ABSTRACT

Title of dissertation: INFORMATION TECHNOLOGY AND RURAL MARKET PERFORMANCE IN CENTRAL INDIA

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Dissertation directed by: Professor Mark Duggan
Department of Economics
Professor Rachel Kranton
Department of Economics

How do improvements in information impact market performance? This dissertation examines the effect of an innovative initiative launched by a private company in the central Indian state of Madhya Pradesh. Beginning in October 2000, it set up 1700 internet kiosks and 45 warehouses that provide wholesale price information and an alternative marketing channel to soybean farmers in the state. I develop a theoretical model of this intervention and estimate the impact using a new market-level dataset with spatial geo-coded information. The causal effect is isolated by exploiting the variation in the timing of the introduction of kiosks and warehouses across districts of the state. The estimates suggest an immediate and significant increase in the monthly wholesale market price of soybeans after the introduction of kiosks, lending support to the predictions of the theoretical model. While the presence of warehouses appears to have no effect on price, warehouses are associated with a dramatic reduction in the volume of sales in the traditional markets. Moreover, there is a significant increase in the area under soy cultivation.

The estimates are robust to disaggregated measures of treatment and comparisons with alternative crops grown in the same season as soy. The analysis suggests that information can substantially enhance the functioning of rural markets by increasing the competitiveness of buyers.

INFORMATION TECHNOLOGY AND RURAL MARKET PERFORMANCE IN CENTRAL INDIA

by

Aparajita Goyal

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Advisory Committee:
Professor Mark Duggan, Co-Chair
Professor Rachel Kranton, Co-Chair
Professor Roger Betancourt
Professor Seth Sanders
Professor Anna Alberini

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Dedication

To my parents for being the reason that this dissertation exists.

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Chapter 1

Introduction

The effect of information provision on market performance has been of considerable interest to economists and policymakers. When a significant fraction of households engaged in agriculture depend on output markets for their livelihood, institutional innovations that improve the functioning of such markets play a potentially important role in determining income (Deaton [1988], Fafchamps [1992], Besley [1997], Bardhan and Udry [1999]). Knowledge of prevailing prices can allow farmers to reap the gains from broader market search. An increase in return can induce farmers to re-optimize their decisions regarding land allocation towards alternative crops.

In the central Indian state of Madhya Pradesh, more than 65 percent of the total workforce is directly involved in agriculture, making it the most important income-earning opportunity [Economic Survey 2005]. Traditionally, farmers sell their produce to traders operating in government regulated wholesale agricultural markets, called *mandis*. The traders in turn sell to processing companies. There are approximately 230 main *mandis* in the state where farmers periodically sell their produce through an open outcry ascending bid auction. The auction begins when a government employee visually inspects the quality and sets the initial bid. From here, the traders bid upwards until the crop is sold [Upton 2003].

Although the traders make up for lack of infrastructure such as transport and storage facilities in rural areas, they are also well informed about prices prevailing in different markets and the price offered by processors (Siamwalla [1978], Hayami et al. [1988], Thomas [2003], Banerji and Meenakshi [2004]). Farmers often do not have information about market conditions prior to the sale. Moreover, processors are unable to perfectly monitor the traders. Access to information as well as direct interactions between farmers and processors can therefore have a potentially important effect both on the price received by rural producers and on their behavior.

A large private sector company, ITC Limited, launched a unique intervention in October 2000 in the state of Madhya Pradesh that to some extent addressed this need.[1] The intervention had two dimensions; internet kiosks were set up in villages that enabled farmers to access daily wholesale prices of soybean, both in the local *mandis* as well as the price offered by ITC (a processor of soybeans). In addition, warehouses (called hubs) were established that enabled scientific testing of quality and facilitated the sale of soybean by the farmers directly to the private company. After comparing the price in nearby *mandis* and the price offered by ITC at the hubs, farmers can decide where to sell their produce. Furthermore, ITC is able to judge the quality of soybean that it purchases directly from the farmers at different prices.

This dissertation examines the impact of this innovative initiative on the price received by soybean farmers in the *mandis* and on their subsequent planting deci-

[1] The ITC group is one of India's largest private sector companies with a market capitalization of approximately 11 billion US dollars and annual sales of 2.6 billion US dollars. ITC has a diversified presence in cigarettes, hotels, agricultural commodities, packaged foods and other consumer goods [Anupindi and SivaKumar 2006].

sions. I develop a theoretical model that explains how the provision of information and the presence of scientific testing together affect the price of soy in local markets. Improvement in price information to farmers, due to the presence of kiosks, is likely to break down the trader's monopsony power leading to an increase in the offer price of the good in the *mandis*. The presence of a hub, however, is likely to exert two opposing forces. On the one hand, direct buying by ITC is expected to divert a part of the sales away from the *mandis*, leading to an upward pressure on price, the competition effect. On the other hand, scientific testing of quality performed at the ITC hubs might induce farmers to self-select, putting a downward pressure on the price offered in the *mandis*, the composition effect. If farmers with good quality soybean have a greater tendency to sell directly to the private company, the effect of the hub on the *mandi* price is *a priori* ambiguous, and is ultimately an empirical question. I test the predictions of the model using a new *mandi* level dataset with spatial geo-coded information.

The location and installation date of each internet kiosk and hub, available from the private company, provide the spatial and time patterns of the implementation of the intervention in the state of Madhya Pradesh. GIS measures of distance are constructed to exploit the heterogeneity in the proximity of *mandis* to hubs. The outcomes, monthly wholesale price and volume of crops sold in all government regulated *mandis* in the state from April 2000 to September 2005, are available from the Madhya Pradesh State Agricultural Marketing Board. Additional price data in a sub-sample of *mandis* is available from April 1998. Measuring the output response to this intervention is crucial for understanding the effect of this intervention on farmers' behavior. Annual district level data on area cultivated, production and yield of crops from 1998 to 2004 is available from the Commissioner of Land Records, Madhya Pradesh.

This is the first attempt to collect detailed data on price and volume of crops sold in government regulated wholesale agricultural markets, along with spatial geo-coded information, to examine the impact of information technology on the functioning of rural markets in Central India. Using differential timing in the introduction of kiosks and hubs across the districts of the state, the analysis finds an immediate and significant increase in the average price of soybean after the kiosks are introduced, lending support to the predictions of the theoretical model. The presence of an internet kiosk in a district is associated with an increase in the monthly *mandi* price of soybean by 1-5 percent, taking into account *mandi* and month fixed effects and district-specific time trends. While the presence of hubs appears to have no effect on average price, hubs are associated with a dramatic reduction in the volume of sales in the *mandis*. This implies that the composition effect perhaps offsets the competition effect, pushing the estimate of the impact of the hub on *mandi* price towards zero. In addition, the dispersion of soybean prices across the affected *mandis* in Madhya Pradesh decreased after the intervention. The increase in price and the reduction in dispersion appears to influence farmers' planting decisions. There is a significant increase in the area under soy cultivation due to this intervention. The estimates are robust to disaggregated measures of treatment and comparisons with alternative crops grown in the same season as soy.

Two contributions of this study stand out. First, the results contribute to the substantial economic literature emphasizing that information is critical for the efficient functioning of markets. A series of theoretical papers including Stigler [1961], Diamond [1971], Salop and Stiglitz [1977], Burdett and Judd [1983], Stahl [1989], McAfee [1995], and Ellison and Ellison [2004] describe models where the presence of costly search lowers competition and creates an inefficient allocation of goods across markets. There is also a growing empirical literature assessing the effects of improvements in information on both the level and dispersion of prices. For instance, Brown and Goolsbee [2002] show that the growth of online price comparison sites reduced term life insurance premia by 12 percent in the US.[2] Finally, a number of studies have examined price dispersion in a variety of product markets. Baye, Morgan and Scholten [2006] provide a survey of studies suggesting that reductions in information costs may lead to either more or less price dispersion, depending on the market environment and the interaction between all market agents.

Second, this analysis sheds light on the role of information technology in enhancing rural development. According to Marker et al. [2002], "the contrast between the complexity and expense of some of these technologies and the urgent, basic needs of the poor has led some to doubt whether it should be a priority for development agencies or for developing countries themselves." Despite the absence of rigorous evidence on the impact of such interventions, there is widespread enthusiasm for the adoption of digital technology for sustainable development.[3] In a recent study,

[2]Similarly, Scott-Morton, Zettelmeyer and Silva-Risso [2001] find that consumers who purchase cars through online markets pay 1.5 percent less than other customers.

[3]Numerous IT projects have been implemented in developing countries, such as the introduction in Bangladesh, Nigeria and Peru of village pay-phones and telecenters that provide remote health care services to villagers, computer literacy and teacher training in rural schools along with improved administrative capacity for local authorities. See World Bank [2003] for a survey of

Jensen [2007] shows, using micro-level survey data, that the adoption of mobile phones by fishermen and wholesalers in South India is associated with a dramatic reduction in price dispersion, the complete elimination of waste and an increase in both consumer and producer welfare. This dissertation presents robust empirical evidence on whether such technologies can improve the functioning of rural markets.

1.1 Agricultural Marketing in Madhya Pradesh

Agricultural markets have been in existence in India for centuries. According to Thomas [2003], at the simplest, each neighborhood had its own designated location, where producers and buyers met in order to engage in trade. The wholesale spot markets for agricultural commodities, as seen today, very much reflects this history. After independence, many major policy decisions affected agricultural commodities markets.

Beginning in 1951, the different Five Year Plans laid stress on the development of physical markets, on farm and off farm storage structures, facilities for standardization, grading, packaging and transportation. To achieve an efficient system of buying and selling of agricultural commodities, state governments and Union Territories enacted legislations (Agricultural Produce Marketing Committee Act) for regulation of agricultural markets. By the end of 1950, there were 286 regulated markets in the country, that increased to 7521 by the year 2005. The basic objectives of the network of physical markets have been to ensure reasonable gain to the farmers by creating an environment for fair play of supply and demand forces,

projects that use information technology to combat poverty.

regulate market practices and attain transparency in transactions.

The Central Government advised all the State Governments to enact Marketing Legislation to promote competitive and transparent transactional methods to protect the interests of the farmers. The Government of India also declares a minimum support price (MSP) for "primary commodities" every year at the national level. The aim is to ensure remunerative prices to the growers of the produce with a view to encourage higher investment and production. Some of the principal crops are rice, wheat, pulses, oilseeds, cotton and sugarcane. Today, there are approximately 25 agricultural commodities for which the government of India sets a minimum support price [Thomas 2003].

According to the Ministry of Agriculture Report [2005], the purpose of regulation of agricultural markets was to protect farmers from the exploitation of intermediaries and traders and also to ensure better prices and timely payment for the produce. However, over a period of time these markets have acquired the status of being restrictive and monopolistic, providing little help in direct and free marketing, competitive trading, information exchange and adoption of innovative marketing systems and technologies [Government of Madhya Pradesh 2008]. Farmers are unable to sell their produce directly. Exporters, processors and retail chain operators are unable to acquire desired quality and quantity of produce for their business due to restrictions on direct marketing. The produce is required to be transported from the farm to the market yard and only then for processing to the plant. There is thus an enormous increase in the cost of marketing and the farmers end up getting a low price for their produce.

An important dimension of state involvement in markets is that of regulation, a phenomenon which has several layers of market penetration. As noted by White [1993], "The first layer is the relatively superficial one of parametric policy intervention by the government to facilitate market operations, correct market distortions, achieve social or developmental goals and the like. At a deeper level, the states involvement is pervasive; it is the source of a complex network of institutionalized arrangements which permeate markets and influence the way they operate: for example, the legal definition of property rights, licensing laws, standardization of weights and measures, creation and validation of money and the regulation of contracts."

The central Indian state of Madhya Pradesh (MP) is the second largest state in terms of area and ranks seventh in population.[4] More than 11 million people are directly engaged in agriculture, contributing 30 percent to the state GDP [Economic Survey 2005]. With most development indicators below the national average, it is among the lower income states of the country.[5] The Madhya Pradesh State Agricultural Marketing Board, established in 1973, facilitated the development of *mandis* (government regulated wholesale agricultural markets) as an essential requirement for farmers to receive a fair price for their produce. Currently there are a total of 233 main *mandis* in the state with well built storage and display areas where farmers periodically sell their produce. In addition, there are 256 'sub-main' *mandis* that

[4]The state has a total area of 308,144 square kilometers and approximately 60 million people [Census of India 2001]. It is closest in area to the state of Arizona in the United States.

[5]In the year 2000, MP had a per capita gross state domestic product of Rs. 7947 and a rural headcount ratio of 37 percent, which was almost 30 percent lower than the national average [UNDP 2002].

have lower levels of infrastructure and are linked to the main *mandis* administratively. Besides the regulated *mandis*, there also approximately 1321 weekly *bazaars* held in the villages where farmers sell some of their surplus produce and buy other goods.[6].

The MP State Agricultural Marketing Act, 1972 prohibits transactions outside the *mandis*. Every farmer is required by law to sell his or her produce in these regulated markets. According to Upton [2003], "transactions outside the *mandis* were officially prohibited by the Government to protect farmers from exploitation by unscrupulous buyers. Open auctions were considered the best safeguard against this." Nevertheless, an estimated 12 percent of the produce is sold by farmers to cooperative societies and village merchants outside these spot markets. There is a provision in the by-laws of the Act that exempts farmers with small landholdings from selling inside the physical confines of the *mandis*. Moreover, a small fraction of farmers prefer to sell the produce directly to cooperatives or village merchants with whom they may have prior credit linkages. The *mandis* in the state are classified into four categories (A-D) based on the annual revenue collected through the payment of *mandi* tax by buyers. There are 30 A grade, 25 B grade, 84 C grade and 94 D grade main *mandis* located in the towns of MP.[7] Every buyer operating inside a *mandi* pays 2.2 percent of the purchased value as tax to the *mandi* committee.[8]

[6]See www.mpmandiboard.com

[7]The A grade *mandis* are largest with a gross annual income of over Rs.40 Lakhs. B grade *mandis* have a gross annual income between Rs.20 Lakhs and Rs. 40 Lakhs. C grade *mandis* have an annual revenue between Rs. 6 Lakhs and Rs. 20 Lakhs and D grade have a gross annual income lower than Rs. 6 Lakhs (1 Lakh=100,000).

[8]Weekly tax is paid by the buyers to the *mandi* committee. Buyers are not allowed to resell the produce in the *mandi* after declaring the total quantity bought to the *mandi* officials.

The procurement process in the *mandis* of different sizes is identical. However, the average price of soybean in A grade markets was 4.5 percent higher than those in D grade markets in the year 2001. This price variation could be due to differences in the number of buyers operating in each market. Farmers, responding to surveys, express a preference for going to A grade markets where a large number of buyers operate, which leads to better price realizations, presumably due to greater competition and lower collusion amongst the traders [World Bank 1997]. The buyers in the *mandi* are all licensed traders; i.e. each buyer needs to obtain a license to operate inside a *mandi*.[9] These traders are mostly intermediaries and eventually sell the produce to millers, processors and plant owners (involved in crushing or refining of the produce). A trader who buys on behalf of a private company is sometimes called a commission agent because the private company pays him a commission to build a relationship that ensures timely delivery of produce in the future.[10]

According to Singh [2005], soybean cultivation in India was negligible until 1970, but it grew rapidly thereafter in response to the domestic deficit of edible oil supply. India is now the 5th largest producer of soybean in the world and MP produces more than 60 percent of India's soybean crop. The largest producer of soybean in the world is the USA, followed by Brazil, Argentina and China as of 2005. India produces about 6 million tons of soybean annually. The state of MP is the largest producer of soybean in India, followed by Maharashtra and Rajasthan.

[9] Each buyer needs to apply for a license from the *mandi* committee. A buyer can apply for multiple licenses to operate in multiple *mandis*. In 2005, the license fees per *mandi* was Rs. 1000 plus security deposit based on a trader's one day maximum purchase. Anecdotal evidence suggests that license fees are not prohibitive.

[10] For example, ITC buys soybean from their agents and pays them 1 percent of the purchased value as commission.

Soybean is usually sown in June because it requires sufficient moisture for its germination, and the monsoon rains are very important for the subsequent growth of the crop. There are 2 major cropping seasons in India: *Kharif* and *Rabi*. The *Kharif* season falls during the south-west monsoon (July-October) when crops are grown both in rain-fed and irrigated areas. Soy is a *Kharif* crop. The *Rabi* season falls during the winter months (November to March) when crops are grown mostly in irrigated areas. From November to March, most soy farmers grow wheat [Government of Madhya Pradesh 2005]. The crop is ready to be harvested in September and being a cash crop, almost the entire crop is marketed. Approximately 65 percent of the total soybean produced in a year is sold in the *mandis* from October-December, immediately after the harvest. There also appears to be considerable seasonal fluctuation in price. For instance, the average price in the fourth quarter, over the years 2000-2005, is 8.5 percent lower than in the second quarter.

Farmers transport their produce by animal-drawn carts and tractors to a nearby *mandi* where it is sold through an open outcry ascending bid auction. Field studies reveal that farmers travel 30-50 kms. on average to reach a *mandi* and they usually make this trip a couple of times each month (Upton [2003], Anupindi and SivaKumar [2006]). The farmer displays his produce in a heap in the *mandi* yard or simply stands besides his tractor. The auction begins when the auctioneer (a government employee) visually inspects the quality and sets the initial bid. From here the traders bid upwards until the produce is sold. This is a very rapid process and in a matter of seconds the final price is decided. The government employee and the traders move from heap to heap picking up samples of the produce and making a price estimate. In principle, edible oilseeds are traded on the basis of fair average quality (FAQ) determined by the presence of dirt, damaged seeds and moisture content in each lot of produce offered for sale. For instance, the highest or the FAQ price is offered to a sample of soybean that is on a 2-2-10 quality scale (2 percent of the sample contains dirt, 2 percent contains damaged seeds and there is 10 percent moisture in the seed).[11] Traders start to discount the price of beans when the proportion of dirt, moisture and damaged seeds exceed that level.

Once the final price is set, the farmer's produce is bagged and weighed on a manually operated balance scale. Various field studies have pointed out that the actual weight of the crop is often manipulated at this point because of the inaccuracy of the crude beam scales. Moreover, the farmer is made to pay for the cost of bagging and the final cash payment to the farmers is also often delayed (Prahalad [2003] and Upton [2003]). After weighing, the full value of the farmers produce is calculated and the farmer is paid in cash. Oilseed grading is undertaken in an unscientific manner in nearly all *mandis*; formal testing of the oil content to discern quality is not performed [World Bank 1997]. It is important to clarify the various dimensions of soybean quality in this context. The transactions between farmers and buyers are based on observable features of quality such as the amount of moisture, dirt and damaged seeds in each lot of produce offered for sale. This is mostly dependent on the storage technology used by farmers, which is likely to be highly correlated with their income. However, there is an unobservable dimension of quality that

[11]If a farmer had soybean with say, 1-1-5 quality parameters, he would still receive the FAQ price.

refers to the amount of oil and protein content of the seed. This aspect of quality is dependent on the variety of seeds planted by the farmers, the timely application of pesticides and fertilizers and use of farming techniques. Discussion of the impact of the intervention on overall improvement in both observable and unobservable aspects of quality is presented in a later chapter.

Soybean prices in India are determined to an extent by conditions prevalent in the international market. Soybean is processed to extract edible oil and a high protein residue called de-oiled cake (DOC).[12] Edible oil produced in India is sold in the domestic market while DOC is exported as animal feed to the Middle East and South East Asian Countries. The *mandi* price of soybean in Madhya Pradesh tracks the Chicago Board of Trade (CBOT) prices of soybean, DOC and oil reasonably closely. The correlation coefficients of the monthly *mandi* price of soybean in MP with the CBOT price of soybean, soy-oil and soy-meal are 0.84 (0.06 s.e.), 0.42 (0.03 s.e.) and 0.87 (0.09 s.e.) respectively.[13]

1.2 Description of the *e-Choupal* Intervention

ITC Limited, an Indian private sector company, implemented an *e-Choupal* program that enabled it to buy soybean directly from the farmers starting in October 2000.[14] Prior to this intervention, ITC bought soybean from traders (operating in

[12]The processing of soybean is done by solvent-extraction process. In India, soybean is composed of 82 percent DOC and 18 percent oil. DOC is used as a major animal feed ingredient for poultry and cattle (www.sopa.org).

[13]The CBOT price is listed in US Dollars/Ton. The monthly *mandi* mode price listed in Rupees/Quintal was converted to US dollars/Ton using monthly exchange rates. CBOT prices of crops and currency exchange rates are available from the *International Financial Statistics* of the International Monetary Fund.

[14]The word *choupal* stands for a village gathering place in Hindi.

the *mandis*) and processed the beans to produce edible oil for sale in the the Indian domestic market and DOC for export.[15] Since ITC did not have any direct contact with the farmers, it commissioned certain traders (called commission agents) to buy soybean from the *mandis* on its behalf. The company was dependent on its agents' knowledge about local farmers and their produce.

Interviews with ITC officials revealed that the distortion of quality undertaken by the agents meant that the company paid a high price for a lower overall quality of soybean, which upon processing yielded less oil and more contaminated DOC.[16] The ability of traders (or middlemen) to identify quality has been noted in markets for many other goods by Biglaiser [1993] and Li [1998]. In this scenario, although traders are skilful in recognizing the quality of soybean sold by farmers, they may not necessarily preserve it while reselling it to the processor.

ITC believed that by bypassing the intermediaries, it would be able to better control the quality of the produce and also lower its transaction costs. A puzzling feature is that ITC was unable to design incentives to correct the behavior of its agents.[17] One possible explanation could be that discerning quality and preserving it while storing and transporting the crop is a very expensive process because quality is measured on a continuous scale. Moreover, the company had dual roles for the infrastructure that it was creating as it planned to sell its own consumer products in

[15] ITC is not a monopsonist in the soybean business, having less than a 10 percent of the market share of soy in MP. There are 5-6 large buyers of soy in MP with Ruchi Industries being the largest.

[16] Agents buy soybean of varying quality throughout the day. They mix different grades of quality and sell the lot to the company at a high price. Moreover, agents often ask ITC to increase its price saying that the price is too low for them to buy any soybean in the *mandis*.

[17] There is substantial theoretical and empirical literature which describes the failure of compensation schemes to generate correct behavior. For instance, see Kranton and Swamy [2005] for a discussion of the failure of the agency system in the context of textiles in colonial India.

rural areas in the future. According to Kumar [2004], "ITC calculated that it saved Rs. 12.9 million in the first year of operation through better quality oil and DOC obtained from processing soybean procured through the *e-Choupal* intervention."

This intervention provided an alternative both to ITC for procuring soybean and to soy farmers for selling their produce. Beginning in the year 2000, ITC established a total of 1700 internet kiosks and 45 hubs over the course of 4.25 years in the major soy growing districts of the state.[18] The intervention has two dimensions. Internet kiosks were set up in villages that provide information about *mandi* prices to soy farmers in the state. Each day the (minimum and maximum) prices of soybean in approximately 60 local *mandis* are posted on the website.[19] Along with this information, ITC's own offer price at its 45 hubs is also posted. Specifically, each evening, ITC posts the prevailing *mandi* prices and its offer price for high (FAQ) quality soybean at the hubs that is guaranteed for the next day.[20] Figure 1 shows a snapshot of the daily average posted prices for a period of 45 days in the year 2004. The posted prices of ITC are relatively competitive with the prevailing *mandi* prices and generally lie between the daily minimum and maximum price of the *mandis*. In addition, information on farming techniques and weather conditions is also available in the local language to farmers through the kiosks. Each internet kiosk was designed to cater to its host village and four other neighboring

[18]The full cost for setting up the infrastructure was borne by ITC and farmers could use these services free of charge.

[19]www.echoupal.com

[20]The offer price of ITC posted in the evening on the website is honored the next day. The next morning, ITC offer prices may be revised according to the *mandi* movements. The ITC price can go up from the posted price (if the *mandi* rates are higher) but can never fall. Thus ITC offers a guaranteed price.

villages within a five kilometer radius [Prahalad 2003]. Host villages were chosen according to population and landholdings of the farmers.[21] The internet kiosks are managed and operated by trained farmers who are selected from within the village and provide free services to other soy farmers.[22]

Hubs are mostly warehouses that are established in towns. The 45 hubs include the 9 processing plants leased by ITC. Hubs represent a point of contact between farmers and the ITC. A farmer can sell directly to ITC by going to the nearest hub. ITC's goal is to have a hub within a 30-40 km. radius of its target farmer [Prahalad 2003]. A cluster of 40 kiosks were set up around each hub such that it would represent the nearest hub to that 'catchment area.' Once the farmer arrives at one of the hubs, his produce is carefully tested to discern quality. ITC can offer a price below the posted FAQ price if quality is below the FAQ level. However, the minimum support price (declared annually by the Government of India) is the lowest price that ITC can offer for a certain poor quality threshold.[23] After the price is

[21] A host village is typically a middle rung village with a population of 1000-3000 (according to the 1991 census) and an average size of atleast 1000 acres.

[22] ITC used its relationship with the commission agents to identify villages where the internet kiosks would be placed. The computer equipment was typically placed in a farmer's house. The chosen farmer was called the *sanchalak*. ITC held meetings in villages to explain the *e-Choupal* concept and asked for nominations for *sanchalak*. Farmers either recommended others or volunteered themselves. Thereafter, ITC interviewed all respondents and selected the farmers according to different criteria such as (i) education level (at least secondary school), (ii) a cement house in the village with young children (iii) farmer with an average of 15-20 acres of landholding and (iv) having a good rapport with other farmers in the village. The chosen farmers were then trained in basic computer usage. The farmers that operate the kiosks receive 0.5 percent of the value of each transaction that is made through the kiosk at the ITC hub, thereby giving them the incentive to spread price information widely to other farmers. Every day, each *sanchalak* gives out a certain number of tokens to farmers who wish to sell their produce to ITC. Tokens were necessary for ITC to keep track of the commission that the *sanchalak* would earn as well as the daily cash requirement at the hub. Conversation with farmers revealed that these tokens are not restrictive. Moreover, cellphones appear to play an important role in transmitting information to farmers in neighboring villages.

[23] If a farmer with a very poor quality of soybean shows up at the hub, such that the offer price falls below the minimum support price, ITC is forced to send him back. ITC is not allowed to

set and accepted by the farmer, his beans are weighed on an electronic weighbridge, and the weight is multiplied by the offered price. The farmer then receives cash instantly.[24]

In the initial period of the intervention (between October 2000 to April 2003), ITC used a provision in the by-laws of the Marketing Act to procure soybean from farmers at its hubs. This provision permitted farmers with small landholdings and annual output, who are unable to travel to the *mandi*, to sell their produce outside the regulated markets, in front of a government official in the village [Government of MP 2003]. The state Marketing Act was subsequently amended in April 2003 allowing farmers to sell outside the *mandis* provided that the buyers obtain a 'Purchase Center License'. This license enables a particular buyer to establish centers to procure agricultural produce outside the physical confines of a particular *mandi* subject to full documentation of its transactions and the payment of *mandi* tax. According to Upton [2003],"At the conception of the e-choupal, ITC was able to convince the government of the potential benefits to the farmer and economy. The government amended the act to legalize purchases of beans outside the *mandis.* Since the website was accessible to anyone, including the government to cross-check posted prices - it facilitated the government's acceptance of the initiative."[25].

buy soybean below the minimum support price (MSP). Transactions below the MSP are allowed in the mandis simply because they take place in front of government officials who can validate the quality claim.

[24]The hubs are managed in part by ITC's former commission agents, who are now called '*samyojaks*' or collaborators. ITC has tried to integrate its commission agents into this intervention because they provide important services like transportation and storage and have knowledge about local village conditions. ITC had approximately 120 CAs before the intervention but only 45 have been turned into *samyojaks*.

[25]Buyers had to pay annual fees to obtain the license as well as pay the regular *mandi* tax on every purchase. The license fees per center is Rs. 10,000 plus security. The license can be renewed every five years [Government of MP 2003]

The amendment of the Act represents an important step towards greater flexibility in the marketing of agricultural produce in the state. The MP Government issued another amendment on June 9, 2004 that decentralized the entire procurement system in MP. Independent buyers could now apply for a central state-wide "Special License" that allows them to procure outside all the *mandis* in the entire state of MP. The special license was issued by the Marketing Board to ITC Limited allowing it to procure outside any *mandi* in the state, subject to full documentation of its transactions and payment of *mandi* tax. Although a few other competitors in the soybean market have started buying outside the *mandis* through the purchase center license starting in 2003, the special license is currently only with ITC. In 2005, the Special License fee was Rs. 2 Lakhs plus security deposit based on the buyer's one day maximum purchase. The license can be renewed every five years. Conversations with Government officials revealed that the tax revenue increased after the intervention, suggesting that traders operating inside the *mandis* might be evading taxes as well. In fact, there is a proposal pending before the Central Agricultural Ministry of the Government of India to allow private procurement of agricultural produce at the national level.

Figure 2 shows the intensity of soy production across all the districts of MP. The 45 districts can be divided into two main regions: the high soy producing region in the west central part of the state and the low soy producing region in the east. The abundance of deep and medium black soil in the western region of the state makes it very conducive to soy production, while the eastern and northern regions are primarily a rice growing belt. The shaded region in Figure 3 shows the districts where the intervention was implemented. The kiosks and hubs were built in the 23 high soy producing districts in the west central region of the state.[26] The "treated" districts are further characterized by slightly higher soy prices, as depicted by the quarterly trend in the raw price of soy from 1998-2005 in Figure 4.[27] Table 1 shows the total number of kiosks and hubs in each district; an average of 74 kiosks and 2 hubs per district were built. The majority of the hubs were established in the same town as a main *mandi*; as depicted by the starred locations in Figure 3. The distribution of a subset of kiosks is depicted in Figure 5.[28]

While paved roads connect major towns and cities, most of the villages and interior areas are connected by poor quality unpaved roads (as depicted by the lighter shaded lines in Figure 6). This makes it especially difficult for farmers to travel from their village to the *mandis* on a regular basis. The importance of rural road infrastructure to economic growth and prosperity has been discussed extensively by Binswanger, Khandker and Rosenzweig [1993], Jacoby [2000], Key, Sadoulet, de Janvry [2000] and Jalan and Ravallion [2002]. Sparse road connectivity leads to extremely high transport costs for the farmers, leading to limited spatial arbitrage opportunities.

In the next chapter, I develop a simple model that captures some of the key

[26] According to Census 2001, there were 45 districts in Madhya Pradesh. Three new districts were created in 2003 making a total of 48 districts in 2005. I have considered the total number of districts as in census 2001 to avoid complications.

[27] According to World Bank [1997], the majority of the soy processing plants are located in the west-central region, thereby reducing the number of soybean buyers in the east. Moreover, being closer to the west coast ports of India as well as to the major oil consumption markets means that freight costs are lower, leading to higher soybean prices in the west. These factors might explain why prices are lower in the east.

[28] This figure was made available from the International Business Division of ITC Limited. It does not represent the spread of all 1704 kiosks.

features of the rural marketing environment. In particular, I consider the presence of physical transport costs and information frictions, which tend to limit farmers' choices of where to sell their produce. An important motive for ITC to start buying directly from the farmers was to be able to control the quality of soybeans that it purchases. The endogeneity of supply in a simultaneous game gives us predictions about the determination of prices of differentiated products. There are other significant features of the intervention, such as the offer of a guaranteed price by ITC Limited and the repeated interactions between the traders and farmers, that are not explicitly modeled. However, even this simple and tractable model provides an understanding of the types of effects that can be expected from the intervention and the underlying mechanisms.

Chapter 2

The Value of Information and Direct Access to Buyers: Theoretical Investigation

Consider a variant of the Hotelling (1929) model in which farmers are uniformly distributed along the interval $[0, 1]$. The good has 2 quality levels - high (H) and low (L). Farmers observe the quality of their good. A proportion λ of the farmers have low quality and are distributed uniformly along the unit interval. The farmers have unit supply; i.e., each farmer sells one or zero unit of the good.

There are two towns located at the extremes and in each town is a market. For simplicity assume that only one trader operates in each market.[1] Trader 1 is located at $x = 0$ and trader 2 at $x = 1$. The unit cost for each trader operating in each market is c, and is independent of quality. For ease of exposition, c is normalized to 0.[2] Farmers incur a transportation cost t per unit of distance.[3] Thus, a farmer living at x incurs a cost of tx to go to trader 1 and a cost of $t(1-x)$ to go to trader 2. Let us assume that traders do not possess the technology to verify quality. Further assume that both traders sell the good to processors at a competitive price $p_i^{'}$, where

[1] As discussed in the previous chapter, there are multiple traders operating in each *mandi* who participate in the procurement auction. Banerji and Meenakshi [2004] structurally estimate the auction procedure in these markets and find evidence of collusive behavior within markets. In this chapter, I do not explicitly model the auction process or the strategic interaction between traders within a given *mandi*, but rather focus on the interaction between traders across *mandis*.

[2] This represents the miscellaneous transaction costs incurred by the traders such as the costs of storing, weighing, loading, and bagging per unit of soybean.

[3] The results of this model hold for more general quadratic transportation costs as well.

$p_i^{'} = \gamma_i p^* + (1-\gamma_i)p^{**}$ such that $p^{**} > p^*$ and γ_i is the proportion of trader i's goods that are of low quality.[4]

The timing of the game is as follows: Traders simultaneously choose prices. Farmers then choose to sell to either trader 1 or trader 2.[5] Let the price offered by trader 1 be p_1 and the price offered by trader 2 be p_2. I will examine outcomes under different assumptions about the observability of prices to farmers.

Suppose first that farmers are not perfectly informed about the price offered by traders prior to sale. A farmer can sell the good to a trader if and only if he knows the price offered by that trader. I adopt the model developed by Tirole [1988], which builds on Butters [1977] and Grossman and Shapiro [1984], to analyze spatial competition with imperfect information. Let $\Theta_i (i = 1, 2)$ denote the fraction of farmers who know the price offered by trader i. Farmers located anywhere along the segment have equal chance of knowing this price information. The potential supply to trader 1 is a proportion Θ_1 of all farmers. A fraction $1 - \Theta_2$ of this potential supply do not know the price offered by trader 2. The remaining fraction Θ_2 also know the price offered by trader 2 and therefore constitute a more elastic or competitive segment of supply. In this competitive segment of supply, the farmer who is indifferent between the two traders is located at x, where x is given by equating $p_1 - tx = p_2 - t(1 - x)$. The supply to trader 1 in the case of imperfect

[4]This captures the idea that a processor samples the quality of the produce and pays a price based on the proportion of low quality. γ_i is determined in equilibrium. $(0 \leq \gamma_i \leq 1)$

[5]I implicitly assume that transport costs are below the price offered by the processor for low quality $(t < p^*)$ such that farmers always prefer to sell.

information is given by:

$$S_1 = \Theta_1 \Big[(1 - \Theta_2) + \Theta_2 \Big(\frac{p_1 - p_2 + t}{2t}\Big)\Big]$$

When the two traders choose prices simultaneously, trader 1's choice is described by:

$$max_{p_1} \Bigg\{ (p_1^{'} - p_1) \Bigg(\Theta_1 \Big[(1 - \Theta_2) + \Theta_2 (\frac{p_1 - p_2 + t}{2t})\Big] \Bigg) \Bigg\}$$

and trader 2's choice similarly. I will examine the situation where $\Theta_1 = \Theta_2 = \Theta$. The symmetric equilibrium prices offered by both traders are:

$$p_1^{pre} = p_2^{pre} = \lambda p^* + (1 - \lambda) p^{**} - \frac{t(2 - \Theta)}{\Theta} \quad (2.1)$$

A. Introduction of Kiosks

When kiosks that post prices are introduced, Θ increases. It is straightforward to see that equilibrium prices will be higher ($\frac{\partial p^{pre}}{\partial \Theta} = \frac{2t}{\Theta^2} > 0$). The provision of price information to farmers increases the proportion of the market where traders compete. This result yields the first testable implication:

Prediction 1: *As the fraction of informed farmers increases, the equilibrium price offered by traders will increase.*

This prediction will be directly tested in the subsequent chapter. The magnitude of the increase will depend on the parameter Θ. If Θ is high to begin with, then the increase in the price caused by the introduction of kiosks is unlikely to be very large. A plausible concern is that interlinked transactions between farmers and traders, such as the provision of credit by traders that binds the sale of the final product by the farmers to them, will imply that better information will not lead to more arbitrage opportunities (as discussed by Bardhan [1989], Bell and Srinivasan [1989]). However, interviews with farmers did not reveal any evidence in support of significant interlinkages in the production of soy. Farmers reported that they obtain credit from nationalized banks and cooperative societies rather than from the traders. I found that farmers with marginal land holdings sometimes do depend on traders for credit, but this was not very prevalent. The village traders buy the produce from the farmer in return for the credit. Thus, instead of giving back the money to the trader, the farmer gives back his produce. Interlinkages appeared to be present for very small farmers in some areas. The rapid expansion of the rural bank network is noted by Burgess and Pande [2005].

B. Introduction of Kiosks and Hubs

Now, suppose that a third trader, which I call trader 3, enters and locates itself next to trader 2 at $x = 1$. This is consistent with how ITC Limited introduced its hubs; 40 out of the 45 hubs were located in the same town as the main market. Theoretically, it might be optimal for trader 3 to locate itself in the middle of trader 1 and 2 to capture supply. In reality hubs must be established in towns and not on farm land. The towns are located at the extremes of farm land, which is where trader 3 can set up hubs. Moreover, since ITC is both a buyer and a seller, there may be potential benefits to ITC for locating itself in a market town. For example, in addition to buying soybeans, it planned to sell its own consumer goods in the future and local proximity of firms that produce similar, competing or related products would reinforce the absolute advantages of many small areas.

According to Jovanovic [2003], the location of firms depends not only on costs of production and marketing, but also on economies of scale, activity-specific backward and forward linkages, path dependence and the existence of sophisticated markets. This is because competitiveness often depends on highly concentrated "local" knowledge; capabilities and common tacit codes of behavior which can be found in spatially concentrated clusters. Firms therefore have an incentive to locate in an agglomeration as externality operates through well-defined anonymous market interactions [Johansson and Quigley 2004].

I assume that the price offered by all traders is known to all farmers prior to sale ($\Theta_i = 1$). Trader 3 has access to superior technology that allows it to verify quality. Farmers know that trader 3 can distinguish between quality levels. I continue to assume that traders 1 and 2 do not possess the technology to verify quality. Each of the three traders set prices. Let p_1 be the price offered by trader 1 and p_2 be the price offered by trader 2. Trader 3 sets p_3^L for low quality good and p_3^H for high quality good. The strategy profile of all traders is given by $\mathbf{p} = (p_1, p_2, p_3^L, p_3^H)$. The proportion of low quality goods received by each trader,γ_i, is determined endogeneously.

The farmers with low and high quality good who are indifferent between going to the two market towns are located at ρ and μ respectively. Since trader 2 and trader 3 are located in the same market town, the outcome of their price competition is similar to a Bertrand outcome. The supply to trader 2 is given by:

$$S_2^L(\mathbf{p}) = \begin{cases} (1-\rho)\lambda & \text{if } p_2 > p_3^L \\ \frac{1}{2}(1-\rho)\lambda & \text{if } p_2 = p_3^L \\ 0 & \text{if } p_2 < p_3^L \end{cases} \qquad S_2^H(\mathbf{p}) = \begin{cases} (1-\mu)(1-\lambda) & \text{if } p_2 > p_3^H \\ \frac{1}{2}(1-\mu)(1-\lambda) & \text{if } p_2 = p_3^H \\ 0 & \text{if } p_2 < p_3^H \end{cases}$$

and similarly to trader 3. I will assume $p_3^H > p_3^L = p_2$ to derive the supply to traders 1, 2 and 3 given the price vector $\mathbf{p}$. Trader 2 will not receive high quality goods. This will be true in equilibrium as I confirm below. Each trader's respective supply of low quality goods is:

$$\begin{aligned} S_1^L(\mathbf{p}) &= \rho\lambda = \frac{p_1 - p_2 + t}{2t}\lambda \\ S_2^L(\mathbf{p}) &= S_3^L(\mathbf{p}) = \frac{1}{2}(1-\rho)\lambda = \frac{(p_2 - p_1 + t)}{4t}\lambda \end{aligned} \tag{2.2}$$

Each trader's respective supply of high quality goods is:

$$\begin{aligned} S_1^H(\mathbf{p}) &= \mu(1-\lambda) = \frac{p_1 - p_3^H + t}{2t}(1-\lambda) \\ S_3^H(\mathbf{p}) &= (1-\mu)(1-\lambda) = \frac{p_3^H - p_1 + t}{2t}(1-\lambda) \end{aligned} \tag{2.3}$$

The profits of the three traders are:

$$\Pi_1(\mathbf{p}) = (p_1^{'}(\mathbf{p}) - p_1)[S_1^L(\mathbf{p}) + S_1^H(\mathbf{p})]$$

$$\Pi_2(\mathbf{p}) = (p^* - p_2)S_2^L(\mathbf{p})$$

$$\Pi_3(\mathbf{p}) = (p^* - p_3^L)S_3^L(\mathbf{p}) + (p^{**} - p_3^H)S_3^H(\mathbf{p})$$

Recall that trader 1 receives a price $p_1^{'}(\mathbf{p})$ from the processors, where $p_1^{'}(\mathbf{p}) = \gamma_1(\mathbf{p})p^* + (1 - \gamma_1(\mathbf{p}))p^{**}$ and $\gamma_1(\mathbf{p}) = \frac{S_1^L(\mathbf{p})}{S_1^L(\mathbf{p})+S_1^H(\mathbf{p})} = \frac{\rho\lambda}{\rho\lambda+\mu(1-\lambda)}$. In equilibrium, the three traders receive different proportions of low and high quality goods. The following prices constitute a unique pure-strategy Nash equilibrium if and only if $t < \frac{\lambda}{3}(1+\lambda)(p^{**} - p^*)$:

$$p_2 = p_3^L = p^*$$

$$p_1 = \frac{3((1-\lambda)p^{**} - t) + \lambda(t + 4p^*)}{3+\lambda}$$

$$p_3^H = \frac{3(p^{**} - t) + \lambda(2p^* - p^{**})}{3+\lambda}$$

Note that trader 1 offers a price based on the proportion of low and high quality goods it attracts. The introduction of a third trader who is able to verify quality, drives down the price of low quality good to the marginal value of low quality, given by p^*. The price offered by trader 2 is then too low for it to attract any high quality goods. The proof is in the Appendix. This result gives us the second testable implication:

Prediction 2: *Entry of an additional buyer with the ability to verify quality of* *the good leads to an ambiguous effect on average prices. The price offered by existing traders will increase if and only if* $t > (p^{**} - p^*)(1 - \lambda)$.

With heterogeneous quality, there are two opposing forces on the prices offered by traders 1 and 2. On the one hand, entry by trader 3 puts upward pressure on the price offered by traders 1 and 2, the competition effect. On the other hand, sorting of farmers based on their quality puts a downward pressure on price offered by traders 1 and 2, the composition effect. It will ultimately be an empirical question to determine which of the two effects dominates.

PROOF

In equilibrium, the two traders charge the same competitive price: $p_2 = p_3^L = p^*$. The proof is as follows: Consider, for example,

$$p_3^L < p_2 < p^*$$

Then trader 3 has no supply, and its profit is zero. On the other hand, if trader 3 charges $p_3 = p_2 + \varepsilon$ where ε is positive and "small", it obtains the entire supply of low quality good and has a positive profit margin of $p^* - p_2 - \varepsilon$. Therefore, trader 3 cannot be acting in its own best interest if it charges $p_3^L < p_2 < p^*$. Now suppose that,

$$p_3^L = p_2 < p^*$$

The profit of trader 3 is $(p^* - p_3^L)(1-\rho)/2$. If trader 3 increases its price slightly to $p_3^L + \varepsilon$, its profit becomes $(p^* - p_3^L - \varepsilon)(1-\rho)$ which is greater for small ε. In this situation, the market share of the trader increases in a discontinuous manner. Trader 3 will not charge more than its marginal value for low quality good p^* (it would make a negative profit if it did). Trader 2 cannot distinguish between quality. If it charged an ε above p^*, while trader 3 charged p^*, it would attract all low quality farmers. In this case, $\gamma_2 \to 1$, and the resale price for trader 2 (which was $p_2^{'} = \gamma_2 p^* + (1-\gamma_2)p^{**}$) reduces to p^*. Thus, trader 2 will also not charge more than its marginal value for low quality good p^* (otherwise it would make negative profits) and earn zero profits. Hence $p_2 = p_3^L = p^*$.

In addition, if $p_3^H > \lambda p^* + (1-\lambda)p^{**}$ (the maximum price that trader 2 can offer without making negative profits), then trader 2 has no incentive to deviate. Figure 7 illustrates the condition under which the prices exist in equilibrium:

$$t < \frac{\lambda}{3}(1+\lambda)(p^{**} - p^*)$$

Note that the curve represents the equation: $tbar = \frac{\lambda}{3}((1+\lambda)$, where $tbar = t/(p^{**} - p^*)$. The shaded region represents $tbar < \frac{\lambda}{3}((1+\lambda)$, where the equilibrium exists. This condition is more likely to be satisfied if t is low relative to the difference between competitive prices of high and low quality good. In other words, the ratio of transport costs to the price difference between high and low quality good should not be very large.

Note that $p_3^H > p_1 > p_2 = p_3^L$ if and only if:

$$t < \frac{3(1-\lambda)(p^{**} - p^{*})}{3-\lambda}$$

This implies that trader 3 attracts a larger proportion of farmers with high quality goods, i.e. the indifferent farmer with high quality goods (μ) is located closer to trader 1. Moreover, trader 1 attracts a larger proportion of farmers with low quality goods, i.e. the indifferent farmer with low quality goods (ρ) is located closer to trader 2. This feature results in two opposing forces. On the one hand, entry by trader 3 puts an upward pressure on the price offered by traders 1 and 2, the competition effect. On the other hand, sorting of farmers based on their quality puts a downward pressure on price offered by traders 1 and 2, the composition effect.

Chapter 3

Information Technology and Rural Markets: New Evidence from Central India

3.1 Data

The data used in this chapter comes from five different sources. First, information on monthly prices and volume of crops sold in all the 233 main *mandis* in the state from April 2000 to September 2005 is available from the MP State Agricultural Marketing Board.[1] Second, annual district level production, yield and net area under cultivation of crops from 1998-2004 is taken from the Commissioner of Land Records, MP.[2] Third, dates of installation and location of all internet kiosks and hubs is obtained from the company's business records. Monthly procurement of soybean by ITC Limited at each of its hubs is also obtained from the company. Fourth, annual administrative and demographic information at the district level is taken from the census of India 2001 and lastly, geographic information on the location of districts, towns and roads in the state is available from GIS files provided by the ML Infomap agency.[3]

A total of 1704 web kiosks and 45 hubs were established in 23 (out of a total of

[1] Price is measured in Rupees/Quintal. (1 Quintal=100kgs) Quantity sold is measured in Tons.

[2] Production is measured in Thousand Tons. Yield is measured in Kgs/Hectare. Area in Thousand Hectares. Net area cultivated refers to area under crops grown only during the *kharif* season of Madhya Pradesh.

[3] These files were processed using the ArcGIS software. Vector data in the form of polygons, points and lines representing districts, towns and roads are available for every district in the state.

45) districts of MP during the time period from October 2000 to January 2005. The installation date of an internet kiosk is defined as the day the computer equipment was installed in the village by ITC. On the other hand, the hub installation date is defined as the day the first direct sale was made by a farmer at the hub. In this way, I measure effective installation of hubs. Table 2 provides the dates at which the first kiosk and the first hub were set up in each district. The installation of the first hub always postdates the installation of the first kiosk in a district. Figure 8 plots the distribution of the total number of kiosks and hubs over time. While there are some kiosks without hubs, there are no hubs without kiosks. Thus at most two effects can be identified - the effect of kiosks without hubs and the effect of kiosks with hubs.

The state marketing board collects monthly data on prices and quantities sold of 17 major crops in the 233 main *mandis* of the state.[4] In a particular *mandi*, different crops of varying quality are sold each day at varying rates. *Mandi* officials record the price and quantity sold of every transaction. At the end of the day, a daily minimum price, maximum price and mode price as well as total quantity sold for every crop are recorded by *mandi* officials. The daily minimum price is the lowest price that prevailed that day. The daily maximum price is the highest price that prevailed that day. The daily mode price is the price at which the highest quantity of a crop is sold in a day. From all the daily entries for a given month, a monthly minimum, maximum and mode price as well as total monthly sales are calculated.[5]

[4]Although approximately 30 different crops are sold in these *mandis* all round the year, detailed price and sales data is collected for only 17 major crops, out of which 10 are *Kharif* crops grown in the monsoon season and 7 are *Rabi* crops grown in the winter months.

[5]The monthly minimum price is the lowest prevailing price in a given month (minimum of

This monthly price and sales data is provided by each *mandi* to the central state marketing board, from which I obtained the data for a period of 66 months (from April 2000 to September 2005). With no measures of average price in a month, the mode price can be considered the best available proxy for mean price. Additional price data for a sub-sample of 30 A grade *mandis* is available for 90 months (from April 1998 to September 2005). Data on individual transactions and on daily prices and sales is not available.[6]

It is important to point out that I observe only the price of crops sold in government regulated wholesale *mandis*. This data does not include the price posted or offered by ITC. Moreover, these are raw monthly prices without any quality grading, which is a major drawback since quality may have changed in response to the intervention. An overall increase in the quality of soybean produced will tend to bias my results towards finding a positive price effect of the intervention. On the other hand, if farmers with high quality soybean prefer to sell directly to ITC at its hubs, I should expect to find a modest decline in the price of soybean in the *mandis* over time. Each of these concerns will be discussed at length in the subsequent sections.

The monthly sales volume of a crop in a *mandi* measures the total quantity that was sold in a month. This volume consists of two key components. The first

daily minimums). The monthly maximum price is the highest prevailing price in a given month (maximum of daily maximums). The monthly mode price is the price that is associated with the highest quantity of a crop sold in a month (mode of daily modes associated with highest quantity sold).

[6]Daily price and sales recorded in individual *mandis* are not compiled by the state marketing board. Moreover, individual *mandis* do not typically keep records of historical daily price and sales information.

component is the total amount of the crop sold inside the *mandi* yard, which is recorded and calculated as described above.[7] The second component is the quantity sold by farmers directly to private buyers outside the *mandi* yard but for which *mandi* tax has been paid to the concerned *mandi*.[8] Thus, the quantity of soybean sold at the ITC hubs is included in the *mandi* sales volume data. On average 3.62 percent of total quantity sold in the state annually is bought by ITC at its hubs.[9] Since I observe monthly procurement of soybean by ITC at its hubs, I deduct this amount from the relevant quantity sold in the *mandi* where it paid tax to obtain my preferred measure of the total sales volume of a *mandi*, which excludes the amount sold at the ITC hubs.

To my knowledge, this is the first attempt to collect and compile detailed data on price and volume of crops sold in government regulated wholesale agricultural markets, along with spatial geo-coded information, to examine the impact of information technology on the functioning of rural markets in the state of Madhya Pradesh.

Table 3 provides summary statistics. Out of a potential 66 months of data for each crop in each of the 233 *mandis*, I exclude any observation where the outcome is recorded as zero. In some *mandis*, located in districts where a particular crop is not intensively grown, transactions do not take place every month leading to a consider-

[7]Some smaller *mandis* are linked to the main *mandi* administratively. The quantity of crops sold in these 'sub-mandis' is also included in the total sales volume of the main *mandis*.

[8]A buyer operating outside the *mandi* yard is required by the law to provide complete documentation (recording the quantity bought) to the *mandi* officials; this amount is added to the sales volume of a particular mandi.

[9]This represents 2.85 percent of annual production of soybean in the state. Total production is not equal to total amount sold because part of the produce may be kept back by farmers as growing seed, or may be sold to village merchants outside the *mandis* who are not accounted for.

able number of missing observations. From a panel of potential 15378 *mandi**month (233*66) observations for soybean, I am left with 10915 (11435) positive observed values of mode price (sales).[10]

3.2 Empirical Strategy

The goal of the empirical analysis is to examine the impact of the increase in information provision and direct access to a large buyer due to this intervention on the functioning of government regulated wholesale agricultural markets over time. To do this, I utilize panel data on monthly crop prices and sales to perform three types of analysis that rely on plausibly exogenous variation driven by the intervention. First, since different districts received kiosks and hubs at different times, I can use this differential timing to isolate the impact of the intervention on the price of soybean in agricultural *mandis* located in a district. Second, I use a triple-difference approach to eliminate the effect of any unobserved determinants of outcomes, by comparing soybean with alternative crops, over time and across districts. Since the intervention potentially affected only soybean, other crops grown in the same season as soybean can be used as comparison groups. Finally, GIS measures of distance are constructed to exploit the heterogeneity in the proximity of *mandis* to hubs to measure disaggregated treatment status.

The identification strategy exploits inter-district variation in the timing of the introduction of kiosks and hubs. To the extent that the timing of the intervention

[10] The 15378 potential number of observations contain 35 (843) instances where the mode price (sales) is recorded as zero and there are 4428 (3100) missing observations. This leaves a total of 10915 (11435) positive observed values of mode price (sales) for soybean.

in different areas was chosen in response to actual and forecastable changes in the local price of soybean, my results would be biased. However, since the date of the introduction varied substantially across districts and was chosen far in advance by ITC officials, this type of endogeneity seems unlikely to have been present.[11] Figure 9 shows the percentage of districts with at least one kiosk and hub in each year. By the end of 2000, 11 out of 45 districts (24 percent) had received at least one internet kiosk while only 2 percent of the districts had at least one hub. By 2004, all the 23 districts (51 percent of total) had received at least one kiosk and hub.[12] Figure 12 shows the trend in each district separately. It is difficult to imagine another factor with a sharp and discrete change that drives both the introduction of kiosks and changes in soybean price. Conditional on *mandi* and month fixed effects as well as district-specific time trends, the timing of the introduction of kiosks and hubs across districts is plausibly orthogonal to future movements in price.

While the fixed effects eliminate any concern that variation in kiosk and hub introduction is driven by some unobserved time-invariant factor that also causes changes in the price of soybean, a primary concern is that the results could be driven by pre-existing differential trends in the price of soy between districts that do and do not receive kiosks and hubs. As discussed in the previous chapter, the

[11]Raisen, Sehore, Ujjain and Harda districts were selected to receive the kiosks first because these districts contained ITC's processing plants, which could serve as a hub. Subsequently additional warehouses were leased (to serve the role of hubs) and kiosks were set up around each one of them. The Chief Executive of the Agri Business Division of ITC Limited stated the following: " We started with all locations around our processing units (to maximize on logistics savings). The actual location of a processing unit is a function of which unit is available for toll operations, as we depend on hired units. Thereafter, once we added warehousing hubs to the model, we rolled into all the key soy growing areas. Even here sequence started with such locations that result in the lowest landed cost of soybeans at each of the processing units."

[12]Shivpuri is the only district which has internet kiosks but no hub. Thus only 49 percent of total districts in the state received a hub.

districts located in the western region of the state that received the intervention are high soy producing districts. Soy constitutes more than 65 percent of total volume of agricultural production in the monsoon season in this group of districts as opposed to approximately 11 percent in the east (see Table 4). Therefore, the placement of kiosks and hubs is by no means random as they were established in districts with higher soy production. However, if districts with rapidly increasing price (or increases in factors that in turn affect price) are also more likely to receive kiosks, I will mistakenly attribute those changes to the introduction of kiosks.

Fortunately, with price data going as far back as 1998 for a sub-sample of districts, it will be possible to test for the impact of pre-existing price trends. Table 5 shows that the 1998 and 1999 levels of soybean price are not predictive of which districts receive kiosks. The dependent variable in panel A is 1 if kiosks were ever introduced and 0 otherwise. The coefficients on initial levels of soybean price are small and statistically insignificant. Moreover, the coefficient on the change in price of soybean from 1998 and 1999 suggests that districts with rapidly increasing prices are actually less likely to receive kiosks, although the results are not statistically significant. In Panel B, I consider whether the *timing* of the introduction of kiosks is correlated with the pre-existing levels and trends of price. The dependent variable is 1 if kiosks were introduced in 2000 and 0 if they were introduced in 2001/2002. All the coefficients are small and none are statistically insignificant, and the direction of the effect is not consistent across the variables. The results suggest that there is no substantial evidence that the timing of kiosk introduction is being driven by differential trends in price.

Overall, the considerable variation in the timing of the introduction of kiosks and hubs across districts will be used to estimate the impact. The identifying assumption is that in the absence of the intervention, there would have been no differential change in the price of soy across the districts over this period.

3.3 Basic Results

I start by estimating:

$$P_{ijt} = \beta_1 + \beta_2 K_{jt} + \beta_3 H_{jt} + \gamma_i + \mu_t + t\phi_j + \epsilon_{ijt} \tag{3.1}$$

where the outcome variable, P_{ijt} is the log mode price of soybean in *mandi* i located in district j at month t. Since prices are likely to change proportionally rather than by a fixed rupee amount, it is sensible to transform the variable using logs.[13] The γ_i's represent a full set of *mandi* fixed effects that control for unobserved time invariant heterogeneity in *mandi* characteristics arising from a differences in infrastructure, soil quality and market size.[14] The μ_t's represent a full set of month fixed effects (there are 65 indicator variables for the sample going from April 2000 to September 2005) that control for any time varying aggregate factors affecting the price of soybean across all the *mandis* in the state, such as world prices, common demand shocks or common climate shocks.

To control for differential price trends across districts during the period of

[13] Moreover, the mode price appears to be positively skewed whereas the log mode price is much more symmetrically distributed [Duggan and Scott Morton 2006]. Results are qualitatively similar when estimated in levels.

[14] District fixed effects are essentially incorporated by including *mandi* fixed effects.

interest, I also include district-specific time trends as represented by $t\phi_j$. The standard errors are corrected to account for the fact that the intervention varies only at the district-month (rather than at the *mandi*-month) level and for serial correlation in the error term. ϵ_{ijt} is a *mandi*-district-month specific error term. K_{jt} is an indicator variable for whether there is a kiosk in district j in month t. Similarly, H_{jt} is an indicator variable for whether there is a hub in district j at month t. Since hubs were set up after kiosks, β_3 measures the marginal effect of adding a hub to a kiosk.

Using the full sample of 233 *mandis* in 45 districts of the state, the results indicate a positive and significant effect of kiosks on the average price of soybean as presented in Table 6. The presence of a kiosk in a district is associated with an increase in the average monthly mode price of soy in the *mandis* located in that district by 1.2 percent. This result lends support to the theoretical prediction that the the availability of price information to farmers reduces the monopsony power of traders in local output markets. An increase in the competitiveness of traders leads to an increase in the price of soybean in the *mandis*. Although the effect of a hub on the *mandi* price of soybean is positive, the coefficient is very small and insignificant (columns 1-3).

The results in columns 1-3 assume that the effect of the intervention is instantaneous. On the one hand, awareness about the presence of kiosks and learning over time is likely to accentuate the effect of the intervention. On the other hand, supply might respond to this sudden increase in price leading to a downward pressure on the market price of soybean over time. To examine whether and how the effect of kiosks varies over time, I include additional pre and post binary variables that indicate time periods immediately preceding or following kiosk introduction. This allows me to differentiate between a level and a trend effect of the intervention. In columns 4-6, I find that the significant increase in soy price tends to persist after kiosk introduction. The coefficients on post 0-5 months and post 6 plus months are significant and not statistically different from each other. In column 5, I add an indicator variable for the months leading up to kiosk introduction, and find that the difference between the post and pre coefficients is significantly positive.[15]

Table 7 summarizes the results from several specifications similar to equation (3.1) above. In panel A, (columns 1-3) I include quarter*year fixed effects instead of month*year fixed effects to check the sensitivity of my results after controlling for alternative seasonal changes in price. The estimate of 0.012 on kiosks is almost identical to the previous estimates. In columns 4-6, my results are robust to controlling for differential price trends across *mandis* during the period of interest. In columns 7-9, I include district specific linear trends and find an estimate of β_2 to be equal to 0.016. Since soy is most heavily traded between October-December, in columns 10-12, I restrict the sample to the fourth quarter and find that the impact of a kiosk is higher by one percentage point in the fourth quarter as compared to the average effect in all periods (β_2=0.023). In panel B, I restrict the sample to the 23 districts located in the west-central region of the state (the "treated" districts). Although it is appealing to use the full sample since the coefficients are more precisely estimated, this test is valuable for eliminating concerns about possible endogeneity

[15]Since I have already included a very rich set of controls for any time varying aggregate factors, market characteristics and district time trends, including other variables (such as district level literacy rate, number of farmers, total area, number of markets per district, do not make any difference to my basic result.

of the location of the intervention. All the results presented in panel B point to the same conclusion that the presence of a kiosk increases the average monthly mode price of soy in the *mandis* and the effect is larger in the fourth quarter. The presence of hubs has no significant effect on price. Moreover, the point estimates are strikingly within the range obtained in Table 6, suggesting that the estimated effect of the intervention is reasonably robust.

Table 8 presents the results for the average monthly minimum and maximum prices of soybean in the local markets. One might expect different effects on minimum and maximum prices, though my theoretical model does not investigate this possibility as it simplifies by assuming a single price. Intuitively, if the minimum price represents the price received by the least informed farmers, then I should expect the presence of kiosks to have a positive and significant effect on the average minimum price in the *mandis*. Similarly, if the maximum price represents the price already received by most informed farmers, I should then expect no additional effect of the kiosks on the maximum price. In columns 1-3, the presence of a kiosk in a district increases the monthly average minimum price by 1.7 percent. The effect of a hub is insignificant. Moreover, the presence of kiosks and hubs have no apparent significant effect on the average monthly maximum price of soybean in the *mandis* of MP. This result further strengthens the argument that improvements in information are responsible for the impact of kiosks on the average price received by farmers in local markets.

There are at least two reasons why the observed effect of a hub might be expected to be smaller than the effect of a kiosk. First, when the kiosks were set up by ITC Limited, the introduction of a hub in the future was also announced. After forming an expectation of strategic price setting behavior by ITC Limited, rational traders operating in *mandis* might adjust their bids in response to this "announced" hub. Thus, K_{jt} might be capturing part of the effect of a future hub in addition to the effect of increased information provision. This would lead to a much smaller additional effect of a hub when it actually becomes functional. Second, since quality is scientifically tested at the ITC hubs, there might be sorting of farmers based on the quality of their produce. If farmers with good quality soybean have a greater incentive to sell directly to the private company, I would expect a modest decline in the price of soybean in the *mandis* overtime. The result implies that the additional competition effect of the hub is being offset by the composition change effect, leading to a small and statistically insignificant net effect of the hub.

By measuring treatment at the district level, I assume that the presence of a kiosk or a hub anywhere in a district affects all the *mandis* belonging to that district equally. These districts are large with an average area of 6850 square kilometers and contain on average five *mandis*. Since the hubs and kiosks are not uniformly distributed within a district, it is quite likely that some *mandis* located close to the kiosks and hubs are affected more by this intervention than others located further away. It is plausible that the true impact on affected *mandis* will likely be underestimated by aggregating treatment at the district level. Moreover, hubs and kiosks located at the edge of a particular district, for instance, may have a greater impact on the *mandis* belonging to a neighboring district. These spillover effects are not allowed for in estimating equation (3.1). In a later section, I allow for treatment effect to vary by distance.

3.4 Alternative Crops

One potential concern with the results so far is that changes in price may be correlated with unobservable changes in agricultural markets over time. For instance, I do not observe the number of traders that bid on average in each *mandi* in each month and changes over time in the number of bidders is likely to affect the monthly price. If such unobservable changes are correlated with the timing of kiosk or hub introduction then my results may be affected by omitted variable bias. To address this possibility, I use a triple-difference approach to estimate the impact of the intervention on the price of soybean using the crops that did not receive the intervention as additional comparison groups. Aside from soy, ITC Limited did not procure any other crop grown during the monsoon season through the *e-Choupal* intervention.[16]. As long as the alternative crops sold in the *mandis* are not impacted by this intervention either directly or indirectly, I can control for time varying *mandi* specific factors using an alternative crop grown in the same season as soy. The second largest crop (in terms of its share in total production) is maize (see Table 4), which is not directly affected by this intervention. A natural starting point is to compare the price of soy to the price of maize. I estimate the following equation:

$$P_{cijt} = \beta_1 + \beta_2 Soy_c + \beta_3 K_{jt} + \beta_4 Soy_c * K_{jt} + \gamma_i + \mu_{tc} + t\phi_j + \epsilon_{cijt} \tag{3.2}$$

[16]ITC began procuring wheat, a *Rabi* (winter) crop, starting in the year 2003 in MP.

where P_{cijt} is the price of crop c in *mandi* i in district j at time t. Soy_c is an indicator for whether a particular observation is soy. μ_{tc} represents a complete set of month fixed effects for each separate crop that control for time-varying aggregate factors affecting each crop separately in the state. The rest of the variables are defined as above. The key coefficient of interest is β_4, which measures the effect of a kiosk on the average monthly price of soybean relative to the price of the alternative crop, after controlling for differential trends across districts.

Table 9 presents the estimates of equation (3.2) for two subsamples. In panel A, the mode price of soy is compared with the mode price of maize. The sample is restricted to those mandi-date cells where the prices of both soy and maize are positive, so that the result is not driven by unobserved *mandi* characteristics which can be a source of bias in OLS estimates. The results indicate that the presence of a kiosk in a district increases the average mode price of soy relative to maize in the *mandis* by 4.6 percent (columns 1-3). The presence of a hub has no discernible effect on the price of soy. Since soybean is an edible oilseed it seems appropriate to consider a competing oilseed, since the price of edible oilseeds in India are determined to some extent by the international market.[17] The second largest edible oilseed grown in the same region and season as soy is groundnut (see Table 4). Panel B compares the price of soy with the price of groundnut. The coefficient on the interaction term is positive and similar in magnitude to the effect estimated in table 6, although the estimate is not statistically significant. In part this may be because the sample size

[17]The oilseeds grown during the monsoon season in MP are soybean, groundnut, sesame, cottonseed, castorseed, nigerseed and sunflower. Castorseed, cottonseed and nigerseed are generally not considered edible oilseeds.

is smaller, since there are fewer observations with price data available on both soy and groundnut.

My triple-difference strategy assumes that the intervention had no impact on crops other than soy. This assumption can be tested directly. The richness of the data gives us multiple control groups formed by crops not affected by the intervention (Meyer [1995], Duflo [2000], Bertrand et al. [2004]). In Table 9, panel C, the results from a placebo test (comparing the price of maize to the price of groundnut) are presented. The impact of the kiosks and hubs is very small and insignificant. The estimated triple-difference is very close to 0. The coefficients are statistically different from the corresponding coefficients in panel A. These results provide evidence that the results are not driven by inappropriate identification assumptions.

3.5 Spatial Heterogeneity

An important underlying assumption in equations (3.1) and (3.2) is that within a district, the effect of the intervention is the same regardless of distance to hubs and kiosks. In this section, the above assumption is relaxed and the treatment effect is allowed to vary by distance. I use geo-coded data to calculate the distance between *mandis* and hubs. Using latitude and longitude of the towns that contain the *mandis* and hubs, I calculate a straight-line Euclidean distance between two planar coordinates. This allows me to construct a new explanatory variable for whether there is a hub located "near" a particular *mandi*. I experiment with different indicators of nearness (within 10 kms, within 20 kms, within 30 kms etc). Figure 10 shows the distribution of the distance to the nearest hub from a given *mandi*. The estimated kernel density function shows that the distance of many *mandis* to the nearest hub is very large in spite of a very low mode.

With no available data on the coordinates of villages that contain kiosks, I resort to an indirect method to capture the effect of "nearness" of a kiosk to a mandi. Before doing so, it is useful to recognize that ITC's goal in placing kiosks was to maximize its covered area. To this end, the kiosks were organized as clusters around the planned hubs, with well defined links based on proximity between a given kiosk to a unique hub. According to ITC, a kiosk i is linked to hub j if hub j is the nearest hub to kiosk i.[18] Using this definition of nearness of kiosks to hubs, and the measure of distance between hubs and *mandis* as discussed in the preceding paragraph, kiosks are assigned near a *mandi*. ITC's location strategy implies that corner cases, where kiosks are equidistant to two or more hubs, are rare enough to ignore the marginal error introduced by them.

It is possible that the price and quantity sold of soybean in *mandis* located further away from a hub (or kiosk) are less affected by this intervention. The specification below investigates this possibility. Moreover, the presence of a hub (and kiosk) in a particular district can potentially affect *mandis* located in the neighboring district.[19] Since treatment is now measured at the *mandi* level, I am implicitly assuming that farmers are allowed to move freely between districts. This allows me to measure the impact of the intervention more accurately. The estimation

[18]Typically, an average of 40 kiosks are located within 30-40 kms of a particular hub.

[19]Farmers living in a particular district are not prohibited by law from selling their produce in another district.

equation is as follows:

$$y_{it} = \beta_1 + \beta_2 K_{it} + \beta_3 H_{it} + \gamma_i + \mu_t + t\phi_i + \epsilon_{it} \tag{3.3}$$

where y_{it} is the outcome of soybean in *mandi* i at time t. K_{it} is an indicator variable for whether there is a kiosk "near" *mandi* i at month t. Similarly, H_{it} is an indicator variable for whether there is a hub "near" *mandi* i at month t. Since hubs were set up after kiosks, β_3 measures the marginal effect of adding a hub to a kiosk. To control for differential price trends across *mandis* during the period of interest, *mandi*-specific time trends represented by $t\phi_i$ are also included. Autocorrelation is accounted by clustering the standard errors at the *mandi*-level. The rest of the variables are as defined earlier.

3.5.1 Effect on Price

Table 10 shows the results for different indicators of nearness. The dependent variable is the log mode price of soybean in *mandi* i at month t. In columns 1-3, H_{it} is an indicator variable for whether there is a hub within 40 kms of a *mandi* i at month t. Similarly, K_{it} is an indicator variable for whether there is a kiosk linked to a hub that is within 40 kms of a *mandi* i at month t.[20] The *mandis* that do not have hubs within 40 kms constitute the comparison group. The presence of a kiosk near a *mandi* is associated with an increase in the average price of soybean in

[20] The difference between H_{it} and K_{it} is in the date on which each of these variables takes the value 1. By construction, I have assumed that the distance between a kiosk linked to a hub is equal to zero.

these *mandis* by 1.6 percent. In columns 4-6, the results indicate that the presence of a kiosk linked to a hub within 60 kms of a *mandi* has a slightly lower effect (1.3 percent) on the average price of soybean (compared to the *mandis* that do not have hubs within 60 kms). Moreover, in columns 7-9, the magnitude of the effect of kiosks linked to hubs within 80 kms of a *mandi* becomes much smaller but is still positive and significant. Finally, in columns 10-12, the effect of a kiosk located within 100 kms. of a *mandi* is close to zero.

The results suggest that the distance between the kiosks and *mandis* matters. The closer the location of kiosks to the *mandis*, the bigger is the effect on price. These effects are slightly larger than the district level aggregate effect presented in Table 6. Table 11 (panels A and B), presents results from estimating alternative specifications. In columns 1-3, I include quarter*year fixed effects instead of month*year fixed effects to control for seasonal changes in price. In columns 4-6, my results are robust to controlling for differential price trends across *mandis*(rather than districts) during the period of interest. In columns 7-9, I include district specific linear trends. The sign and the magnitude of the effects are consistently similar to those presented in Table 10.

Interestingly, the observed difference in the effect of the intervention on price in a *mandi* located near a kiosk as compared to a *mandi* located further away from a kiosk does not appear to be enormous. A plausible explanation could be that information is being obtained and transmitted between farmers located far away by means other than kiosks. In fact, as pointed out by Jensen (2007), it has become increasingly common to find farmers using mobile phones and pagers for marketing their output. Thus, even if a farmer is not physically located near a kiosk, he may still have access to price information, which is likely to result in the underestimation of the effect of kiosks.

3.5.2 Effect on Sales

The theoretical model predicts a reduction in the supply of the good to the existing traders operating in the *mandis* after the introduction of the hubs by ITC Limited. Recall that the supply to traders 1 and 2 after the introduction of trader 3 is lower than the supply prior to trader 3, leading to upward pressure on price. Moreover trader 2 (the one located nearest to the hub) does not receive any farmers with good quality soybean. An empirical test of whether direct buying by ITC caused sales to be diverted from the *mandis* is therefore imperative to understanding the effect of the intervention.

I investigate the impact of the intervention on sales volume in Table 12. The dependent variable is the log volume of soybean sold (excluding sales to ITC) in *mandi* i at month t. In columns 4-6 of Table 12, I compare the quantity sold of soybean in the *mandis* located within 40 km. radius of a hub with that in *mandis* located at a distance greater than 40 kms of a hub. The presence of a hub is associated with a decline in the volume of sales in the *mandis* located within 40 kms of a hub by approximately 20 percent. The coefficient is significant at the 1 percent level. In columns 7-9, the presence of a hub within 60 km. radius of a *mandi* leads to an insignificant decline in the quantity sold in these *mandis.* As the hub is located further away, the significant effect on sales disappears.[21] The district level effect of the intervention on the volume of sales in the *mandis* as presented in columns 1-3 of Table 12 is also statistically insignificant. By measuring the presence of kiosks and hubs at the district level in columns 1-3, I assume all *mandis* in a district to be affected equally by a hub, even though some *mandis* are closer to hubs than others. Moreover, some *mandis* in neighboring districts might be affected as well. The results in columns 4-9 suggest a dramatic reduction in the volume of soybean sales in the *mandis* when the hub is located within 40 kms of a *mandi*. This result strengthens the argument in favor of investigating heterogeneous effects of the intervention by distance.

An important point to note is that columns 4-9 of Table 12 also indicate that the presence of a kiosk is associated with a significant increase in the quantity of soybean sold in the *mandis*. This result is consistent with the prediction of the model that improvements in information reduce local monopsony power and compel traders to increase both the price and the quantity purchased. Moreover, improvements in information are likely to increase the incentives of farmers to sell soybean in the *mandis* as opposed to outside village merchants, leading to a higher volume of soybean being transacted in government regulated markets.

[21]A similar pattern of result emerges with alternative measures of nearness such as within 10 kms, within 30kms, within 50kms, etc.

3.6 Price Dispersion

In the theoretical model presented above, the pre-intervention price offered by each trader depends on the $\Theta_i (i = 1, 2)$, the fraction of farmers who know the price offered by trader i. With asymmetric Θ's, there is price dispersion in equilibrium. The penetration of kiosks over time increases information provision, making $\Theta_i \rightarrow 1$. Therefore, we expect dispersion in the price of soybean to reduce within the group of *mandis* that were "treated". However, information provision could increase dispersion between the treated and untreated *mandis*, since price went up only in treated *mandis* but not in the untreated.

The magnitude of price dispersion faced by soybean farmers is substantial. For instance, the tenth and ninetieth percentile of the mode price of soybean across *mandis* in May 1998 is Rs.775/Qtl. and Rs.1002/Qtl. respectively. I examine the amount of price dispersion by computing the standard deviation and the coefficient of variation of mode price across *mandis* located in a district within a given month. These two complementary measures are commonly used in the literature. The coefficient of variation, defined as (sd/mean), is a unit free measure of relative price dispersion (Sorensen [2000], Baye and Morgan [2001], Bizan and Greenstein [2004]). There are on average five *mandis* located in each district as shown in Map 3. My sample is collapsed to observations at the district-month level. Table 13, shows that the mean coefficient of variation of price across *mandis* declines on average after internet kiosks are introduced. The coefficients in columns 1-2 are negative and significant but very small. Similarly, the standard deviation in the price of soy across *mandis* is also decreasing post intervention, suggesting a reduction in spatial price variability.

3.7 Output Response

If the average price of soybean in the *mandis* increased after the introduction of the kiosks, it is important to examine the output response on the part of farmers. The presence of kiosks and hubs may create entry and exit in response to an increase in the price. To the extent that farmers have an incentive to expand area and production of soy, we might expect a change in the mix of crops grown by farmers. Moreover, the triple difference estimation relies on the assumption that the alternative crops (maize and groundnut) are not affected by the intervention. This can be directly tested by using annual district level production data to estimate the following equation:

$$y_{jt} = \beta_1 + \beta_2 K_{jt} + \beta_3 H_{jt} + \delta_j + \nu_t + t\omega_j + \epsilon_{jt} \tag{3.4}$$

where y_{jt} is the outcome of interest for district j in year t. δ_j's are a full set of district fixed effects that control for time invariant district characteristics. ν_t's represent a full set of year fixed effects controlling for climate shocks and other secular changes in outcome variables that are common across all districts of the state. District-specific linear time trends ($t\omega_j$) controlling for the possibility of a spurious correlation between the introduction of kiosks (and hubs) and outcomes across districts are also included in the above specification. ϵ_{jt} is a district-year specific error term. Standard errors are adjusted for within-district correlation, since the data consists of repeated observations over time for each district. K_{jt} and H_{jt} are indicator variables denoting whether kiosks and hubs exist in district j in year t.

Panel A in Table 14 presents the results from estimating equation (3.4) to examine the effect of the intervention on net area cultivated.[22] The total (net) area cultivated under all crops grown in the same season as soy is not significantly affected by the intervention.[23] However, there appears to be a positive and significant impact of the intervention on the area cultivated under soy (columns 2-3). The presence of a kiosk in a district is associated with an increase in the fraction of area under soy by 2.9 percentage points. Since the overall area cultivated is not affected by the intervention, this suggests that farmers are substituting away from an alternative crop and into soy. In columns 4-6, I find a negative association between the presence of kiosks and the area cultivated under rice in a district. I do not find a significant effect of the intervention on any of the other 16 crops grown in this season in the state. Specifically, the fraction of area under maize and groundnut are not significantly affected by the presence of kiosks and hubs as presented in columns 7-10. This result lends further support to our identification assumption in the triple difference strategy. In panel B (columns 3-4), the intervention is associated with a positive effect on the production of soy, and the coefficient is significant at the 10

[22]According to Duflo and Pande [2005], the net measure accounts for relevant area at a single point in the year, while gross area accounts for each separate use of the same area during a year. Soybean, maize and groundnut are cultivated only during the monsoon season, hence the relevant measure in this analysis is net.

[23]Total (net) area cultivated includes area under all 18 crops (6 cereals, 5 pulses, 7 oilseeds) grown during the *kharif* season of Madhya Pradesh.

percent level.

This important effect on output strengthens the argument that improvements in information are indeed translating into higher return for farmers; otherwise I would not expect to find a change in their planting behavior.

3.8 Welfare Analysis

Figure 11 shows the basic analytics of the welfare change as a result of this intervention. The pre-intervention monopsony equilibrium in the *mandis* is given by (p_m, q_m).[24] After the intervention, there is, on average, a 2 percent increase in the *mandi* price and a 19 percent increase in soy production as estimated above. Of the 19 percent increase in total production, approximately 3 percent is bought by ITC annually, which results in an increase of soy production by 15 percent being transacted in the *mandis*. Hence, the post-intervention competitive equilibrium in the *mandis* is characterized by $(1.02p_m, 1.15q_m)$.[25] Under the assumption of a linear supply curve, the pre-intervention profits of the farmers, given by D, can be calculated to be $0.065p_m q_m$. After the intervention, the profits of the farmers are characterized by D+C+F.[26] There is a 33 percent (C+F) net gain in profits of

[24]Since the supply curve facing the monopsonist slopes upward, the marginal factor cost curve lies above the supply curve. The traders purchase soybeans up to the quantity at which the marginal factor cost is equal to the marginal revenue product, q_m in Figure 11. Since the traders want to pay the lowest price at which the farmers are willing to provide q_m, the equilibrium price is given by the height of the supply curve at this quantity p_m.

[25]With a linear supply curve, $P = a + bQ$, b is calculated to be equal to $0.13p_m/q_m$ and $a = 0.87p_m$. The marginal factor cost $(a + 2bQ)$ at q_m is calculated to be equal to $1.13p_m$. For the traders, the demand for soybeans is a derived demand determined by its marginal revenue product. Under the assumption of linearity, $P = r - sQ$, s is calculated to be equal to $0.73p_m/q_m$ and $r = 1.86p_m$.

[26]This can be calculated to be equal to $0.0865p_m q_m$, where C $=0.02p_m q_m$ and F$=0.0015p_m q_m$

the farmers of which 31 percent (C) represents the redistribution of surplus away from traders to farmers and an additional 2 percent (F) is the the welfare gain of deadweight loss under monopsony.

The profits of the traders before the intervention, given by $A+B+C$, can be calculated to be equal to $0.5p_mq_m$. The traders lose 4 percent of its profits (C) to the farmers and gain an additional 2 percent E after the competitive equilibrium, resulting in a net loss of 2 percent in traders profits. Thus, here is an example of an important innovation that results in a much larger net gain for the farmers but not a huge net loss for the traders. A caveat is in order when interpreting these results for soybeans since a general equilibrium approach of monopsony would require an examination of its effects within the context of the entire market economy comprising of all crops transacted in the *mandis*.

3.9 Alternative Explanations

Improvement in Quality

A legitimate concern is that the increase in price observed post intervention may actually reflect an increase in the overall quality of soybean over time. As mentioned earlier, there is an unobservable aspect to soybean quality that refers to the oil and protein content of the seed, and there is an observable aspect of quality that refers to the presence of moisture, dirt and damaged seeds in each lot of produce. An increase in either one or both of these aspects of quality will tend to bias my results. Kiosks provide information on farming techniques, and this information could lead to an improvement in unobservable aspects of quality. Unfortunately, I do not observe quality contingent prices of crops. The M.P. Marketing Board does not publish monthly prices with quality grading. Given this shortcoming, I provide two pieces of suggestive evidence that an overall improvement in quality is not what is driving my results.

Table 15 provides estimates of the effect of the intervention on the annual yield of crops. While this is circumstantial evidence, it seems plausible that improvements in technique that led to increased quality would also improve yield. I find no evidence of a significant increase in annual district level yield of soy.

A related concern is that perhaps, farmers clean up their produce more after the introduction of kiosks, which would increase the observable aspects of quality leading to an increase in price. This is a valid concern, because daily buying of soybean in local markets and hubs is based on observable features of quality. The Government of India announces a minimum support price (MSP) of soybean for a certain quality threshold each year. It is required by law that only soybean of quality below the MSP quality be sold at a price below MSP. To examine the impact of the intervention on observable quality, I restrict the sample to mandi-month cells where the observed monthly mode price of soybean is below the MSP. This sub-sample has 1101 observations. If improvement in observable aspects of quality creates an increase in price that is spuriously attributed to the key explanatory variables, then the impact of the intervention on the price of soybean in this sub-sample should also be positive. The coefficients on K_{jt} and H_{jt} are negative, very small and not significantly different from zero.[27] Moreover, any systematic improvement in quality over time is likely to be captured by the time trends included in all the estimation equations. The incentive of the farmers, post intervention, to clean up each lot offered for sale is the same as before since the quality scale used by buyers operating both inside and outside the *mandis* is the same pre and post intervention.

These pieces of empirical evidence lend support to the assertion that the increase in price was due primarily to the increase in information to farmers and the resulting increase in competitiveness of buyers in *mandis*. Anecdotally, farmers were not aware of any new varieties of soy growing seed being introduced in this period leading to a substantial improvement in overall quality. Although information on improved farming techniques and weather forecasts are available through the kiosks, considerable overall improvement in quality appears to be a longer term change.

3.10 Conclusion

The introduction of internet kiosks across districts of the state of Madhya Pradesh is associated with a significant increase in the monthly price of soybean in government regulated wholesale agricultural markets. On average, the *mandi* price of soy increased by 1-5 percent after the introduction of kiosks, lending support to the predictions of the theoretical model. While the presence of hubs appears to have no significant effect on price, hubs are associated with a dramatic reduction in the volume of sales in the *mandis*, as sales are diverted from the *mandis* to the hubs.

[27]The results are similar if the sample is restricted instead to those *mandi*-month cells where the monthly minimum or maximum price is below the MSP. These sub-samples contain 3193 and 566 observations respectively.

The dispersion in price across affected *mandis* in Madhya Pradesh also appears to decrease post intervention. Moreover, there is a significant increase in the area under soy cultivation due to the intervention.

I use inter-district variation in the timing and spatial heterogeneity in the location of kiosks and warehouses to isolate the causal effect. My estimates are robust to disaggregated measures of treatment and comparisons with alternative crops grown in the same season as soy. The findings show that information provision is potentially crucial to increasing the efficiency of rural markets in central India. The analysis also contributes to an understanding of the role of information technology in enhancing rural development by removing information asymmetries and making traders in local *mandis* more competitive.

The movement from monopsony to competitive equilibrium results in a significant redistribution of surplus away from the traders to the farmers. The efficiency gain of the deadweight loss from monopsony is shared amongst farmers and traders. This results overall, in a much larger net gain for the farmers but not a huge net loss for the traders. It appears that the traders are losing some of their traditional monopsony power and facing a shrinking market. The ITC initiative is part of an overall institutional change in the marketing environment, although traders might well be able to manoeuver themselves to a more advantageous position in rural central India in the long run.

I conclude that a change in the procurement strategy of a private buyer of soybean in Madhya Pradesh has had significant spillover effects on the movement of prices across agricultural *mandis* in the state. The immediate benefit to ITC

Limited of this intervention was the improvement in procurement efficiency of soybeans resulting from the creation of a direct marketing channel and a reduction in its transaction costs. According to Kumar [2004], "ITC calculated that it saved Rs. 13.3 million in transaction costs or almost 2 percent of the total value of the produce in the first season of procurement through this intervention." This feature makes the intervention self sustaining because it is profitable for the private company to implement it. As pointed out by Jensen [2007], this is important because many of the experiments undertaken by governments and NGOs to implement internet based projects in developing countries have not met with the same success. With subsequent expansion across nine states in India, this intervention has become the single-largest information technology based intervention by a corporate entity in rural India.

Although this study sheds light on the implications of this intervention for the functioning of *mandis*, the impact on net income and welfare of the farmers is an open question. If panel data were available measuring farmer characteristics such as the number of acres owned, the types of crops grown and harvested, quantity and quality of the crop sold, transportation costs incurred, number of traders and daily prices, one could measure accurately the individual response to this intervention. Future research could then determine the general equilibrium effects of improved information on wages, poverty and investment incentives faced by farmers.

Table 1: Total Number of Kiosks and Hubs Built Across 23 (out of 45) Districts of the State

Districts	# Kiosks	# Hubs
Betul	43	1
Bhopal	62	2
Chhindwara	31	1
Damoh	16	1
Dewas	127	1
Dhar	46	1
Guna	152	3
Harda	68	3
Hoshangabad	89	4
Indore	105	3
Khandwa	53	1
Mandsaur	56	1
Narsinghpur	32	1
Neemuch	53	2
Raisen	64	2
Rajgarh	110	4
Ratlam	91	2
Sagar	58	2
Sehore	110	3
Shajapur	116	2
Shivpuri	13	0
Ujjain	133	3
Vidisha	76	2

Table 2: Installation Date of the First Kiosk and First Hub Across Districts of Madhya Pradesh

District	Date of First Kiosk	Date of First Hub
Betul	Mar-03	Apr-03
Bhopal	Nov-00	Oct-03
Chhindwara	Mar-03	Oct-03
Damoh	Apr-03	Nov-03
Dewas	Dec-00	Apr-03
Dhar	Jan-01	Oct-02
Guna	Mar-01	Nov-01
Harda	Oct-00	Oct-02
Hoshangabad	Nov-00	Oct-02
Indore	Dec-00	Sep-01
Khandwa	Sep-01	Oct-01
Mandsaur	Mar-02	Nov-03
Narsinghpur	Apr-03	Nov-03
Neemuch	Jun-02	Oct-02
Raisen	Oct-00	Oct-00
Rajgarh	May-01	Nov-03
Ratlam	Dec-00	Oct-03
Sagar	Apr-03	Nov-03
Sehore	Oct-00	Apr-02
Shajapur	Dec-00	May-02
Shivpuri	Nov-01	None
Ujjain	Oct-00	Oct-03
Vidisha	Apr-01	Apr-02

Notes: The installation date of an internet kiosk is defined as the day the computer equipment was installed in the village by ITC. The hub installation date is defined as the day the first direct sale was made by a farmer at the ITC warehouse.

Table 3: Summary Statistics

	N	Mean	Std. Dev.
A. Kiosks and Hubs			
Any Kiosk in a District	15378	0.47	0.50
Number of Kiosks in a District	15378	26.13	39.59
Any Hub in a district	15378	0.30	0.46
Number of Hubs in a District	15378	0.52	0.95
Kiosk within 40 Kms of a mandi	15378	0.37	0.48
Kiosk within 60 Kms of a mandi	15378	0.48	0.50
Kiosk within 80 Kms of a mandi	15378	0.55	0.50
Hub within 40 Kms of a mandi	15378	0.23	0.42
Hub within 60 Kms of a mandi	15378	0.32	0.47
Hub within 80 Kms of a mandi	15378	0.41	0.49
B. Mandi Level Price and Sales			
Mode Price of Soy	10915	1163.02	235.70
Maximum Price of Soy	10921	1230.28	256.05
Minimum Price of Soy	10921	1046.04	230.79
Mode Price of Soy below Minimum Support Price	1101	836.35	63.79
Mode Price of Soy in the Fourth Quarter	2672	1102.66	187.06
Coefficient of Variation in Price of Soy across mandis	15378	0.08	0.02
Mode Price of Maize	6463	473.36	80.35
Mode Price of Groundnut	2914	1357.21	283.74
Sales Volume of Soy	11435	1359.34	3245.49
C. District Level Output			
Total Area Cultivated	315	223.63	116.47
Fraction of Area under Soybean	315	0.39	0.34
Fraction of Area under Maize	309	0.06	0.07
Fraction of Area under Groundnut	312	0.02	0.06
Fraction of Area under Rice	315	0.20	0.26
Total Production	315	186.22	118.17
Soy Production	315	97.39	101.47
Maize Production	309	30.72	44.13
Groundnut Production	312	4.92	12.40
Rice Production	315	30.53	54.31

Table 4: Share (%) in Total Volume of Production of Crops Grown during the Monsoon Season in the State

State		Western Region		Eastern Region	
Crops	Share (%)	Crops	Share (%)	Crops	Share (%)
Soybean	49.44	Soybean	68.57	Rice	39.61
Rice	14.82	Maize	11.36	Maize	12.40
Maize	11.71	Sorghum	6.61	Soybean	10.94
Sorghum	7.62	Cottonseed	3.78	Sorghum	9.66
Cottonseed	4.59	Red Gram	2.83	Cottonseed	6.21
Red Gram	3.13	Rice	2.51	Millet	5.29
Groundnut	2.51	Groundnut	2.30	Red Gram	3.74

Notes: Sample includes district level production in the year 1998/99 obtained from the Commissioner of Land Records, Government of Madhya Pradesh. Total production includes production of all 18 crops (6 cereals, 5 pulses, 7 oilseeds) grown during the monsoon (*kharif*) season of Madhya Pradesh.

Table 5: Initial Levels of Soybean Price and Timing of Kiosk Introduction

Panel A: Dependent Variable: District Ever Received Kiosks				
	(1)	(2)	(3)	(4)
Soy Price in 1998	0.006		0.004	
	[0.006]		[0.007]	
Soy Price in 1999		0.010	0.006	
		[0.010]	[0.011]	
Change in Soy Price 1998-1999				-0.004
				[0.006]
Constant	-4.985	-7.584	-8.323	0.373
	[5.256]	[7.910]	[8.080]	[0.681]
Observations	22	22	22	22
R-squared	0.06	0.05	0.07	0.02
Panel B: Dependent Variable: District Received Kiosks in 2000 Rather than 2001/2002				
Soy Price in 1998	0.020		0.024	
	[0.012]		[0.013]	
Soy Price in 1999		-0.002	-0.009	
		[0.009]	[0.012]	
Change in Soy Price 1998-1999				-0.015
				[0.011]
Constant	-17.501	1.67	-13.568	-1.017
	[11.081]	[7.659]	[11.921]	[1.067]
Observations	15	15	15	15
R-squared	0.14	0.02	0.18	0.19

Table 6: Basic Result - Effect of the Intervention on Monthly Price of Soybean in Wholesale Markets of Madhya Pradesh

Dependent Variable	Log(Mode Soybean Price)					
	(1)	(2)	(3)	(4)	(5)	(6)
Kiosk	0.012		0.012			
	[0.006]*		[0.006]*			
Hub		0.005	0.004			
		[0.007]	[0.007]			
Kiosk Pre 1-6 Months					0.004	
					[0.006]	
Kiosk Post 0-5 Months				0.013	0.016	
				[0.005]*	[0.008]*	
Kiosk Post 6+ Months				0.011	0.015	
				[0.008]	[0.011]	
Hub Pre 1-6 Months						-0.001
						[0.006]
Hub Post 0-5 Months						0.011
						[0.008]
Hub Post 6+ Months						-0.004
						[0.011]
Observations	10915	10915	10915	10915	10915	10915
R-squared	0.86	0.86	0.86	0.87	0.87	0.87

Notes: The dependent variable is the log monthly mode price of soybean in mandis located in districts. Sample includes the price of soybean recorded in 233 main mandis in 45 districts of the state of Madhya Pradesh over a period of 66 months (from April 2000 to September 2005). The unit of observation is a mandi-district-month. Kiosk is an indicator variable for whether there is a kiosk in a district. Similarly, Hub is an indicator variable for whether there is a hub in a district. Kiosk Pre1-6 Months is an indicator variable for six months leading up to kiosk introduction in a district. Kiosk 0-5 months is an indicator variable for the month the kiosk is introduced and the first five months thereafter. Kiosk 6+ is an indicator variable for the sixth month and beyond kiosk introduction in a district. All regressions include mandi and month fixed effects as well as district time trends. Standard errors in brackets are clustered by district to account for the fact that the intervention varies only by district-month, and correct for serial correlation in the error term. * significant at 5%; ** significant at 1%

Table 7: Impact of the Intervention on Monthly Mode Price of Soybean in Wholesale Markets (Robustness Checks)

Panel A: Full Sample (45 Districts)												
	All Quarters									Fourth Quarter		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Kiosk	0.012		0.013	0.017		0.016	0.018		0.016	0.023		0.019
	[0.005]*		[0.006]*	[0.007]*		[0.007]*	[0.007]*		[0.007]*	[0.010]*		[0.012]
Hub		0.002	0.002		0.011	0.009		0.011	0.009		0.024	0.02
		[0.005]	[0.006]		[0.007]	[0.007]		[0.007]	[0.007]		[0.014]	[0.015]
Mandi FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mandi Linear Trend	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No
District Linear Trend	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10915	10915	10915	10915	10915	10915	10915	10915	10915	2672	2672	2672
R-squared	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Panel B: 23 "Treated" Districts												
	All Quarters									Fourth Quarter		
Kiosk	0.009		0.009	0.009		0.008	0.009		0.008	0.024		0.021
	[0.005]+		[0.005]+	[0.006]		[0.006]	[0.006]		[0.006]	[0.013]+		[0.013]
Hub		0.003	0.002		0.010	0.009		0.010	0.009		0.019	0.015
		[0.006]	[0.006]		[0.006]	[0.006]		[0.006]	[0.006]		[0.014]	[0.014]
Mandi FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mandi Linear Trend	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No
District Linear Trend	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8259	8259	8259	8259	8259	8259	8259	8259	8259	1965	1965	1965
R-squared	0.83	0.83	0.83	0.84	0.84	0.84	0.83	0.83	0.83	0.82	0.82	0.82

Table 8: Effect on Monthly Minimum and Maximum Price of Soybean in Wholesale Markets of Madhya Pradesh

Dependent Variable: Log Monthly Soybean Price								
	Minimum Price				Maximum Price			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kiosk	0.017		0.016		0.006		0.006	
	[0.007]*		[0.008]*		[0.005]		[0.005]	
Hub		0.008	0.005			0.005	0.004	
		[0.011]	[0.011]			[0.007]	[0.006]	
Kiosk Pre 1-6 Months				0.017				0.0006
				[0.010]				[0.007]
Kiosk Post 0-5 Months				0.030				0.006
				[0.009]**				[0.007]
Kiosk Post 6+ Months				0.028				0.007
				[0.012]*				[0.010]
Observations	10921	10921	10921	10921	10921	10921	10921	10921
R-squared	0.74	0.74	0.74	0.74	0.87	0.87	0.87	0.87

Notes: The dependent variable is the log monthly minimum or maximum price of soybean in mandis located in districts. Sample includes the price of soybean recorded in 233 main mandis in 45 districts of the state of Madhya Pradesh over a period of 66 months (from April 2000 to September 2005). The unit of observation is a mandi-district-month. There are 38 instances where the price is recorded as zero and 4419 missing observations. Kiosk is an indicator variable for whether there is a kiosk in a district. Similarly, Hub is an indicator variable for whether there is a hub in a district. Kiosk Pre1-6 Months is an indicator variable for six months leading up to kiosk introduction in a district. Kiosk 0-5 months is an indicator variable for the month of kiosk introduction and five subsequent months in a district. Kiosk 6+ is an indicator variable for the sixth month and beyond kiosk introduction in a district. All regressions include mandi and month fixed effects as well as district time trends. Standard errors in brackets are clustered by district to account for the fact that the intervention varies only by district-month, and correct for serial correlation in the error term. * significant at 5%; ** significant at 1%

Table 9: Effect on Monthly Price of Soybean Relative to Alternative Crops

Dependent Variable: Log Price of Crops			
	(1)	(2)	(3)
Panel A: Soybean to Maize			
Soy*Kiosk	0.047		0.053
	[0.021]*		[0.021]*
Soy*Hub		0.019	-0.011
		[0.018]	[0.014]
Observations	11588	11588	11588
R-squared	0.97	0.97	0.97
Panel B: Soybean to Groundnut			
Soy*Kiosk	0.018		0.017
	[0.031]		[0.035]
Soy*Hub		0.013	0.002
		[0.029]	[0.033]
Observations	5166	5166	5166
R-squared	0.67	0.67	0.67
Panel C: Maize to Groundnut			
Maize*Kiosk	-0.002		-0.018
	[0.034]		[0.045]
Maize*Hub		0.017	0.028
		[0.037]	[0.048]
Observations	3582	3582	3582
R-squared	0.94	0.94	0.94

Table 10: Effect on Monthly Price of Soybean in Wholesale Markets Located Near a Hub and Kiosk

Dependent Variable: Log of monthly mode price of soy

	within 40 kms of a mandi			within 60 kms of a mandi			within 80 kms of a mandi			within 100 kms of a mandi		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Kiosk	0.016		0.016	0.013		0.014	0.006		0.005	0.0005		-0.003
	[0.005]**		[0.005]**	[0.005]**		[0.005]**	[0.005]		[0.006]	[0.006]		[0.007]
Hub		0.003	0.002		0.002	0.003		0.004	0.003		0.008	0.008
		[0.005]	[0.005]		[0.004]	[0.004]		[0.004]	[0.004]		[0.005]	[0.005]
Observations	10915	10915	10915	10915	10915	10915	10915	10915	10915	10915	10915	10915
R-squared	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87

Notes: The dependent variable is the log monthly mode price of soybean in mandis. Sample includes the price of soybean recorded in 233 main mandis in the state of Madhya Pradesh over a period of 66 months (from April 2000 to September 2005). The unit of observation is a mandi-month. There are 35 instances where the price is recorded as zero and 4428 missing observations. In columns 1-3, Hub is an indicator variable for whether there is a hub within 40 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 40 kms of a mandi. In columns 4-6, Hub is an indicator variable for whether there is a hub within 60 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 60 kms of a mandi; similarly in columns 7-9. All regressions include mandi and month fixed effects as well as mandi linear trends. Robust standard errors in brackets are clustered by mandi. * significant at 5%; ** significant at 1%

Table 11: Impact of the Intervention on Monthly Mode Price of Soybean in Wholesale Markets (Robustness Checks)

	Dependent Variable: Log Monthly Mode Price of Soy								
Panel A: Within 40 kms of a mandi									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kiosk	0.009		0.011	0.022		0.021	0.014		0.014
	[0.006]		[0.006]	[0.007]**		[0.007]**	[0.007]		[0.007]*
Hub		-0.001	-0.005		0.008	0.007		0.004	0.001
		[0.005]	[0.006]		[0.006]	[0.007]		[0.006]	[0.007]
Mandi FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mandi Linear Trend	No	No	No	Yes	Yes	Yes	No	No	No
District Linear Trend	No	No	No	No	No	No	Yes	Yes	Yes
Observations	10915	10915	10915	10915	10915	10915	10915	10915	10915
R-squared	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83
Panel B: Within 60 kms of a mandi									
Kiosk	0.011		0.013	0.019		0.019	0.015		0.015
	[0.005]		[0.005]**	[0.006]**		[0.006]**	[0.005]**		[0.005]**
Hub		-0.001	-0.005		0.002	0.002		0.001	0.001
		[0.005]	[0.004]		[0.004]	[0.004]		[0.005]	[0.004]
Mandi FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mandi Linear Trend	No	No	No	Yes	Yes	Yes	No	No	No
District Linear Trend	No	No	No	No	No	No	Yes	Yes	Yes
Observations	10915	10915	10915	10915	10915	10915	10915	10915	10915
R-squared	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83

Notes: The dependent variable is the log monthly mode price of soybean in mandis. Sample includes the price of soybean recorded in 233 main mandis in the state of Madhya Pradesh over a period of 66 months (from April 2000 to September 2005). The unit of observation is a mandi-month. There are 35 instances where the price is recorded as zero and 4428 number of missing observations. In columns 1-3, Hub is an indicator variable for whether there is a hub within 40 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 40 kms of a mandi. In columns 4-6, Hub is an indicator variable for whether there is a hub within 60 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 60 kms of a mandi. All regressions include mandi and month fixed effects as well as mandi linear trends. Robust standard errors in brackets are clustered by mandi. * significant at 5%; ** significant at 1%

Table 12: Effect on Monthly Sales Volume of Soybean in Wholesale Markets Located Near a Hub and Kiosk

	Dependent Variable: Log Volume of Soybean Sales								
	District Level Effect			Within 40 kms of a mandi			Within 60 kms of a mandi		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kiosk	0.190		0.190	0.260		0.265	0.416		0.419
	[0.157]		[0.164]	[0.091]**		[0.090]**	[0.095]**		[0.098]**
Hub		0.026	0.002		-0.200	-0.205		-0.029	-0.019
		[0.107]	[0.110]		[0.068]**	[0.067]**		[0.066]	[0.068]
Observations	11435	11435	11435	11435	11435	11435	11435	11435	11435
R-squared	0.75	0.75	0.75	0.76	0.76	0.76	0.77	0.76	0.77

Notes: The dependent variable is the log monthly sales volume of soybean in mandis. Sample includes the quantity of soybean sold in 233 main mandis in the state of Madhya Pradesh over a period of 66 months (from April 2000 to September 2005). There are 843 instances where the price is recorded as zero and 3100 missing observations. In columns 1-3, Kiosk is an indicator variable for whether there is a kiosk in a district. Similarly, Hub is an indicator variable for whether there is a hub in a district. In columns 4-6, Hub is an indicator variable for whether there is a hub within 40 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 40 kms of a mandi. In columns 7-9, Hub is an indicator variable for whether there is a hub within 60 kms of a mandi and Kiosk is an indicator variable for whether there is a kiosk linked to a hub that is within 60 kms of a mandi. The regressions in columns 1-3 include mandi and month fixed effects and district time trends. The standard errors are clustered at the district level. In columns 4-9, all regressions include mandi and month fixed effects as well as mandi linear trends. The standard errors in brackets are clustered by mandi. * significant at 5%; ** significant at 1%

Table 13: Effect on Price Dispersion

Dependent Variable	Coefficient of Variation		Standard Deviation	
	(1)	(2)	(3)	(4)
Kiosk	-0.009	-0.008	-10.004	-8.663
	[0.004]*	[0.004]*	[4.500]*	[4.105]*
Hub		-0.006		-7.304
		[0.004]		[5.351]
Observations	2188	2188	2188	2188
R-squared	0.27	0.27	0.34	0.34

Notes: The dependent variable is the coefficient of variation, or the standard deviation in the monthly mode price of soybean across mandis located in a district within a given month. The unit of observation is a district-month. There are 782 number of missing observations. All regressions include district and month fixed effects as well as district linear trends. Robust standard errors in brackets are clustered by district. * significant at 5%; ** significant at 1%

Table 14: Effect on Area and Production of Crops

PANEL A : Area	Dependent Variables									
	Log (Total Area Cultivated)		Fraction of Area under Soybean		Fraction of Area under Rice		Fraction of Area under Maize		Fraction of Area under Groundnut	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Kiosk	0.0003	0.001	0.029	0.029	-0.012	-0.013	-0.0001	-0.0001	0.001	0.001
	[0.025]	[0.025]	[0.009]**	[0.009]**	[0.005]*	[0.005]*	[0.004]	[0.004]	[0.001]	[0.001]
Hub		-0.005		-0.002		0.009		-0.002		0.001
		[0.031]		[0.013]		[0.009]		[0.003]		[0.002]
Observations	315	315	315	315	315	315	306	306	311	311

PANEL B: Production	Dependent Variables									
	Log(Total Production)		Log(Soybean Production)		Log(Rice Production)		Log (Maize Production)		Log (Groundnut Production)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Kiosk	0.052	0.042	0.192	0.192	-0.002	-0.025	0.043	0.042	-0.092	-0.103
	[0.094]	[0.097]	[0.114]$^{+}$	[0.117]	[0.101]	[0.102]	[0.093]	[0.094]	[0.092]	[0.101]
Hub		0.090		0.002		0.201		0.006		0.093
		[0.119]		[0.134]		[0.156]		[0.141]		[0.179]
Observations	315	315	315	315	315	315	306	306	311	311

Table 15: Effect of the Intervention on Yield of Crops

	Dependent Variable:							
	Soy Yield		Rice Yield		Maize Yield		Groundnut Yield	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kiosk	0.066	0.038	-0.025	-0.040	0.016	0.011	0.068	0.059
	[0.137]	[0.126]	[0.123]	[0.132]	[0.084]	[0.086]	[0.125]	[0.127]
Hub		0.245		0.128		0.052		0.075
		[0.167]		[0.141]		[0.100]		[0.094]
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Linear Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	315	315	315	315	308	308	311	311
R-squared	0.72	0.73	0.78	0.78	0.75	0.75	0.58	0.58

Notes: All dependent variables are in Logs. The unit of observation is a district-year. Missing district*year observations account for actual sample size. Kiosk is an indicator variable for whether there is a kiosk in a district. Similarly, Hub is an indicator variable for whether there is a hub in a district. All regressions include district and year fixed effects as well as district linear trends. Robust standard errors in brackets are clustered by district. + significant at 10%; * significant at 5%; ** significant at 1%

Figure 1: Daily Average Posted Prices (A snapshot of 45 days in 2004)

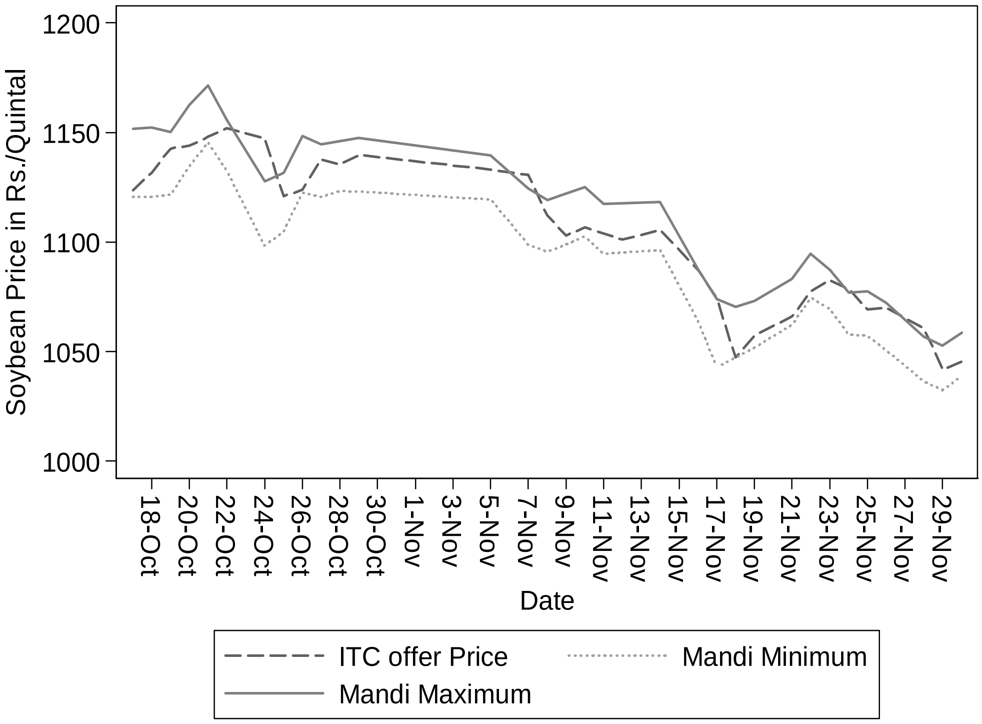


Figure 2: Major Soybean Producing Districts of Madhya Pradesh
(Darker Shades represent higher soybean growing intensity in the year 2000)

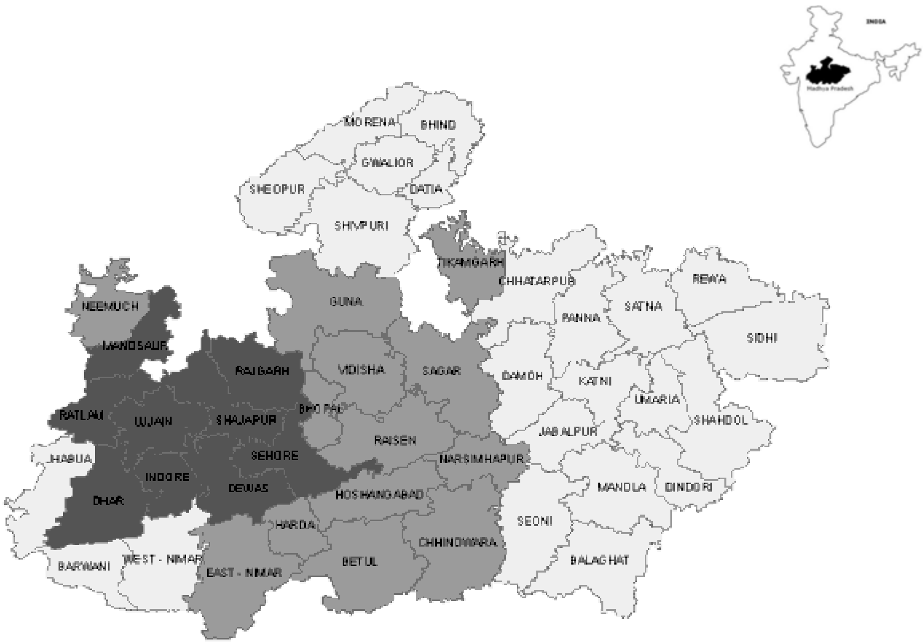


Figure 3: Distribution of *Mandis* and Hubs in the State
(The 23 intervention districts are shaded)

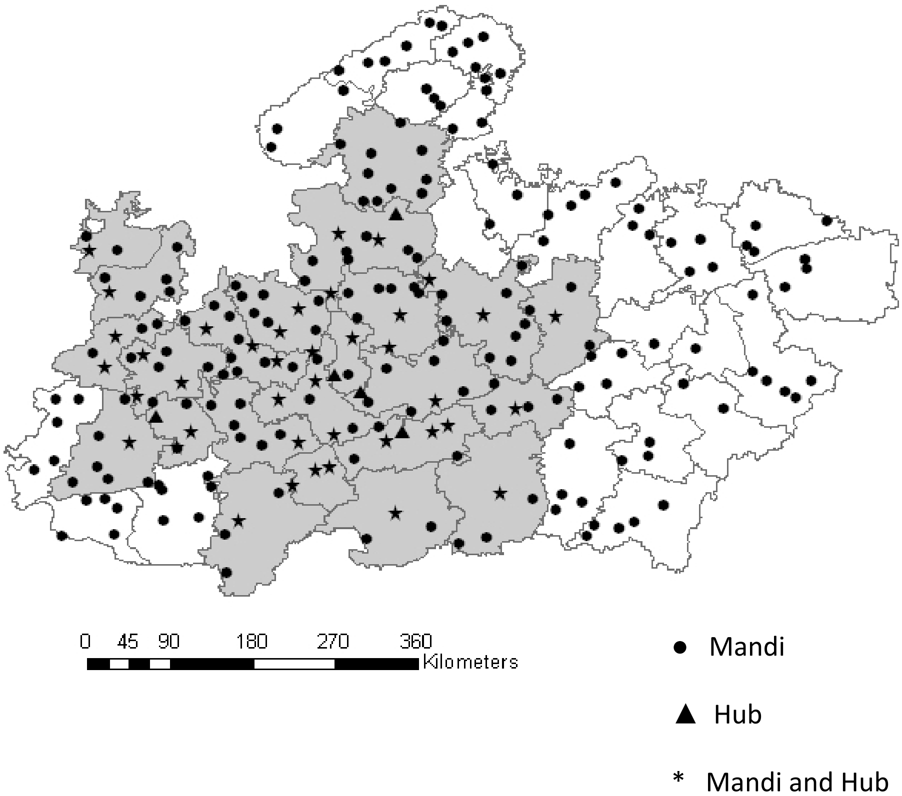


Figure 4: Broad Trends in Mode Price of Soybean Across Districts of the State

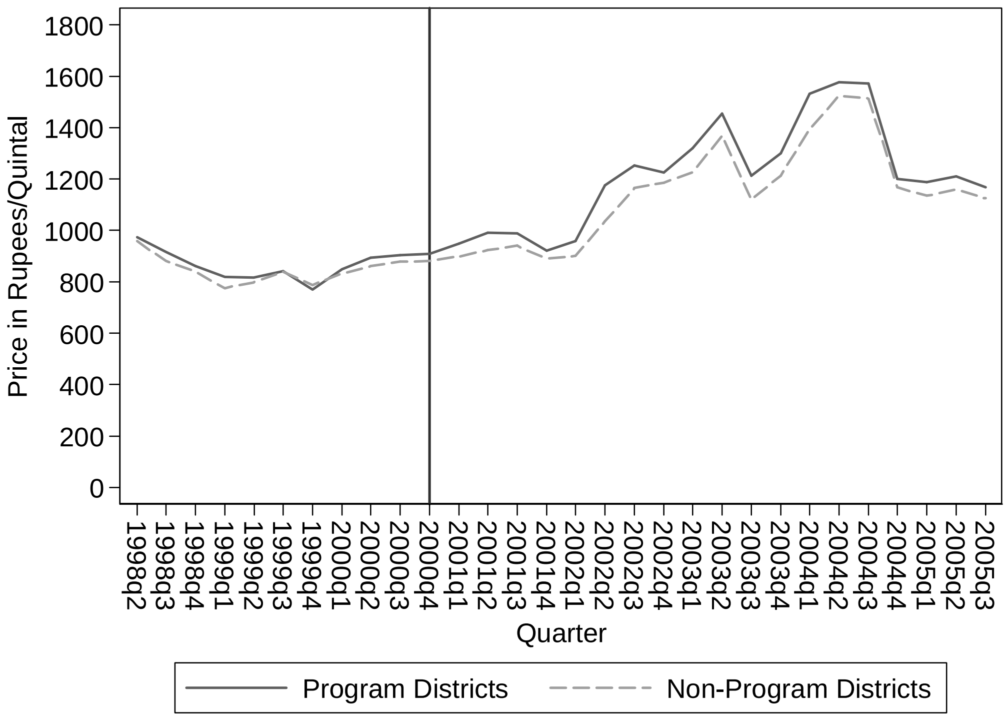


Figure 5: Partial Distribution of Kiosks in the State

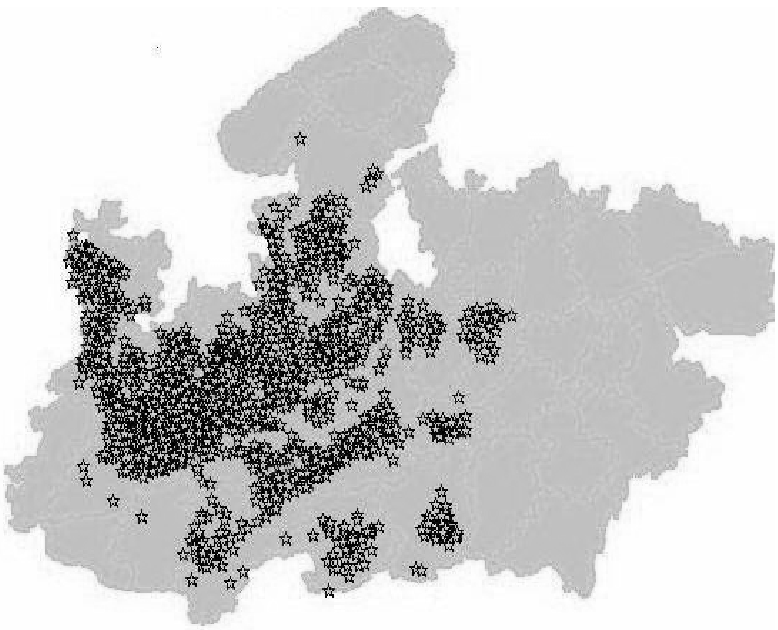


Figure 6: Network of Roads in the State

(Darker lines represent paved roads)

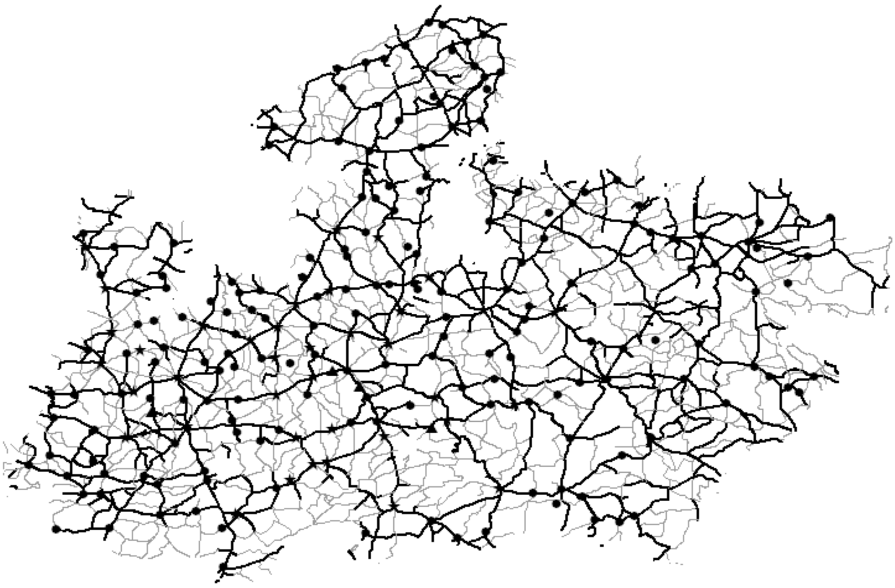


Figure 7: Equilibrium Condition

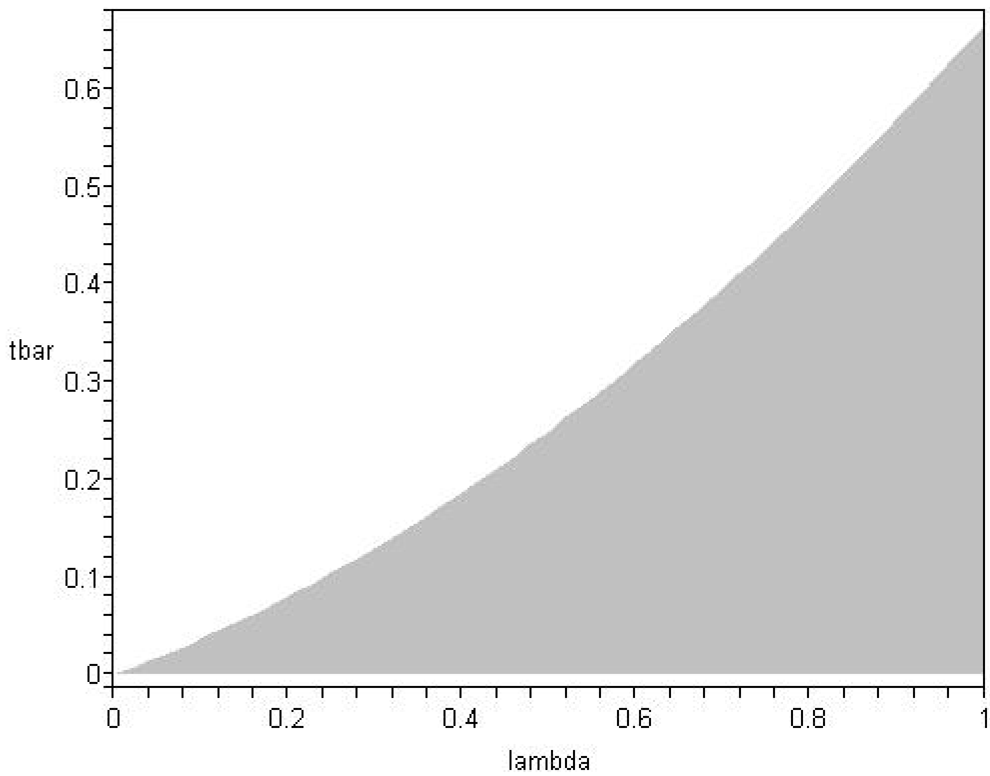


Figure 8: Total Number of Kiosks and Hubs Introduced Over Time

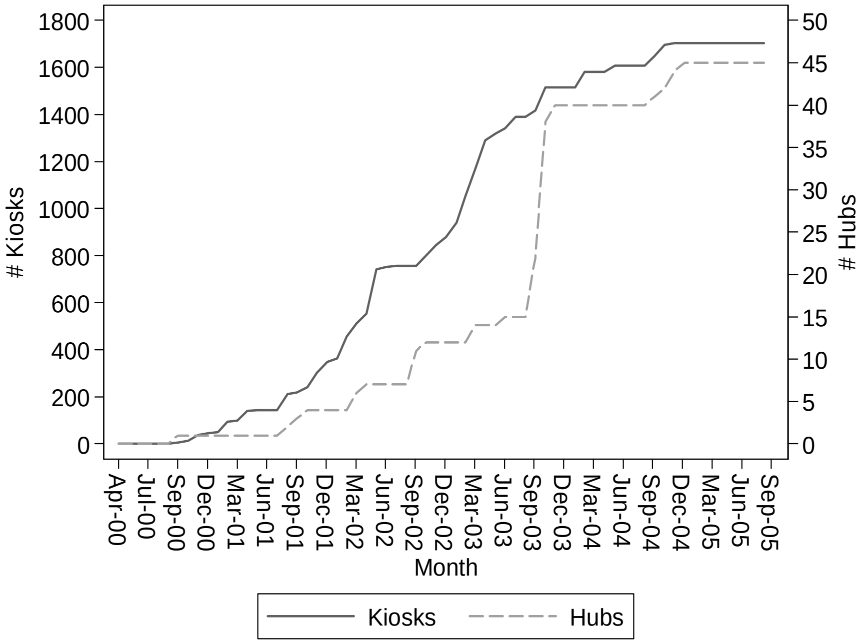


Figure 9: Percentage of Districts with Any Kiosk and Any Hub in the State

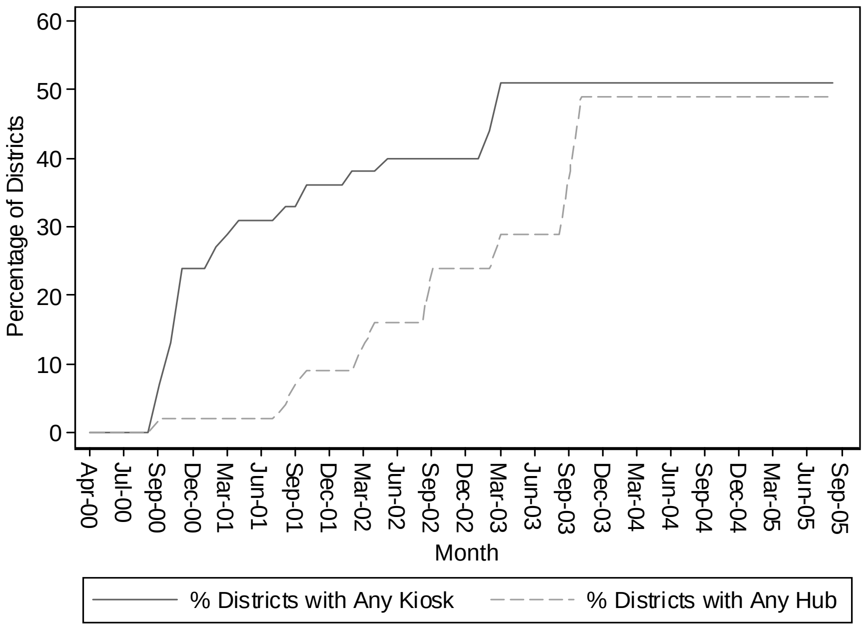


Figure 10: Distribution of Distance of the *Mandis* to the Nearest Hub

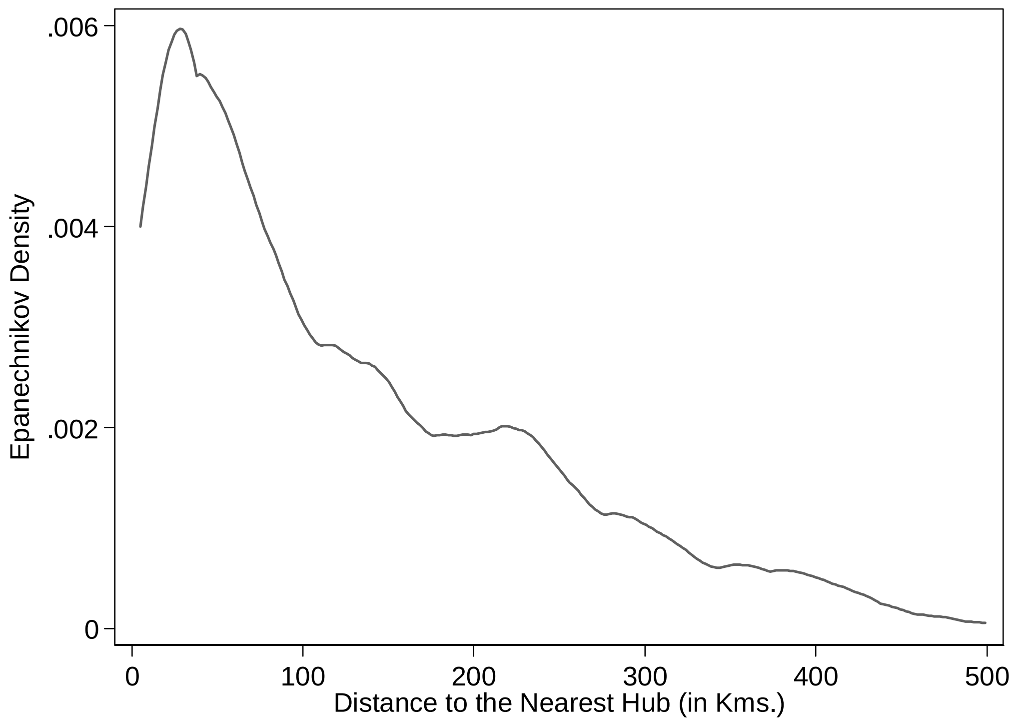


Figure 11: Welfare Analysis

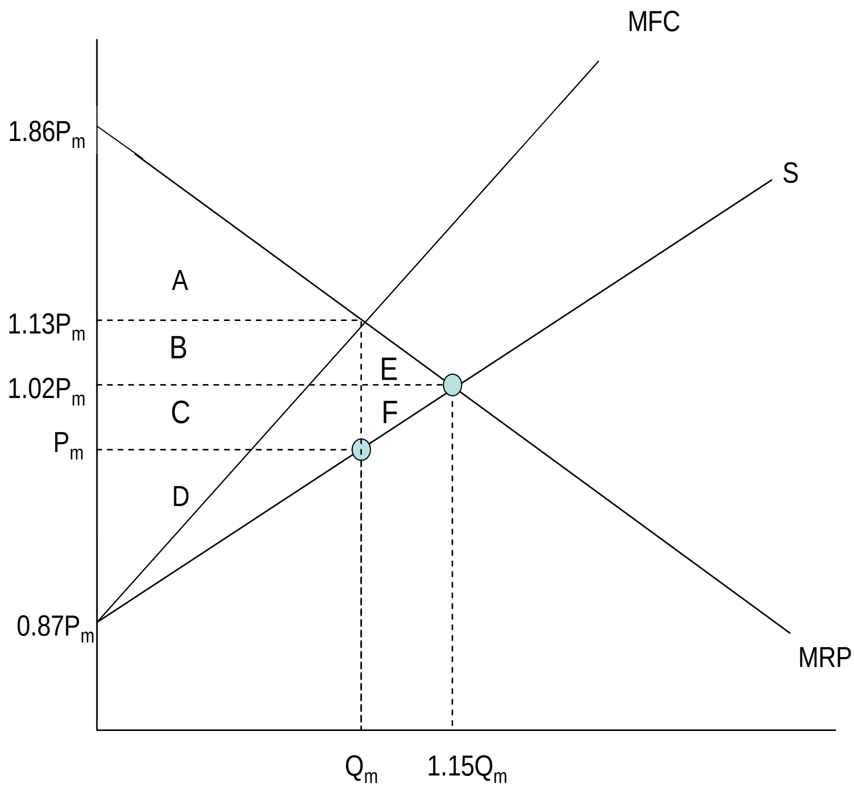
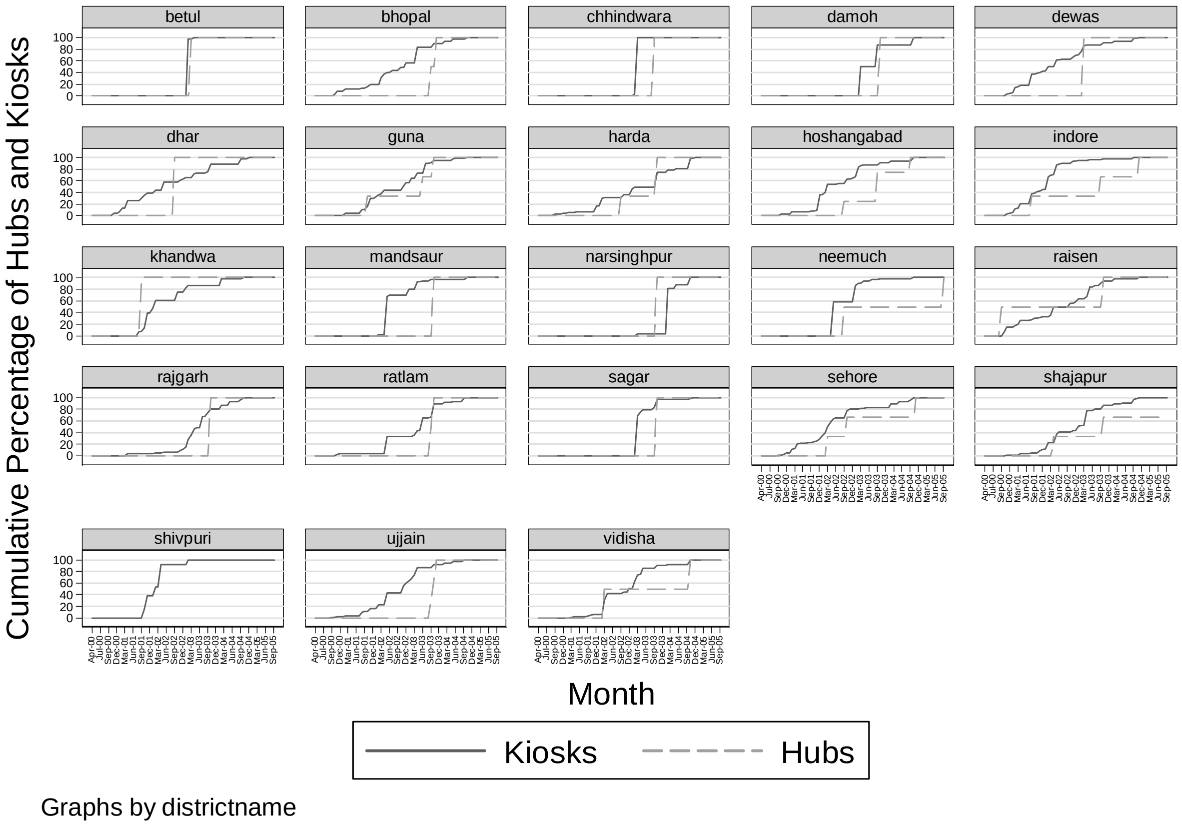


Figure 12: Timing of the Rollout of Internet Kiosks and Hubs in 23 Districts of Madhya Pradesh



Bibliography

[1] Akerlof, G. (1970) "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics*, vol. 84(3), pages 488-500, August.

[2] Allen, F. (1984) "Reputation and Product Quality," *RAND Journal of Economics*, 15, 311-27.

[3] Anupindi, R. and SivaKumar, S. (2006) "Supply Chain Re-engineering in Agri-Business A Case study of ITCs e-Choupal," in Supply Chain Issues in Emerging Economies, Hau L. Lee and Chung-Yee Lee (Editors), Elsevier-Springer.

[4] Banerjee, A., Mookherjee, D., Munshi, K. and Ray, D. (2001) " Inequality, Control Rights and Rent Seeking: A Theoretical and Empirical Analysis of Sugar Cooperatives in Maharashtra," *Journal of Political Economy* 109, 138-190.

[5] Banerji, A. and Meenakshi, J.V. (2004) "Millers, Commission Agents and Collusion in Grain Auction Markets: Evidence From Basmati Auctions in North India," *Working Paper* 129, Center for Development Economics, Delhi School of Economics.

[6] Bardhan, P. (1989) "The Economic Theory of Agrarian Institutions," Oxford University Press.

[7] — and Udry, C. (1999) "Development Microeconomics," Oxford University Press.

[8] Baye, M. and Morgan, J.(2001) "Price Dispersion in the Lab and on the Internet: Theory and Evidence," *Working Paper*, Haas School of Business and Department of Economics, University of California, Berkeley.

[9] Baye, M., Morgan, J. and Scholten, P.(2006) "Information, Search, and Price Dispersion," in Terry Hendershott, Handbook of Economics and Information Systems, Elsevier, forthcoming.

[10] Bell, C. and Srinivasan, T.N.(1989) "Interlinked Transactions in Rural Markets: An Empirical Study of Andhra Pradesh, Bihar and Punjab," *Oxford Bulletin of Economics and Statistics*, 51, 1, 73-83.

[11] Bertrand, M., Duflo,E. and Mullainathan,S. (2004) “How Much Should We Trust Differences-in-Difference Estimates,” *Quarterly Journal of Economics*, 119 (1) 249-275.

[12] Besley, T.(1997) “Monopsony and Time-Consistency : Sustainable Pricing Policy for Perennial Crops,” *Review of Development Economics*, 1 (1). pp. 57-70.

[13] Binswanger, H., Khandker, S., Rosenzweig, M. (1993) “How Infrastructure and Financial Institutions Affect Agricultural Output and Investment in India,” *Journal of Development Economics*, 41(2), 337-366.

[14] Biglaiser, G. (1993) “Middlemen as Experts,” *RAND Journal of Economics*, 24, 212-223.

[15] Bizan O. and Greenstein, S. (2004)“Price Dispersion in ISPs Contract Offerings,” *Working Paper*, Northwestern University.

[16] Brambilla, I. and Guido, P. (2005) “Farm Productivity and Market Structure: Evidence from Cotton Reforms in Zambia,” *Working Paper* NBER No. 11804.

[17] Brown, J. and Goolsbee, A. (2002) “Does the Internet Make Markets More Competitive? Evidence from Life Insurance Industry,” *Journal of Political Economy*, Vol 110, 3, 481-507.

[18] Burdett, K., and Judd, K.(1983) “Equilibrium Price Dispersion,” *Econometrica*, 51, 955-69.

[19] Burgess, R. and Pande, R. (2005) “Can Rural Banks Reduce Poverty? Evidence from the Indian Social Banking Experiment,” *American Economic Review* Vol. 95 (3), 780-795.

[20] Butters, G. (1977) “Equilibrium Distribution of Prices and Advertising,” *Review of Economic Studies* Vol 44, 465-492.

[21] Deaton, A. (1988) “Quality, Quantity, and Spatial Variation of Price,” *American Economic Review*, Vol. 78, No 3, pp. 418-430.

[22] — (1989) “Rice Prices and Income Distribution in Thailand: A Non-parametric Analysis,” *Economic Journal*, Supplement 1989, Vol. 99, 395, pp. 1-37.

[23] Diamond, P. (1971) “A Model of Price Adjustment,” *Journal of Economic Theory*, 3: 156-68.

[24] Duflo, E. (2001) "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment," *American Economic Review*, vol. 91(4), pages 795-813.

[25] — and Pande, R. (2005) "Dams," NBER *Working Paper* W11711.

[26] Duggan, M. and Scott-Morton, F. (2006) "The Distortionary Effects of Government Procurement: Evidence for Medicaid Prescription Drug Purchasing," *Quarterly Journal of Economics*, February, 1-30.

[27] Ellison, G. and Ellison S. (2004) "Search, Obfuscation, and Price Elasticities on the Internet," MIT Working Paper.

[28] Fafchamps, M.(1992) "Cash Crops Production, Food Price Volatility, and Rural Market Integration in the Third World," *American Journal of Agricultural Economics* 74, pp. 90-99.

[29] Government of India (2005), "Marketing Reforms," Ministry of Agriculture.

[30] Government of Madhya Pradesh (2000) "Compendium of Statistics, Directorate of Economics and Statistics," Department of Planning, Economics and Statistics.

[31] — (2003) "Agricultural Marketing Act, 1972," [M.P. Act No. 24 of 1973].

[32] — (2004) "Agricultural Statistics at a Glance," Commissioner of Land Records, Gwalior.

[33] — (2005) "Economic Survey," Directorate of Economics and Statistics, Department of Planning, Economics and Statistics.

[34] — (2008) "Reinventing Mandi: Market Yards in a Globalized World," Vision Paper.

[35] Grossman, G. and Shapiro, C. (1984) "Informative Advertising and Differentiated Products," *Review of Economic Studies*, Vol 51, 63-82.

[36] Grossman, S. and Stiglitz, J. (1976) "Information and Competitive Price Systems," *American Economic Review*, vol. 66(2), pages 246-53, May.

[37] Harriss-White, Barbara (1996), A Political Economy of Agricultural Markets in South India: Masters of the Countryside, Sage Publications.

[38] Hayami, Y., Kawagoe, T. and Morooka, Y. (1988) "Middlemen and Peasants: The Structure of the Indonesian Soybean Market," *Developing Economies*, March v. 26, issue 1, pp. 51-67.

[39] Jacoby, H. (2000) "Access to Markets and the Benefits of Rural Roads," *The Economic Journal*, 110, 713-737.

[40] Jalan, J., and Ravallion, M. (2002) "Geographic Poverty Traps? A Micro Econometric Model of Consumption Growth in Rural China," *Journal of Applied Econometrics*.

[41] Jensen, R. (2007) "The Digital Provide: Information (Technology), Market Performance and Welfare in South Indian Fisheries Sector," *Quarterly Journal of Economics*, Vol.122:3, August.

[42] Johansson, B. and Quigley,J. (2004) "Agglomeration and Networks in Spatial Economies," *Papers in Regional Science* 83 (1), 165-176.

[43] Jovanovic, M. (2003), "Spatial Location of Firms and Industries: An Overview of Theory," *Economia Internazionale*, pp. 23-81.

[44] Key, N., Sadoulet, E. and De Janvry, A. (2000) "Transaction Costs and Agricultural Household Supply Response," *American Journal of Agricultural Economics*, 82, pp.245-259.

[45] Kranton, R. and Swamy, A. (2005) "Holdup and Exports: Textile and Opium in Colonial India," *Working Paper*, University of Maryland.

[46] Kumar, R. (2004) "eChoupals: A Study on the Financial Sustainability of Village Internet Centers in Rural Madhya Pradesh," *Information Technologies and International Development*, Volume 2, Number 1, pp. 45-74(30).

[47] Li, Y. (1998) "Middlemen and Private Information," *Journal of Monetary Economics* 42, 131-59.

[48] Marker, P. McNamara, K. and Wallace, L. (2002) "The Significance of ICT for Reducing Poverty," DFID.

[49] Meyer, B. (1995) "Natural and Quasi-Experiments in Economics," *Journal of Business and Economic Statistics*, Vol. 13, No. 2, pp. 151-161.

[50] McAfee, R.P. (1995) "Multiproduct Equilibrium Price Dispersion," *Journal of Economic Theory*, 67, 83-105.

[51] Planning Commission (2002) Tenth Five Year Plan, Government of India.

[52] Prahalad, C.K. (2003) "Case Study Series," The University of Michigan Business School

[53] Pratt, J., Wise, D. and Zeckhauser, R. (1979)"Price Differences in Almost Competitive Markets." *Quarterly Journal of Economics* 93, 189-211.

[54] Registrar General (2001) "Results of Census of India 2001 by States and Union Territories," Office of the Registrar General, New Delhi, India.

[55] Rogers, R. and Sexton, R. (1994) "Assessing the Importance of Oligopsony Power in Agricultural Markets," *American Journal of Agricultural Economics*, Vol. 76, No. 5, Proceedings Issue, pp. 1143-1150.

[56] Rust, J. and Hall, G. (2003) "Middlemen versus Market Makers: A Theory of Competitive Exchange," *Journal of Political Economy*, University of Chicago Press, Vol. 111(2), pp. 353-403.

[57] Salop, S. and Stiglitz, J. (1977) "Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion," *Review of Economic Studies* 44, 493-510.

[58] Schware, R. and Bhatnagar, S. (2001) "Information and Communication Technology for Development: Cases from India," Sage Publications India Ltd.

[59] Scott-Morton, F., Zettelmeyer, F. and Silva-Risso, J. (2001) "Internet Car Retailing," *Journal of Industrial Economics*, 49(4), 501-519.

[60] Siamwalla, A. (1978) "Farmers and Middlemen: Aspects of Agricultural Marketing in Thailand," *Economic Bulletin for Asia and the Pacific*, 29, 1, 38-50.

[61] Singh, B. (2005)"Success of Soybean in India: The Early Challenges and Pioneer Promoters," mimeo, International Institute of Tropical Agriculture (IITA), Nigeria.

[62] Sorensen, A. (2000) "Equilibrium Price Dispersion in Retail Markets for Prescription Drugs," *Journal of Political Economy*, volume 108 (2000), pp. 833-850.

[63] Stahl, Dale O.(1989) "Oligopolistic Pricing with Sequential Consumer Search." *American Economic Review* 79, 700-712.

[64] Stigler, G. (1961) "The Economics of Information." *Journal of Political Economy* 69, 3, 213-225.

[65] Thomas, S. (2003) "Agricultural Commodity Markets in India: Policy Issues for Growth," Technical Report, IGIDR.

[66] Tirole, J. (1988) "The Theory of Industrial Organization," Cambridge: MIT Press.

[67] Torero, M. (2000) "The Access and Welfare Impacts of Telecommunications Technology in Peru." Center for Development Research, Universitt Bonn, Discussion Papers on Development Policy No. 27.

[68] UNDP (2002) Madhya Pradesh Human Development Report.

[69] Upton, D. and Fuller, V. (2003) "The ITC eChoupal Initiative," Harvard Business School Case study, N9-604-016.

[70] Varian, Hal R.(1980) "A Model of Sales," *American Economic Review* 70: 651-59.

[71] White, G. (1993) "Towards a Political Analysis of Markets," IDS Bulletin 24.3

[72] World Bank (1999) "The Indian Oilseed Complex: Capturing Market Opportunities," South Asia Rural Development Series.

[73] — (2003) "ITCs and MDGs: A World Bank Group Perspective," GICT.

[74] — (2005) "India: Re-energizing the Agricultural Sector to Sustain Growth and Reduce Poverty," Oxford University Press.