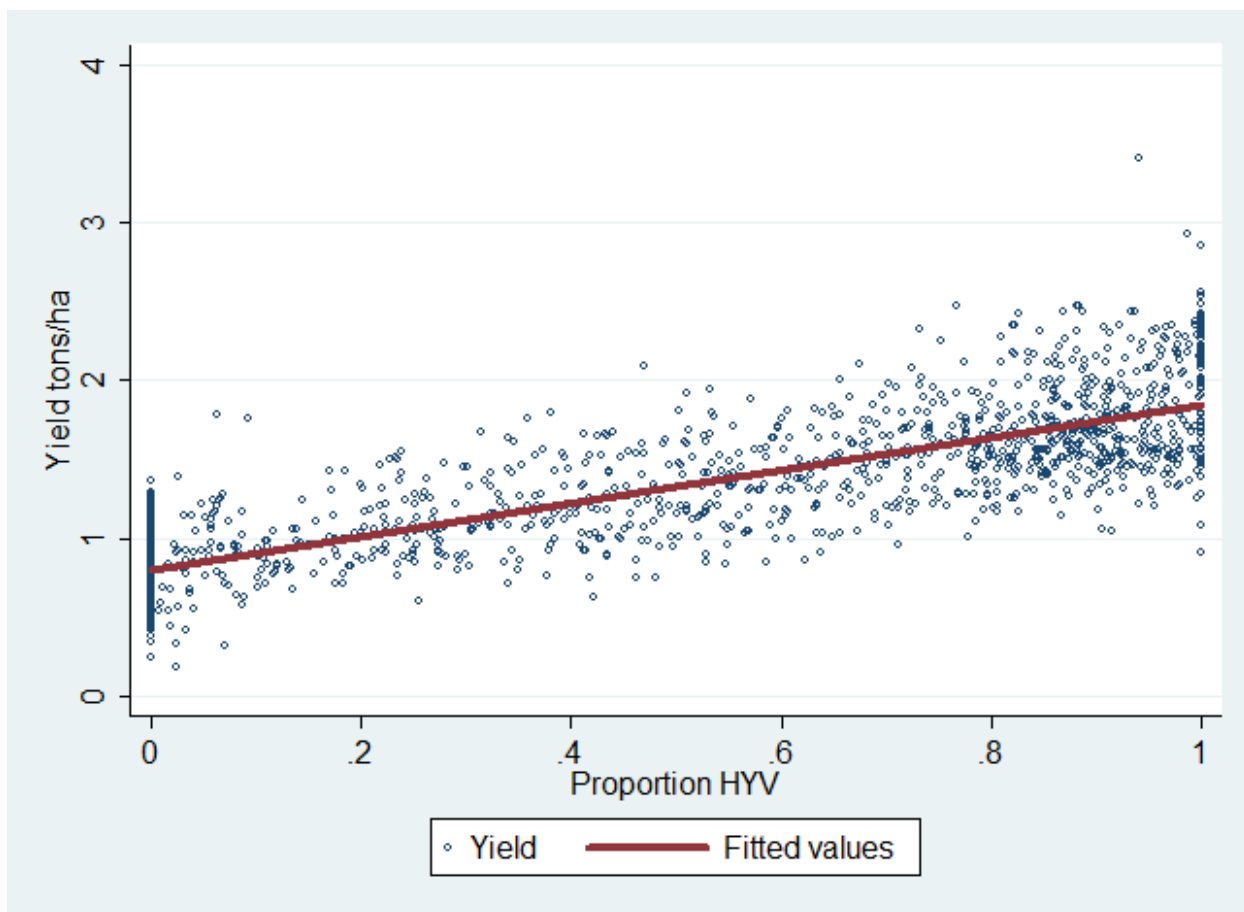
Notes: The data for Janata Party(JP) include the sum of vote shares for parties representing the medium peasantry in each election. The data are taken from election commission reports.

47

Figure 4: Map of Uttar Pradesh

48

Figure 5: Agricultural yields in UP

Notes: The unit of observation is a district-year pair. The variable on the Y-axis is the yield of Wheat in tons/ha and the variable on the X-axis is the proportion of land planted under HYV wheat.
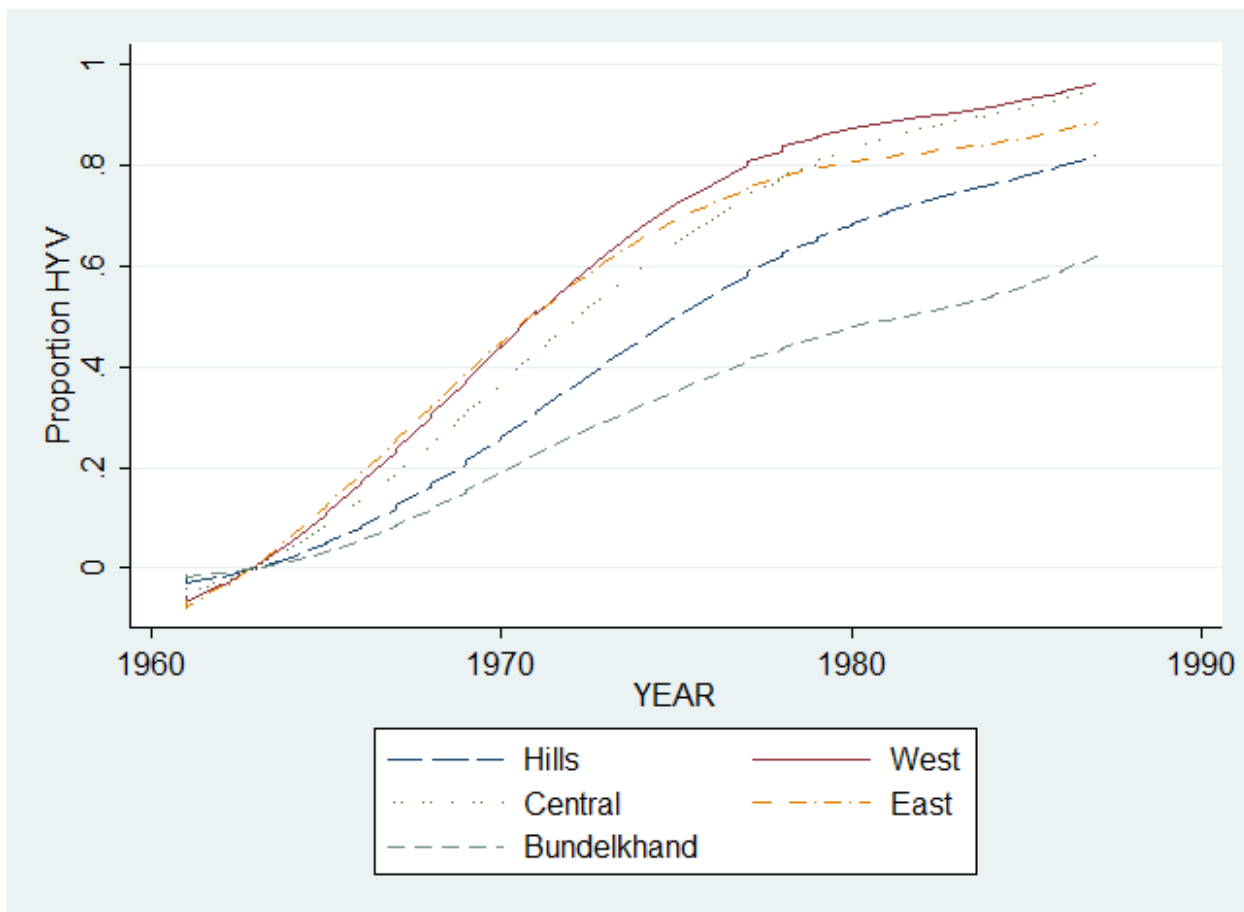
Figure 6: HYV adoption by region in UP
Notes: The dependent variable is proportion of land under HYV wheat. The graphs have been smoothed using locally weighted scatteplot smoothing with a bandwidth=0.8
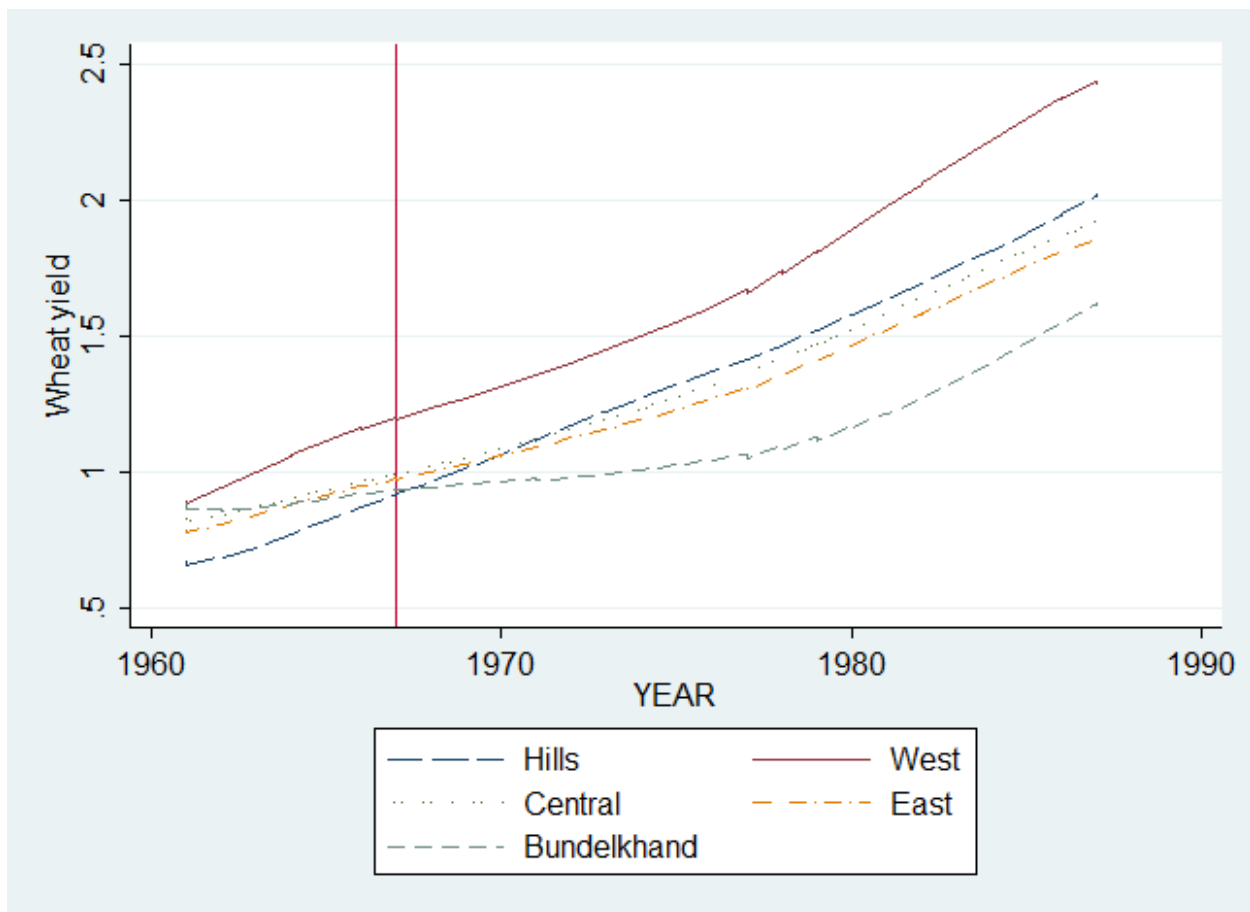
Figure 7: Yields of wheat by region in UP

Notes: The dependent variable is the yield of wheat in tons/ha . The graphs have been smoothed using locally weighted scatteplot smoothing with a bandwidth=0.8. The vertical line is drawn at 1967, the year the HYVs were mass introduced.
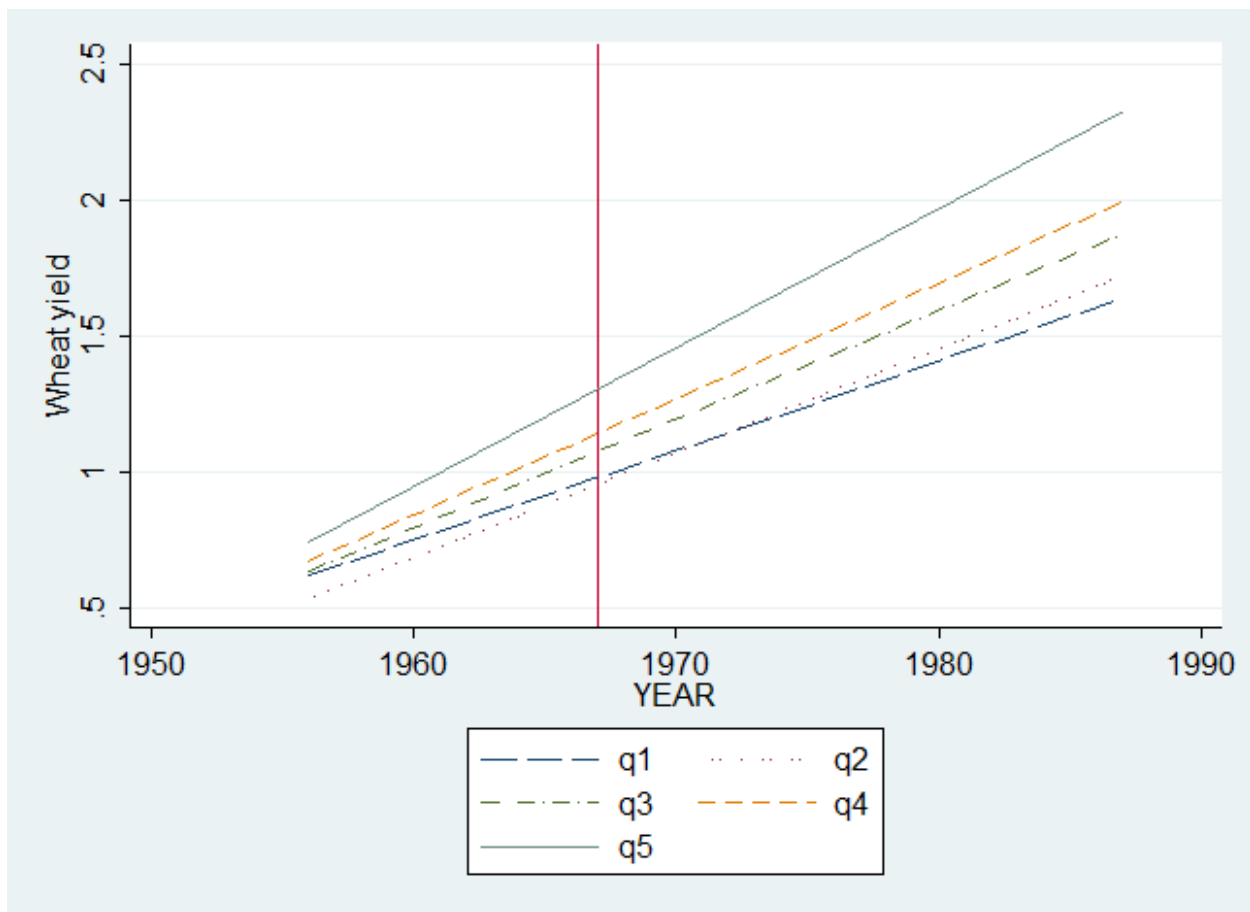
Figure 8: Yields of wheat by Irrigation in 1931 quintiles
Notes: The dependent variable is the yield of wheat in tons/ha . The graphs have been
smoothed using locally weighted scatteplot smoothing with a bandwidth=0.8. The vertical
line is drawn at 1967, the year the HYVs were mass introduced.