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How Does India's Rural Roads Program Affect the Grassroots?

Findings from a Survey in Orissa

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Abstract

This paper analyzes the effects of all-weather rural roads on households' net output prices, education and health in a poor, drought-prone region of India. Of 30 villages originally surveyed in 2001–02, when two had such roads, a further nine received them between January 2007 and December 2009 under the program Pradhan *Mantri Gram Sadak Yojana.* Cross-section comparisons involving all villages and 'before and after' comparisons in the nine yielded these findings: (i) net output prices were 5 per cent or more higher; (ii) substantially fewer days of schooling were lost due to bad weather, largely because teachers had fewer absences; (iii) the acutely sick received more timely treatment and were more likely to be treated in a hospital than in the nearest primary health clinic; and (iv) the respondents ranked the resulting benefits in the domains of health and education at least as highly as the 'commercial' ones.

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How Does India's Rural Roads Program Affect the Grassroots? Findings from a Survey in Orissa

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*University of Heidelberg, INF 330, D-69120 Heidelberg, Germany. We are much indebted to Bijaya Behera, who, as in previous surveys of these villages, organized and directed the field work, personally cleaned the data, and provided numerous insights based on his knowledge of the region and its people. Abhiroop Mukhopadhyay and Indira Rajaraman provided valuable comments on an earlier draft. We alone bear responsibility for any errors that remain. The re-survey was undertaken in connection with the preparation of a World Bank loan proposal. The views expressed in this paper are not, however, necessarily those of the World Bank or its Board.

1 Introduction

In 2000, the Government of India launched the program known as *Pradhan Mantri Gram Sadak Yojana* (hereinafter PMGSY), under which all of India's habitations with populations exceeding 500 persons (250 in hilly and desert areas) were to enjoy an all-weather road connection by 2015. At that time, about 170,000 habitations were eligible; at this time of writing, somewhat over 40 percent have their road. By the end of 2010, accumulated expenditures had amounted to about US$14.6 billion, and it is estimated that a further US$40 billion will be required to complete the program by 2020 (World Bank, 2010). By any measure, PMGSY is a very large undertaking.

The aim of the program is to draw all of India's villages into the mainstream, especially in three domains. First, with improved connections to markets, villagers should face more favorable prices for inputs and outputs, which will raise their incomes and sharpen their incentives to cultivate more intensively, pursue new activities and invest in new methods. Secondly, by reducing the time spent traveling to and from school (and in the rainy season, by making the trip actually possible), the provision of an all-weather road should improve the attendance not only of pupils, but also of their teachers, thus promoting the formation of human capital. Thirdly, by likewise improving the villagers' access to timely treatment, especially in the event of accidents and bouts of acute sickness, the connection should lower morbidity and mortality. Improvements in these domains will, if realized, reduce poverty and increase productivity in the short and the long run.

The effects of investments in rural roads on villagers' well-being, broadly interpreted, is hardly a new topic, but it has received considerable attention in the past decade or two, as governments and aid donors have sought to find efficient ways of improving rural welfare. Beginning with the sub-continent, two well-known studies are Binswanger *et al.* (1993), which is largely concerned with output and investment in rural India, and Fan *et al.* (2000), which addresses welfare more directly, in that it also investigates the effects of government spending on rural poverty. Rather closer to the present paper in the type of evidence and methods employed is Khandker *et al.* (2009), which analyzes two panels of data, comprising 42 and 18 villages, respectively, in connection with Bangladesh's Rural Roads and Market Improvement and Maintenance Projects, which were undertaken in the late 1990s. The salient findings conform to the expectations outlined above. Transport costs were much reduced, output and net prices were boosted, as were agricultural wages and per capita household consumption. Boys' and girls' schooling rose, too. The distribution of consumption changed favorably, or at least broadly neutrally, so that there was a substantial associated reduction in poverty. There is evidence that providing all-weather roads also reduces poverty in south-east Asia. Between 1997-98 and 2002-03, the headcount ratio in rural Laos fell by 9.5 percentage points: Warr (2010) estimates that 13 percent of this decline is attributable to the conversion of dry- into all-weather roads.

In a quite different tradition, there is the so-called 'capitalization' approach to estimating benefits (net of any costs entailed by ownership, such as land taxes), which is well-established in the regional and urban economics literature. Although there are drawbacks when applying it to poor rural regions, one careful study of Madagascar (Jacoby and Minten, 2009) arrives at the conclusion that this approach yields a much larger estimated benefit than that based on the savings of time.

Thus motivated, this paper presents the main findings of a specially designed resurvey of 30 villages in upland Orissa, which had been the subject of an earlier study of how households respond to, and cope with, fluctuations in the state of nature in this drought-prone region (van Dillen, 2008). The original survey covered three seasons, starting in *kharif* 2000,[1] when only two of the villages surveyed had an all-weather road. As time passed, PMGSY began to make itself felt; it turned out that, starting in 2007, a further 9 villages had been provided with such a connection by the end of 2009. This development offered an opportunity to investigate the effects of PMGSY on the lives and doings of the villagers so served. In particular, a re-survey of the original households promised to provide certain empirical underpinnings for an economic analysis of PMGSY in connection with a proposed World Bank loan.

The paper is organized in keeping with the three domains identified above. Following a brief description of the area studied and the sample frame in Section 2, the effects of the new roads on trade, education and health are described and analyzed in Sections 3, 4 and 5, respectively. The emphasis is on positive rather than normative measurement, whereby the former supports and serves the latter. The only attempt at normative measurement is made in Section 6, which reports and discusses the respondents' rankings of the benefits they derived in each of the three domains. Those readers who hanker after a normative analysis of PMGSY may consult Bell (2011a, 2011b), which draw on some of the material presented here. The main conclusions are drawn together in Section 7.

[1] The agricultural year runs from 1 July to 30 June, the first six months of which define the *kharif* season, the second the *rabi* season.

2 The Study Area and the Survey

The study area, which is located in Bolangir and Kalahandi Districts, is a patchwork of small river basins and often densely forested hills. The population is highly heterogeneous, with scores of different tribal groups and Hindu communities. What makes this remote rural area particularly interesting for present purposes is its poverty and notorious proneness to drought (Sinha, 1999). In six years of the decade 1996-2005, for example, precipitation was deficient, untimely, or both (van Dillen, 2008). The most important sources of household income are cultivation, animal husbandry, non-timber forestry, government employment schemes and earnings from various forms of migration, where the latter are often a response to drought.

The original survey was carried out in 2001-02 (see van Dillen [2008] for an extensive account). Four administrative blocks (Titlagarh, Saintala, Muribahal and Bongomunda) were selected in Bolangir, and Kesinga, the most north-eastern block of Kalahandi. These five, contiguous blocks have a combined area of approximately 1,900 sq. km and a population of about half a million. Employing a stratification aimed at ensuring a fairly even spatial distribution at the second stage, six clusters of villages were defined in each block and one village was drawn at random from each cluster. Eight households were then selected from each village, yielding 240 households in all. Again, only spatial stratification was employed, households being selected at random from different parts of the village settlement area. Detailed quantitative information was collected on each household's activities and income portfolio in each of three consecutive six-month periods, namely, for the entire crop year 2000-01 and the *kharif* season of 2001-02. Also canvassed were the details of the household's demographic features and wealth. In addition, the team of investigators collected qualitative information in the form of household 'histories' of what decisions had been made in periods of drought-induced crises in the past, and why. Data on infrastructure and land use at various spatial and administrative levels completed the picture. Summary statistics of the sample villages are presented in Table 1.

These households were re-surveyed in the early months of 2010. Due to the pressure of time, the primary emphasis was on the immediate past *kharif* season, when 11 of the 30 villages had an all-weather road, nine more than in 2001-02. The original household questionnaire was heavily redesigned so as to capture more fully the villagers' activities in the domains of central interest, namely, trade in goods, education and health. The households' individual members and their salient characteristics in 2004-05, a complete list of which was available from the previous survey round, provided both the basis for,

Table 1: Summary statistics of village characteristics ($m = 30$)

Characteristic	mean	s.d.	min.	max.
Forest area (percent of total)	8.10	14.0	0	19.0
Irrigated area (percent of total)	3.67	5.9	0	60.0
Pop. density (persons per ha., total area)[a]	2.36	1.64	0.34	6.83
Pop. density (persons per ha., cultivable)[a]	2.63	1.69	0.69	6.84
Road jeepable (months per year)	10.6	1.9	6.0	12.0
Distance to bus stop (km)	4.4	2.9	0	13.0
Distance to train station (km)	13.3	8.1	2.0	35.0

[a] Refers only to the four blocks selected in Bolangir district. Source: van Dillen (2008).

and an important extension of, these newly canvassed data, especially in the domains of education and health. In this connection, it was decided to collect certain other data pertaining to earlier seasons only from households in the said nine villages (see below). In the event, no fewer than 236 of the original 240 households could be traced and re-surveyed, though births, deaths, marriage and migration had combined to alter the character of many families in the interim. The associated summary statistics are reported in Table 2.

The re-survey of households was supplemented by so-called focus group interviews. Dr. Behera personally assembled a diverse group of villagers in each community and put to them a set of structured questions aimed at cross-checking and extending the answers to those in the household questionnaire. Important disagreements among the participants were duly noted. As time had become very short in relation to the preparation of the loan proposal, such interviews could be conducted in only 12 of the 30 villages. Included in these 12 were the 9 villages that had received a new road no earlier than 2007. Of the remaining three, two had had an all-weather road at the time of the original survey; the other still awaited such a connection.

Before embarking on an analysis of the survey data, it should be noted that this task is somewhat complicated by a feature common to many surveys, namely, that households were sampled in clusters (villages). All members of the same village share a common socio-economic and natural environment, and the great majority have some familial and other social ties; so that the observations in the whole sample are unlikely

Table 2: Summary statistics of household characteristics, *kharif* 2001, 2009 ($n = 236$)

	2001				2009			
Characteristic	mean	s.d.	min.	max.	mean	s.d.	min.	max.
Age of hh. head (years)	44.8	12.2	24	80	49.1	12.2	20	87
Educ. of hh. head (years)	3.10	3.23	0	14	3.19	3.34	0	15
Household size	5.04	1.95	2	14	6.09	2.15	2	14
Landholding (acres)	2.31	2.94	0	30	2.82	3.20	0	30
No. of milk animals	0.60	1.25	0	7	0.86	1.87	0	14
No. of draught animals	1.42	1.09	0	6	1.73	1.56	0	7
No. of sheep and goats	1.15	2.49	0	24	3.42	4.46	0	36
Nearest rural road[a] (km.)					0.61	1.31	0	5.7
Nearest district road (km.)					5.58	3.56	0	12.0
Nearest highway (km.)					10.59	7.95	1.5	35.0

[a] *Kutcha* or all-weather. Source: van Dillen (2008) and re-survey.

to be independent. As Deaton (1997: 14) puts it so cogently, 'In the (absurd) limit, if everyone in the same cluster were replicas or clones of one another, the effective size of the sample survey would not be the number of households, but the number of clusters.' Some of the data also relate to various periods, and here, too, care is needed.

With this warning in mind, and as a preliminary to the sections that follow, let x_{ijt} denote the value of some characteristic or action of household i in village j in period t. Suppose x_{ijt} is given by the linear relation

$$x_{ijt} = \mu + \beta_r \cdot d_{jt} + u_i + v_j + w_t + e_{ijt} \equiv \mu + \beta_r \cdot d_{jt} + \epsilon_{ijt}\,, \qquad (1)$$

where: μ is the population mean; $d_{jt} = 1$ if village j has an all-weather road in period t, and $d_{jt} = 0$ otherwise; u_i is a term specific to household i representing unobserved heterogeneity; v_j and w_t are analogously defined for village j and period t, respectively, whereby w_t represents time-varying common effects such as the weather and macroeconomic conditions; and e_{ijt} is an idiosyncratic disturbance term. Observe that this specification involves the assumption that the adjustment to the provision of the road takes just one period. Let $Eu_i = Ev_j = Ew_t = E(e_{ijt}|u, v, w) = 0$. To test whether, in period t, the mean of x in villages with an all-weather road differs from that in villages lacking it, one needs an estimate of β_r and its associated standard error. One problem that may arise in the present setting is that whether a village has an all-weather road at some particular time may depend on some of the unobserved characteristics making up v_j : $\text{Cov}(d_{jt}, v_j) \neq 0$. Another problem arises in connection with the standard error of β_r; for the terms ϵ_{ijt} within a given village are unlikely to be independent of one another, for which due allowance must be made. Let J denote the set of households, n_j in all, sampled in village j, there being m villages altogether. The mean of x in village j in period t is $\bar{x}_{jt} = (1/n_j) \sum_{i \in J} x_{ijt}$, and the overall mean is simply

$$\bar{x}_t = \left(\sum_j \sum_{i \in J} x_{ijt} \right) \Big/ \sum_j n_j \,.$$

A consistent estimate of the variance of $\bar{x}_t$ can be obtained by treating all the households within a cluster as if they were identical (Deaton, 1997: 54), so that there are effectively just m observations. For simplicity, suppose n_j $(= n)$ is the same for all villages. Then, using the cluster means, one obtains the said estimate:

$$\hat{v}(\bar{x}_t) = \frac{1}{n(n-1)} \sum_j (\bar{x}_{jt} - \bar{x}_t)^2. \tag{2}$$

The other comparison that will be pursued in the following sections is of the 'before and after' kind. Suppose village j obtains its all-weather road at the start of period t_j and the closing round takes place in period T (*kharif* 2009). In the re-survey, x_{ijt} may be observed in periods $t_j - 1$ and T. For household i in this village, we then have

$$\Delta x_{ij,t_j-1} \equiv x_{ijT} - x_{ij,t_j-1} = \beta_r(d_{jT} - d_{jt-1}) + (w_T - w_{t_j-1}) + (e_{ijT} - e_{ij,t_j-1})\,. \tag{3}$$

It is seen that the problem of clustering on villages disappears; but others remain, even when the e_{ijt} are serially uncorrelated. First, there is the term $(w_T - w_{t_j-1})$. Data relating to $t_j - 1$ were collected only for households in the villages that enjoyed an operational connection throughout a full season for the first time in season t_j. Thus, a difference-in-difference estimator cannot be used to obtain β_r by employing an estimate of $(w_T - w_{t_j-1})$ from those villages that lacked an all-weather road throughout. The remaining possibility of identifying β_r arises if not all of the villages served by all-weather roads in period T were first served in the same period earlier in the past, thereby introducing some variation into the term $(w_T - w_{t_j-1})$. It turns out that there is some such variation. Of the 8 villages that received such a new connection between January 2007 and June 2009, two enjoyed an operational connection throughout a full season for the first time in *kharif* 2007. Another village followed starting in *rabi* 2008, two more in *kharif* 2008, and three in *rabi* 2009. This clustering (on the $t_j - 1$) will make the standard error of the estimate of β_r correspondingly that much larger. More importantly, the variation in the date of first provision introduces a second problem: it could be that changes in the unobserved, time-varying components in (1) are correlated with such timing. By assumption, w_t is common to all villages; but a shock to a specific village might affect its chances of getting a road over the interval in question.

The ninth village's road became fully operational only in October 2009, and the household data collected therein followed the pattern for those villages with no all-weather road in that *kharif* season. This village is, however, included in the 'before and after' comparisons arising from the focus group interviews, which were conducted in September 2010, by which time the respondents would have been able to form a more reliable – or at least settled – view of the changes wrought by their new road. A careful inspection of the household data also revealed that these villagers had been making unauthorised use of the road before its official completion, which led us to classify it as having an all-weather connection for the purposes of cross-section analysis in Sections 3 and 5.

To close this section, it should be remarked that the great majority of these villages are comprised of a collection of hamlets, scattered in varying degrees. Even within a village, therefore, the distance from the house or field to a passable road or track – or even the village primary school – can vary quite substantially. Such variation makes it unlikely that, for many of the variates that concern us here, the intra-cluster correlation coefficient is very high.

3 Trade

Transport costs matter in most spheres of economic activity, but they are especially burdensome to remote rural communities that lack all-weather roads. As producers, farming families must then pay stiffer prices for inputs like chemical fertilizers, certified seeds and diesel fuel, and they obtain correspondingly lower net prices for their marketed surpluses, whether they sell at the farm gate or organize transport to the market of their choice. The gross prices farmers pay for their inputs and the net prices they receive for their outputs also depend on the structure of competition in the markets for transportation and marketing services. If perfect competition rules, the prices for these services will be their respective marginal costs, which improvements in the road network should lower. In remote and poor regions, however, it is quite possible that such improvements will lead to sharper competition among truckers and traders. In that event, the changes in prices confronting farmers will also reflect a fall in truckers' and traders' pure profits: in effect, there will be a transfer of 'rents' in favour of farmers. For this reason, it is useful to investigate the behaviour of unit transport costs and prices faced by farmers separately, even though the former reflects the organization of the transport industry.

3.1 The household survey

The household survey covered marketing in considerable detail, but only for the *kharif* crop of 2009 ($t = T$). Unit transport costs depend, of course, on the good in question, and all the villages marketed a diverse basket of crops, though most households had rather few transactions. We concentrate here on the marketing of paddy, which is the main commercial crop, in terms of the aggregate volume and value of transactions as well as the number of households selling a surplus.[2] A summary of the main results for the remaining crops of commercial importance for which there is sufficient variation in households' transport connections, namely, cotton, various pulses and millets, is given at the close of this sub-section.

Of the 136 households selling paddy, 74 did so at the farm gate. Only for the remaining 62, therefore, are the transport costs actually observed. To deal with the censoring that results from households choosing to sell at the farm gate, we employ a Tobit specification:

$$\tau^*_{ijT} \equiv \beta_T X_{ijT} + \epsilon_{ijT}; \quad \tau_{ijT} = \tau^*_{ijT} \text{ if } \tau^*_{ijT} > 0\,, \tau_{ijT} = 0 \text{ otherwise,} \tag{4}$$

where τ_{ijT} is the (observed) unit transport cost incurred by household i in village j, τ^*_{ijT} is an indicator function, X_{ijT} is a vector of regressors and ϵ_{ijT} is the stochastic disturbance term defined in (1), whereby the common term w_T is absorbed into the constant in β_T. The household's characteristics included in X_{ijT} are its ownership holding and caste membership; the village's are its total area, population density and the administrative block in which it is located. Finally, and very importantly, there is the length and quality of the road connection between the farm gate and the market

[2] An early cost-benefit analysis of surfaced roads along traditional lines is Spriggs (1977).

chosen. The trip is divided into four segments, namely, the length (in km.) on a *kutcha* track, on an all-weather village road, on a district road, and a state or national highway, respectively. The all-weather PMGSY roads were new and in good condition; but many of the district roads and even stretches of the state and national highways were in a deplorable state, which condition is represented by a dummy variable.

A preliminary remark is needed at the outset. In principle, households have the possibility of selling in more than one market, as opposed to doing so at the farm gate. If so, the observed length and quality of the trip involved arise from a choice, and with it, a potential problem of (econometric) endogeneity. In practice, the households sampled in each village usually chose just one market for each particular crop; otherwise, the modal choice was very strong. This fact does not, however, do away with the possibility that the 9 villages that received a PMGSY road were a non-random selection from the 28 that had no all-weather connection in 2001, a point already made in Section 2. The presence of the village-level regressors and block dummies will mitigate this problem, to the extent that they reflect those systematic factors which influenced whether or not a village was indeed favoured with such a connection.

The results are reported in Table 3. The dependent variable is the cost (in Rs.) of transporting one quintal of paddy (100 kg.) from the farm gate to the market of the household's choice. To allow for the possibility that transportation involved some fixed costs, the inverse of the quantity marketed, Q_{ijT}, is employed as a control; although it has the expected sign, it is not remotely statistically significant. A family's landownership and caste arguably influence its social network and general standing, both of which may affect its dealings with marketing agents and its ability to do without them by organising its own transport; but no such influence can be detected here. Larger and more populous villages offer traders more business, all else being equal, and so may depress unit transport costs. This expectation is indeed confirmed, the coefficient on totarea being statistically significant, with a negative sign: an extra 100 hectares reduces the trip-cost by an estimated Rs. 18 per quintal. Blocks also vary in their general infrastructure and the efficiency with which their markets function. Relative to the reference block (namely, Block 1, whose administrative HQ is in the large town of Titlagarh), the inhabitants of Block 4 enjoyed substantially lower trip-costs – statistically, significantly so – but those of other blocks did not. The nature and quality of the segments making up the trip to market conform largely to prior expectations. The point estimate of the cost of transporting one quintal one km. on a track or *kutcha* road is Rs. 12.32 and is fairly precise (see the associated confidence

Table 3: Transport costs for 1 quintal of paddy, *kharif* 2009

Variable	Coeff.	Std. Err.	t	$P > \|t\|$	[95% Conf.	Interv.]
$1/Q_{ijT}$	− 1.89	22.46	− 0.08	0.933	− 46.36	42.58
ownhold (ha.)	− 0.45	0.81	− 0.56	0.574	− 2.05	1.14
sc	− 1.96	9.43	− 0.21	0.836	− 20.63	16.72
obc	− 5.33	8.14	− 0.65	0.514	− 21.44	10.78
totarea (ha.)	− 0.18	0.04	− 4.42	0.000	− 0.26	− 0.10
popdens	0.34	2.44	0.14	0.891	− 4.50	5.18
block2	− 21.22	14.45	− 1.47	0.145	− 49.83	7.04
block3	− 11.73	10.48	− 1.12	0.265	− 32.48	9.03
block4	− 32.80	12.87	− 2.55	0.012	− 58.29	− 7.32
block5	9.82	9.17	1.07	0.286	− 8.34	27.98
d0 (km.)	12.32	1.90	6.48	0.000	8.55	16.08
d1 (km.)	4.69	1.02	4.61	0.000	2.68	7.61
d2 (km.)	− 0.85	2.88	− 0.30	0.768	− 6.55	4.85
d2c3*d2	18.38	7.75	2.37	0.019	3.03	33.73
d3 (km.)	− 0.02	0.69	− 0.03	0.977	− 1.39	1.35
d3c3*d3	27.89	5.18	5.39	0.000	17.64	38.14
const.	29.96	16.00	1.87	0.064	− 1.73	61.64
σ_ϵ	24.33	2.31			19.76	28.90

$n = 136$; 74 left-censored obs. LR: $\chi^2\,(16\,d.f.) = 159.91$. Pseudo $R^2 = 0.2093$. $\epsilon_{ijT} \sim N(0, \sigma_\epsilon)$.
sc: dummy variable for scheduled caste; obc: other backward caste; reference group, scheduled tribe.
d0: trip segment on a track or *kutcha* road; d1, d2 and d3 analogously defined for segments of village all-weather road, district road and state/national highways, respectively; d2c3 is a dummy for a d2 segment in deplorable condition; d3c3 analogously defined.

interval).[3] The corresponding cost on a good PMGSY road is Rs. 4.69 per quintal-km., also rather precisely estimated, with a confidence interval that does not overlap that of the coefficient on d0. Replacing a track with a nice new PMGSY road therefore yields an estimated saving of Rs. 7.63 per quintal-km. The estimated unit cost per km. on a district road in good condition is essentially zero (see the associated confidence interval). If, however, this segment is in poor condition (d2c3 = 1), the unit cost increases by no less than Rs. 18.38 ($t = 2.37$) for each km. so travelled. The same qualitative finding holds for highway segments, whereby the estimated trip-cost per quintal-km. is even larger when the road is in poor condition.

[3]Since the question of primary interest concerns the effects of the road network on the entire population rather than just those who used it at the time of survey, the relevant marginal effects are those pertaining to τ^* rather than τ. In the latter case, an adjustment must be made to reflect the condition $\tau_i > 0$, conventionally by evaluating the derivative at the mean value of X_{ij} for non-zero observations.

If there is full market integration, and transport and trade services are supplied completely elastically, any reduction in their cost will be passed on in full to farmers, whether they sell at the farm gate or organize transport to the market of their choice, where, by hypothesis, the ruling price for their crops will be correspondingly higher than at the farm gate. This arbitrage condition implies that the price obtained, *net* of such costs, should decline with the distance from the farm gate to the market, and more strongly so if the segments making up the trip are in poor condition. The prices ruling in the various market centers will be likewise related, subject to any regulation of prices through public policy: for paddy, there is the ubiquitous support price. If the ruling price is indeed the same in all markets, then what is needed for present purposes is the trip from the farm gate to that market which involves the least unit cost; for this is the best alternative to selling at the farm gate. The trip in question is not always available. In those villages where all households sold at the farm gate, we have information on the trips to what the villagers regard as important business destinations. Almost always there were at most two: the shorter is chosen here. In those villages where at least one farmer sold elsewhere, the most frequently chosen destination serves as the alternative to selling at the farm gate. In contrast to the variables d0, d1, d2, d2c3, d3 and d3c3, which reflect the individual household's *actual* choice of where to sell, the variables Vd0, Vd1, Vd2, Vd2c3, Vd3 and Vd3c3 represent the household's position in the trading network, which, by hypothesis, will determine the *net* price it obtains. Given the imperfect nature of the position in the network, so measured, the block dummies are also employed. Recall that Vd0 and Vd1 may be endogenous, a problem that the village-level variables should mitigate.

In the absence of full market integration, reductions in transport costs do not tell the whole story where the 'commercial' benefits ensuing from a new all-weather road are concerned. Farmers may switch to larger, more distant markets, and so increase the volume of transactions therein. The entry of new traders, if it occurs, will sharpen competition; and even if entry is limited, competition among existing traders may lead to greater exploitation of economies of scope and scale, which may be passed on to farmers in the form of higher offered prices. This must be borne in mind when evaluating the findings that follow.

Since the net price obtained is always positive, no censoring is involved, and we employ the simple regression model

$$p_{ijT} = \gamma_T Y_{ijT} + \epsilon_{ijT}, \tag{5}$$

where p_{ijT} denotes the net price obtained for a quintal of paddy by household i living in village j in period T. Model (5) is estimated by OLS with robust standard errors and clustering on villages. The results are set out in Table 4. Note that, apart from the trip variables, the regressors comprising X_{ij} and Y_{ij} are identical.

Table 4: Net price obtained for paddy, *kharif* 2009

Variable	Coeff.	Std. Err.	t	$P > \|t\|$	[95% Conf.	Interv.]
$1/Q_{ijT}$	– 50.83	15.26	– 3.33	0.002	– 82.04	– 19.63
ownhold (ha.)	0.28	1.00	0.28	0.783	– 1.76	2.32
sc	– 2.47	5.22	– 0.47	0.640	– 13.16	8.21
obc	12.54	6.87	1.82	0.078	– 1.52	26.59
totarea (ha.)	0.07	0.04	1.93	0.063	– 0.00	0.15
popdens	1.99	3.27	0.61	0.547	– 4.70	8.69
block2	21.14	12.75	1.66	0.108	– 4.94	47.21
block3	3.68	16.28	0.230	0.823	– 29.62	36.98
block4	42.01	13.82	3.04	0.005	13.75	70.27
block5	20.44	12.32	1.66	0.108	– 4.77	45.64
Vd0 (km.)	– 5.20	1.58	– 3.30	0.003	– 8.42	– 1.96
Vd1 (km.)	2.75	1.22	2.26	0.032	0.26	5.24
Vd2 (km.)	3.19	1.00	3.19	0.003	1.14	5.24
Vd2c3*Vd2	7.85	4.10	1.91	0.066	– 0.54	16.24
Vd3 (km.)	–0.79	0.55	– 1.44	0.162	– 1.91	0.33
Vd3c3*Vd3	– 10.12	1.47	– 6.87	0.000	– 13.14	– 7.11
const.	821.28	15.66	52.44	0.000	789.25	852.31

$n = 136$; 30 groups. $R^2 = 0.730$. Root MSE = 23.19.
Vd0: trip segment on a track or *kutcha* road; Vd1, Vd2 and Vd3 analogously defined for segments of village all-weather road, district road and state/national highways, respectively; Vd2c3 is a dummy for a Vd2 segment in deplorable condition; Vd3c3 analogously defined.

Recall that the market for paddy is strongly influenced by public policy, notably in the form of the support price. This is duly reflected in the constant term: Rs. 821 per quintal, with a tight 95 percent confidence interval. With the price so tethered, we turn to the specific influences thereon. The net price rose with the quantity marketed, and the coefficient is statistically highly significant: all else being equal, a farmer who sold 10 quintals obtained Rs. 45.75 ($= 0.9 \times 50.83$) more per quintal than one who sold but a single quintal. Households with bigger holdings did receive slightly higher prices, but the effect is not remotely statistically significant, controlling for the quantity marketed. The null that caste had no influence cannot quite be rejected at the 5 percent level. Farmers who lived in large and populous villages also enjoyed higher prices: every additional 100 hectares yielded an extra Rs. 7.5 per quintal, though the effect is statistically borderline. With the exception of Block 4, there was no statistically significant advantage to living in any particular block.

Turning to the central question of how the village's connection to the larger network influenced its households' net price, the negative and statistically significant coefficient on Vd0 conforms to the arbitrage condition, but the positive and significant coefficient on Vd1 does not. Be that as it may, the difference between them, namely, Rs. 7.95 per quintal-km., may be interpreted as the improvement in the net price that would result if one km. of *kutcha* track were converted into a km. of PMGSY road. In this connection, it is interesting to compare this estimate with those of the corresponding unit costs per km. in Table 4. Carting one quintal an extra km. along a track cost an extra Rs. 12.32, along an all-weather village road Rs. 4.69. That the two estimated differences are so close is consistent with complete arbitrage. For the two higher levels of the road network, namely, district roads and highways, the results are decidedly mixed. The net price *rose* with distance along a stretch of district road in good condition, but fell with distance, as expected, along a stretch of good highway; the coefficient on the former is statistically highly significant, but that on the latter is not significant even at the 10 percent level. Equally mixed are the findings concerning the quality of these roads. The net price fell more sharply for trips on stretches of highway in poor condition, an effect that is statistically highly significant; but the corresponding coefficient on district roads is *positive*, and statistically borderline. We conclude that there is indeed evidence that improvements in the quality of road connections improved farmers' net paddy price, but there is at best partial support for the simple arbitrage model.

The other crops of commercial importance for which there were sufficient numbers of households with and without an all-weather connection to estimate model (4) are listed in Table 5. Like paddy, a majority of households sold cotton at the farm gate; but their pulses and millets they sold directly in markets outside the village. The main qualitative findings are much like those for paddy. To sum up,[4] unit transport costs for cotton were lower (and statistically so) for households with larger holdings and those not belonging to the ascriptive reference group, scheduled tribes. No such advantages could be found in transporting the other crops. Those households living in large and populous villages faced lower unit transport costs, most of the associated coefficients being statistically significant at conventional levels. The block dummies, in contrast, were not statistically significant, and often had to be dropped.

[4]The details are available from the authors upon request.

Moving to the central question, namely, the difference between the cost of transporting one quintal of each good one kilometre on a *kutcha* track and an all-weather village road, respectively, the corresponding pairs of estimates and the associated standard errors are reported in Table 5. The difference between these pairs of estimates ranges from about Rs.7-8 for horse gram and millets (as for paddy) to about Rs.18-20 for cotton and green gram. All estimates of the coefficient on d0 are positive and statistically significant; the hypothesis that the coefficients on d0 and d1 are the same is rejected for all these crops. These results suggest that a household that markets a one-tonne 'representative' basket of paddy and these crops and whose village benefits from the conversion of a 5-km. *kutcha* track to a PMGSY road would enjoy a reduction of about Rs.500 in transport costs on this score alone. A corresponding improvement in effective net prices might also induce substitution among crops; but the data needed to establish such an effect, which involve before and after comparisons, were not canvassed in the household survey for want of time and resources. The effect on cropping patterns was, however, taken up in the focus group interviews.

Table 5: Transport costs for 1 quintal of selected commercial crops, *kharif* 2009

Crop	n	uncensored	d0 (km.)	d1 (km.)	pseudo R^2
cotton	53	22	22.26	3.87	0.3748
			(3.49)	(2.29)	
horse gram	75	70	14.52	7.53	0.0705
			(5.61)	(3.36)	
green gram	48	41	33.00	13.00	0.1190
			(7.31)	(3.62)	
kandul	42	41	16.37	2.15	0.0822
			(7.67)	(3.01)	
millets	54	49	28.17	19.31	0.1192
			(13.98)	(6.54)	

d0: trip segment on a track or *kutcha* road; d1 analogously defined for segments of village all-weather road and district road, respectively. Standard errors in parentheses.

3.2 The focus group interviews

As emphasized above, an all-weather road affects villagers' welfare not only by reducing transport costs, but also by enlarging their set of marketing opportunities, for example, by encouraging more competition among marketing agents and making arrangements to market jointly more attractive. The qualitative findings from the focus group interviews in this connection are summarized in Table 6, whereby it should be pointed out that village 1 is just 5 km. from Titlagarh, and the advent of an all-weather road has smoothed rather than transformed its transactions with that large town. This village apart, the responses give the strong impression that competition among traders has sharpened considerably, both directly, as more outside brokers find it worthwhile to visit the villages in search of new business, and indirectly through more extensive joint marketing by farmers in order to take advantage of the higher prices ruling in markets that have become more accessible. Fewer farmers sell at the farm gate in four villages; but more now do so in village 2, following an unhappy experience in an earlier year, which is worth recounting. Tempted by a good price in the nearest regulated market, a group got together to rent a truck and duly obtained the (gross) ruling price. What they had not bargained for was the haggling with the government's agents over the quality of their grain and the inordinate delay before finally getting paid. This chastening experience prompted a switch to visiting brokers, competition among whom still ensured a good farm gate price.

Table 6: Changes in paddy marketing in villages with new all-weather roads

Question	1	2	3	4	5
Village					
1	no	no	no	d.k.	yes
2	yes	yes	no	no	yes
3	yes	yes	no	yes	yes
11	no	yes	no	no	no
18	yes	no	no	no	yes
19	yes	yes	no	yes	yes
26	yes	yes	d.k.	yes	yes
29	yes	yes	no	yes	yes
30	yes	no	no	no	yes

Q1: Do you have further plans to exploit the opportunities offered by the road?
Q2: Do outside crop brokers now visit the village more frequently?
Q3: Have village brokers become less important?
Q4: Has the proportion of farmers selling at the farm gate fallen?
Q5: Do more farmers now club together to market jointly?
d.k.: don't know.

The respondents in each village were also asked what areas had been sown to various crops in the *kharif* season before their road became operational and in that of 2009, respectively. Their estimates are reported in Table 7. Nine villages are a shaky basis on which to try to draw firm conclusions, especially as changes in prices and growing conditions were at work over the varying intervals in question, but the overall impression is that the provision of an all-weather road induced a switch towards commercially more important crops, whereby commercialisation in this sense can involve a switch from pulses to paddy, as well as one from paddy to cotton – soils permitting. This general switch also appears to be more marked for those villages that had longer in which to adjust. Somewhat surprisingly in this heavily populated zone, there appears to be an expansion in the total cropped area itself. If this was indeed so, the reason may lie in the fact that the provision of an all-weather road should make engaging in cultivation in one's home village more attractive than the alternative of seasonal out-migration, which plays an important role in this region's economy (van Dillen, 2008).

Table 7: Cropping patterns before and after (in acres)

Village	year	paddy	other cereals	pulses	oilseeds	cotton	sugar-cane	vegetables
1	2007	300	0	40	0	0	10	10
	2009	300	0	35	0	0	5	15
2	2006	100	0	50	50	0	0	8
	2009	250	0	70	5	0	0	60
3	2007	200	0	100	0	0	0	0
	2009	150	0	75	0	50	0	0
11	2006	125	0	0	0	0	0	5
	2008	150	5	0	0	0	0	0
18	2009	200	0	50	50	0	0	25
	2009	270	0	50	50	0	0	25
19	2007	250	0	10	0	150	0	11
	2009	300	0	10	0	150	0	10
26	2007	100	2	15	0	3	0	0
	2009	150	5	20	0	5	0	0
29	2008	60	0	10	0	0	0	3
	2009	60	0	6	0	10	0	1
30	2008	150	0	45	0	0	0	25
	2009	150	0	45	0	0	0	40
All	before	1485	2	320	100	153	10	87
	2009	1780	10	311	55	215	5	151

If each acre is viewed as an indivisible unit that must be allocated to one of the seven crop categories and the nine villages as random draws from a large population of villages that were provided with an all-weather road at some stage over the period 2006-2009, then the independence of the observed cropping patterns before and after such provision can be tested. The table yields $\chi^2 = 40.14$, with the main contributions thereto coming from oilseeds and vegetables. Since $\chi^2_{0.01}(6) = 16.81$, the null is decisively rejected.

4 Education

The provision of an all-weather connection to schools has a variety of effects, depending on their location in relation to the village. If, as is usual, the teachers live elsewhere, they should suffer fewer forced absences due to poor weather, especially in the monsoon season. At all events, those who take their duties lightly will lose an excuse. The same applies to those children who have to travel to a school outside their village. An easier trip for teachers and pupils alike will normally affect not only attendance conditional on enrolment, but also enrolment and graduation rates. Here, the only factor that might work to dampen the accumulation of human capital that results from better and more extensive schooling is over-crowding of classrooms, should there be inadequate complementary expenditures on additional staff and facilities.

A brief description of the school system in relation to age is needed at the outset. A child normally begins primary school (standard 1-5) on turning six. If he or she progresses normally, promotion to secondary school (standard 6-10) will follow on turning eleven, with the further prospect of continuing on to high school (standard 11-12) on reaching sixteen. In fact, some children start a year earlier, others a year or two later; and some have to repeat a class. Some children attending primary school will, therefore, be twelve or thirteen; likewise, some of those attending secondary school will have turned sixteen. To allow for all this, we have added one year to the 'normal' progression, so that nineteen-year olds are included.

4.1 The household survey

The general position in *kharif* 2009 was as follows. There were altogether 394 children aged six to nineteen, whose classification by age group, whether their village enjoyed an all-weather road, and whether they were attending school is set out in Table 8. All but two of the 30 villages had a primary school, and all but two of the 163 children of primary school age were attending school: here, the existence of such a road does not matter. Only one village, in contrast, had a secondary school, so that the trip may then come into play. It is seen that the attendance rate is a little higher in villages with roads, but the difference is not statistically significant ($\chi^2(1) = 2.093, \chi^2_{0.05}(1) = 3.84$). The same applies to attendance at high school ($\chi^2(1) = 0.613$).

Table 8: School attendance by age group and all-weather road, *kharif* 2009[a]

Villages:	With road			Without road			All
Status:	In school	Not in school	Total	In school	Not in school	Total	Total
Age group							
6 - 10	40	0	40	121	2	123	163
11 - 15	36	7	43	66	25	91	134
16 - 19	10	19	29	18	50	68	97

[a] Included are 13 children who were at boarding schools or living with relatives elsewhere.

The length of the daily trip to school is also a potentially important factor. As noted above, two villages had no primary school, so it is only in these that distance was likely to matter where normal attendance is concerned. Since there were but six children in this sub-sample, five of whom were attending school regularly some 2 km. away, nothing much can be said.[5] Attending secondary school, however, involved a daily trip elsewhere in all but one village.[6] The distance from home to the secondary school in villages with and without an all-weather road averaged 3.98 km. (33 pupils) and 3.59 km. (74 pupils), respectively, a difference that is not statistically significant ($t = 0.52$, clustering on villages). Although the t-test is fairly robust, both distributions look distinctly non-normal. Two non-parametric tests for their equality are the (combined) Kolmogorov-Smirnov, $D = 0.2314$ ($p = 0.122$), and Kruskal-Wallis, $\chi^2(1) = 0.006$ ($p = 0.938$). On balance, the t-value being so small, it seems fairly safe to conclude that the presence of an all-weather road had no influence on whether children were normally attending school.

The same cannot be claimed for involuntary absences due to bad weather. The

[5] All but a single child in this age-group attended primary school in the other 28 villages; the difference between the two types of villages is significant only at the 8 percent level (Fisher's exact test).

[6] We discarded the 13 children who were at boarding schools, or living with relatives elsewhere, or attending local private schools. Recall also that some children in primary school were older than eleven, and some in secondary school, older than fifteen. Four villages had a primary school extended to include standards 6 and 7. Children attending the latter were also excluded from the comparisons that follow.

five children forced to attend primary school elsewhere lost, on average, 20.6 days of schooling, 14.3 days more than those lost, on average, by the 143 attending their village primary school. The difference is statistically highly significant ($t = 2.75, p = 0.010$; clustering on villages). The two non-parametric tests also overwhelmingly reject the null that the distributions are equal: (combined) K-S, $D = 0.7790$ ($p = 0.001$), and Kruskal-Wallis, $\chi^2(1) = 6.679$ ($p = 0.001$). In the 28 villages with a primary school, the children faced a walk of at most 1.5 km., so that bad weather hardly posed a serious obstacle – to them at least. Yet when the villages are categorized by whether or not they had an all-weather road, the respective averages of days so lost were 1.9 (41 pupils) and 8.6 (107 pupils). Again, the difference is statistically highly significant ($t = -4.34, p = 0.000$; clustering on villages). The two non-parametric tests also decisively reject the null that the distributions are equal: (combined) K-S, $D = 0.8598$ ($p = 0.000$), and Kruskal-Wallis, $\chi^2(1) = 57.839$ ($p = 0.000$). This finding arouses the strong suspicion that a large proportion of the days lost in villages without an all-weather road reflected the teachers' absences, a suspicion strengthened by the fact that the corresponding averages for secondary-school children are very similar, at 2.9 (33 pupils) and 9.4 (74 pupils) days, respectively ($t = -5.76; D = 0.7907, p = 0.000; \chi^2(1) = 42.298$, $p = 0.000$).

In addition to fewer involuntary absences, there are the savings of time needed to make the daily round-trip under normal conditions. A mere four of the primary school children went by bike, one of them outside the village; the rest went on foot. For the 143 attending their village school, therefore, having an all-weather road should not play a real role, unless it includes a bridge over a deep gully and the villages in question comprise widely dispersed hamlets. As it turns out, the average round-trip took 18.4 minutes in villages with such a road, and 5.0 minutes longer in those without, a difference that is borderline significant at the 10 percent level ($t = -1.73$; clustering for villages). The non-parametric tests reject the null that the distributions are equal: $D = 0.2507\,(p = 0.043), \chi^2(1) = 6.786\,(p = 0.009)$; it is hard to know what might be at work here. The majority of secondary school children went by bike, 30 of 33 and 57 of 74 in the villages with and without an all-weather road, respectively; the rest went on foot. One might indeed expect a switch to bikes, if families have them; but the choice of mode is independent of the existence of an all-weather road (Fisher's exact test, $p = 0.111$). The round-trips took, on average, 72.7 and 75.6 minutes, respectively, a difference that is not remotely statistically significant; and the null also survives the two non-parametric tests very comfortably.

Univariate comparisons of this kind may be misleading when other factors, particularly distance, are at work. Regressing the time taken on distance and a dummy for the presence of an all-weather road interacted with distance, with village random effects, yields an estimated saving of 1.6 minutes per km. when there is such a road, but this modest effect is not significant even at the 10 percent level ($z = -1.31$). The effect of pure distance, in contrast, is highly statistically significant: an extra km. each way adds 13.7 minutes to the round-trip ($z = 14.57$). A Hausman test is, moreover, unable to reject this specification against the fixed-effects alternative ($\chi^2(2) = 2.78$, $p = 0.250$). The addition of the child's age and sex as regressors does nothing to alter these results. To sum up, according to the cross-section data, the provision of an all-weather road had no effect on the travel-time to primary and secondary schools.

We turn, therefore, to 'before' and 'after' comparisons, which are possible for the 8 villages that had received a new all-weather road at some point after the start of 2007.[7] Since children normally progress through the school system and the roads became operational at various times over this period, such comparisons are not completely straightforward. Given the locations of the primary and secondary schools, one simple alternative is to compare what can be called 'rolling' cohorts of both primary- and secondary-school children. Fifty-three children were attending school, 28 of them at the primary level, before their village got its road. Subsequently, some graduated out of secondary school, some dropped out and yet others again started to go to school, with the result that 52 children were attending school, 25 of them at the primary level, in December 2009. Forty of these 52 belonged to the original cohort of 53.

In view of the fact that 7 of the 8 villages in question had their own school, it is no surprise that the primary-school children saved, on average, no time in getting to and fro: the difference was 4.1 minutes ($t = -0.737$). The average number of days lost due to bad weather in the last *kharif* before the road became operational was much higher than that in *kharif* 2009 with the road, at 8.4 and 1.6 days, respectively. The difference is essentially identical to that in the cross-section: $t = -7.70$ (robust standard error); combined K-S, $D = 1\,(p = 0.000)$; K-W, $\chi^2(1) = 39.82\,(p = 0.000)$. At all events, one presumes that this difference measures their teachers' absences. For the secondary-school children, the corresponding averages were 14.8 and 2.4 days, respectively, a noticeably larger difference than in the cross-section: $t = -4.74$ (robust standard error); combined K-S, $D = 0.9259\,(p = 0.000)$; K-W, $\chi^2(1) = 37.08\,(p = 0.000)$. The average distance to their schools was 4.5 km., and here the provision of the road

[7]That is, between 1 January 2007 and 30 June 2009. Recall that one further village was so connected late in *kharif* 2009, after the monsoon period, and that for this village, household data were collected only for that season.

had a substantial and statistically significant effect on the duration of the round-trip: the average fell from 94.2 minutes 'before' to 62.6 minutes 'after': $t = -2.46$ (robust standard error); combined K-S, $D = 0.3807\,(p = 0.033)$; K-W, $\chi^2(1) = 8.48\,(p = 0.003)$. Accumulated over a whole school-year, savings of 30 minutes a day add up to a fair slice of time.

The alternative to comparing the rolling cohorts is to restrict attention to the common sub-group of 40 children. This has the advantage that any unobserved, time-invariant effects specific to these individuals and their villages can be purged by forming the set of individual differences between 'before' and 'after'. Recall from (3), however, that there may be clustering on the periods, and this turns out to be so here. To eliminate the effects of switches in the location of the schools attended, we discarded 8 children in all. Most of these were promoted from primary to secondary school during the period in question, and so had to commence commuting. Of the remaining 32 children, 11 were attending primary school. This latter group spent no less time making the trip than they had before, which, as remarked above, is no surprise; for only one of them was attending a school outside the village, and then close by. As for the mode of transport, here there were no changes: 10 went by foot, the other cycled. What did change was the average number of days lost due to bad weather, which declined from 8.8 to 2.4, a difference that is statistically highly significant ($t = -6.24$). The two non-parametric tests confirm this rejection of the null: combined K-S, $D = 1$ ($p = 0.000$); K-W, $\chi^2(1) = 15.77$ ($p = 0.000$).

The 21 secondary-school pupils who did not change schools faced, on average, an each-way trip of 4.4 km. With the new road at hand, four of the nine who had gone on foot, cycled to school instead, a switch that is not statistically significant (Fisher's exact test, $p = 0.337$). In stark contrast to the cross-section finding once more, this group of 21 pupils enjoyed, on average, a substantial and statistically highly significant saving of time, namely, 16.9 minutes a day ($t = -3.50$). To refine this result somewhat, it is desirable to control for the varying length of the trips to school: OLS yields an estimated saving of 4.5 minutes per km. ($t = -3.92, p = 0.001$; robust standard errors), and the estimated constant, -2.2 minutes, is not significantly different from zero ($t = -0.57$). The average number of days lost involuntarily fell from 12.7 to 2.1 ($t = -6.89$), a difference which is almost twice as large as the corresponding cross-section difference of 6.5 days for the whole sample of 30 villages. It should be added that the distribution of these individual differences betrays non-normality (a cluster at zero, with none positive). The two non-parametric tests overwhelmingly reject the null that the 'before' and 'after' distributions are equal: combined K-S,

$D = 1$, $(p = 0.000)$; K-W, $\chi^2(1) = 37.77$ $(p = 0.000)$. Introducing distance, as before, yields an estimated reduction of 1.7 days lost per km. $(t = 5.98)$, but now with a statistically very significant 'fixed' reduction of 5.0 days $(t = -4.28)$.

What is one to make of these findings? Given the relatively small distances and clunky bikes involved, a nice stretch of tarmac does not seem to offer much of an advantage over a *kutcha* track – except in the monsoon season; and the respondents almost certainly reported travel-times under 'normal' conditions. Hence, the all-weather road may well affect whole-day attendance, by pupils and teachers alike, at certain times of the year, but regular travel-time hardly at all. The cross-section results suggest that this pattern indeed holds, once an allowance for distance is made. The 'before' and 'after' results, in contrast, point to substantially shorter trip-times as well, even under normal conditions, along with still greater reductions in the days lost due to bad weather. Comparing the rolling cohorts and then ridding the data of fixed effects at the cost of reducing the sample size both pay off handsomely in terms of establishing with very high probability the existence and magnitude of a particular and substantial benefit in the sphere of education.

The households in those nine villages that had received a PMGSY road were also asked qualitative questions concerning the changes in attendance – of teachers and children alike – and progression through the school system. Not all of them had children of school-going age, of course, but some of those without still voiced an opinion. Of the 71 households in all, 58 gave responses, which are summarised in Table 9. There appears to have been little effect on primary-school attendance, perhaps because primary-school teachers sometimes live in the village itself. It is in the middle and high schools where the effects are marked, with much better attendance by teachers and better progression by pupils, which imply better final attainments. Here it should be recalled that these roads were very recent, so that the resulting adjustments in behavior were almost surely incomplete.

It is possible, in principle, that more regular attendance by all concerned, together with all the other effects wrought by an all-weather road, also affect school-children's use of time outside school hours. Respondents were asked how such hours were allocated among study, housework, fieldwork, tending cattle, play and other activities during a representative day 'before' and 'after'. For the common sub-group of 40 children, who are most relevant for this purpose, no real difference is discernible to the eye.

Table 9: Changes in school attendance in villages with new all-weather roads

	no	yes	d.k.	total
Question:				
1	52	6	0	58
2	0	45	13	58
3	0	41	17	58
4	57	1	0	58
5	33	13	12	58
6	2	50	6	58

Q1: Has the primary school teachers' attendance become more regular?
Q2: Has the middle school teachers' attendance become more regular?
Q3: Has the high school teachers' attendance become more regular?
Q4: Are children attending school more regularly?
Q5: Are children dropping out of school later?
Q6: Are more children continuing on to high school?
d.k.: don't know.

4.2 The focus group interviews

The focus group interviews largely squared with these qualitative findings and inferences, and in certain respects, extended them. For the 9 villages that received a new road after January 2007, the answers to the questions in Table 9 are summarized in Table 10. There are some striking uniformities, as well as mixed assessments. Teachers' attendance improved in the primary and middle schools, though the respondents in village 29, which had neither kind, did not seem too clear on this matter. The picture where high school teachers' attendance is concerned is generally much less clear. The fact that the high schools in question were not located in these villages can hardly be the ground for parents in four villages seeming not to know whether such attendance had improved; for more children were attending high school, and so were in the position of being able to report on their teachers' doings. Children's attendance, it was universally agreed, had improved, though only in three villages were respondents of the opinion that dropping out, when it occurred, came later than heretofore. That more children in *all* villages were continuing on to high school after the provision of the road can be squared with the assessment that dropping out was not everywhere delayed, only if a substantial fraction of those children completing middle school before the advent of an all-weather road failed to go on, and that this counted as not dropping out – a not unreasonable view of a child's progression in this structured system.

Some of the summary notes are also illuminating. Improved attendance and progression through the system were by no means limited to boys. In most villages, indeed, it

Table 10: Changes in school attendance in villages with new all-weather roads: focus groups

Question	1	2	3	4	5	6
Village						
1	yes	yes	yes	yes	yes	yes
2	yes	yes	yes	yes	no	yes
3	yes	yes	d.k.	yes	yes	yes
11	yes	yes	yes	yes	yes	yes
18	yes	yes	yes	yes	no	yes
19	yes	yes	d.k.	yes	no	yes
26	yes	yes	yes	yes	no	yes
29	d.k.	d.k.	d.k.	yes	yes	yes
30	yes	yes	d.k.	yes	no	yes

Q1: Has the primary school teachers' attendance become more regular?
Q2: Has the middle school teachers' attendance become more regular?
Q3: Has the high school teachers' attendance become more regular?
Q4: Are children attending school more regularly?
Q5: Are children dropping out of school later?
Q6: Are more children continuing on to high school?
d.k.: don't know.

was claimed that after the advent of the road, dropping out before the end of middle school had become quite rare. The respondents in one village complained bitterly about overcrowding at all three levels, a state of affairs surely exacerbated by pupils' improved attendance and continuation through the system, despite the mitigating effect that the teachers also appeared more often.

5 Health

The role played by an all-weather road in this sphere is like that in the sphere of education. If there is no doctor or clinic in the village, the sick and injured can be brought to one without excessive delay, or the doctor himself may come in good time, whereby the ubiquitous cell telephone now places taxis and ambulances alike on call. In a grave emergency, timely treatment and a fairly smooth ride on the way can make the difference between life and death; and in less acute cases, such treatment can restore the patient more swiftly to full health. With a shorter and less tiresome journey, the chronically sick may present themselves more frequently, as may the healthy for routine check-ups and immunizations.

A preliminary matter must be addressed at the outset: it is improbable that the provision of the road in itself will alter the villagers' disease environment – unless, for example, the excavation work leaves behind fine breeding grounds for mosquitoes, or the easier access to towns and markets increases their exposure to communicable diseases. It remains the case, however, that any attempt to measure the effect of providing an all-weather road on morbidity and mortality must address the question of whether villages with all-weather roads have the same disease environment as those without. This is particularly important when there are no 'before' and 'after' data, so that comparisons are perforce cross-sectional ones. If, for example, villages that are infested with malaria are specially favored with the provision of all-weather roads by way of compensation, or, on the contrary, neglected as hopeless cases, then comparing villages with and without such roads will be hazardous where drawing inferences is concerned. As in Section 4, we begin with the data from the household survey, which cover individuals' life histories (births and deaths), but their ailments only in the *kharif* season of 2009.

5.1 The household survey: Morbidity

In the absence of 'before' and 'after' data, the only available measure of the disease environment where morbidity is concerned is the incidence of disease among the 1,292 villagers comprising the sample, 455 of whom were residents of the 11 villages with an all-weather road. The simplest index of morbidity is the fraction of the population reporting not a single episode of sickness during *kharif* 2009: in villages with and without such a road, respectively, this fraction was 55.4 and 56.4 percent. A small refinement is to break down the category of the sick into those suffering one, two and three or more episodes, respectively; but this alters the finding not at all ($\chi^2(3) = 2.30$). A further alternative is to break down episodes of sickness by ailment: viral fever, malaria, influenza and colds, and others, whereby sick individuals are classified by their first ailment in *kharif* 2009 (about one-half of them had two or more episodes). With 'healthy' as the complementary status, the null hypothesis that there is no difference in the two patterns of incidence is not quite rejected at the 10 percent level ($\chi^2(4) = 7.33$). We conclude that, based on the observed incidence of resulting episodes of illness, there are no differences in the disease environments where morbidity is concerned.

Although the environments appear to be equally hazardous to health, it could be that better and more timely treatment shortens the individual episodes of illness. The 455 residents of villages with an all-weather road had, on average 5.77 days of sickness; the average for the 837 residents of those without was 5.63. Discarding those who were healthy throughout, yields 12.97 and 12.92, respectively. It might be thought that this signal absence of any difference is due to a failure to control for other factors, such as age, sex, infrastructure, and the ability to recognize the importance of treatment and the capacity to pay for it. A Tobit regression (to allow for censoring at zero) of the number of days of sickness on sex, four age-groups, administrative block, the household's landholding, education of its head, and a dummy for the road confirmed the univariate findings, with the profound additional insight that those older than 45 suffered significantly higher morbidity. Apart from the fact that residents of one particular block enjoyed better health, nothing else was statistically significant.

These findings do not, however, allow one to draw the conclusion that the provision of an all-weather road does nothing to improve the villagers' health, still less that they do not value its contribution in this sphere. Timelier and better treatment may well have long-term consequences for health and productivity, which are rarely captured in short-term surveys. To give an example, the high fever that usually accompanies a bad bout of malaria can so damage the brain as to leave the individual impaired for life, should he or she survive. This particular hazard is especially acute for children. Timely treatment may not affect the duration of the bout, but it can certainly affect the long-term outcome. Long-term consequences aside, villagers may value the road because the assurance of better and timely treatment reduces both anxiety in advance and pain and suffering in the event of actual need. In the absence of the road, getting such treatment may be virtually impossible in the monsoon, so that the household is then rationed in its decisions. Even when not so constrained, the household may make use of the improved opportunity to obtain such treatment, which will normally involve additional outlays of time and money. Since the improvement in the set of opportunities is surely substantial, the value accorded to it will then easily exceed the expenditures required to exploit it.

The network of health facilities includes government primary health clinics (PHCs) and hospitals, private doctors and hospitals, and traditional healers. The null that, for the first episode of illness, residents of villages with an all-weather road make use of these facilities in the same proportions as those of villages without is comprehensively rejected (using Fisher's exact test). The proportions going to public facilities were much the same, at 84 and 89 percent, respectively; but the source of the difference lay in their use of public hospitals as opposed to PHCs, at 63 and 32 percent of the whole, respectively. It could well be, of course, that the network of roads and facilities is such that public hospitals are simply closer to the villages with all-weather roads than are the corresponding PHCs, and conversely for those villages without such a road; but this turns out not to be so. For residents of villages with all-weather roads, the average distances travelled for treatment at PHCs and hospitals were 9.6 and 14.4 km., respectively; for those resident in villages without, the corresponding distances were 8.0 and 14.7 km., respectively. While the gap between the average distance to the PHC and the hospital was a bit smaller for the former group, the hospital was equally far off for both groups. This suggests that those households with such a road at their disposal decided to sacrifice some of the savings in time in favor of a longer journey to the hospital, presumably in the hope of getting better treatment there than at the PHC that served as their alternative.[8]

In order to investigate this further, it should be noted that villagers often have some limited choice among facilities, so that the reported distance travelled to get treatment then reflects the choice made and may not be (econometrically) exogenous. In virtually each and every village, however, there was a sharply defined and strong modal choice, whose distance from the village in question has been taken as representing a single available option. The time taken to reach a health facility for treatment, whatever kind it might be, was regressed on the variables used above in connection with morbidity together with village dummy variables to capture any fixed effects other than the existence of an all-weather road and the distance to the modal choice of facility. OLS yields the finding that an all-weather road reduced the duration of the journey by about 130 minutes, an estimate that is statistically rather precise ($|t| = 2.62$, robust standard errors). An increase of 1 km. in distance alone increased the duration of the trip by an estimated 1.5 minutes, which is likewise statistically highly significant ($|t| = 4.37$). Other than the head of household's years of education, each of which lengthened the trip by 2.1 minutes (perhaps the better-educated are more likely to decide for the longer trip to the hospital), no regressor other than the village dummies is remotely significant at conventional levels. In contrast, all but four of the said dummies are highly so, and the estimated values of their coefficients vary strongly, which confirms the initial impression of a very heterogeneous network of connections to health facilities.

Turning to outlays, the sick must often be accompanied by relatives or friends, whose time has an opportunity cost. Of the 566 cases, 381 were so accompanied. A Tobit regression with the same set of regressors yields an estimated saving of 43.2 minutes ($|t| = 6.72$) when there is an all-weather road, whereby one may wish to interpret the 'saving' as the ability and willingness to pay for faster transport rather than a decision to leave the patient to his own devices. An increase in distance of 1 km. reduces this

[8]Klemik *et al.* (2009) find strong evidence of such behaviour in rural Tanzania.

expenditure of time by 3.1 minutes ($|t| = 5.91$), an unit increase in landholding by 2.8 minutes ($|t| = 3.16$); the former is harder to interpret than the latter. Where total monetary outlays on transportation are concerned, 256 cases involved positive amounts. The same specification yields the finding that the presence of an all-weather road increases the outlay by Rs. 54.7, but this estimate is statistically borderline ($t = 1.82$). An increase in distance of 1 km. increases the outlay by an estimated Rs. 7.1 ($t = 2.97$). Of the remaining regressors that are statistically significant at conventional levels, a larger landholding increases such expenditures, but the purse-strings are tightened, by Rs. 82.6 ($|t| = 2.57$), for a child of school age.

As already noted, the distance to the health facility poses problems; for whenever there is a choice of facility, distance is likewise chosen, and the use of the modal distance may not be fully satisfactory. Since an all-weather road should offer greater average speed over the whole trip, an alternative way of skirting this difficulty is to use speed – or rather its inverse, minutes per km. – as the regressand. OLS with all the other regressors and village dummies yields an estimated saving of 7.0 minutes per km. with such a road, and this is statistically highly significant ($|t| = 5.12$). Speed is also greater over longer stretches: 0.2 minutes per km. less with each additional km. ($|t| = 4.55$); but the household and demographic variables are not statistically significant at conventional levels, nor are over one-half of the village dummies.

5.2 The household survey: Mortality

Over the period from the beginning of 2006 to the end of 2009, there were 53 deaths among members of the households comprising the sample, which corresponds to an crude annual mortality rate of about 10 per thousand. The distribution of deaths by age-group and year is set out in Table 11; the causes of death by age-group are reported in Table 12. The spike in deaths in 2009 is probably just sampling fluctuation. The age-specific mortality rates follow the expected pattern, being lowest among adults in prime age. The causes of death in these poor communities are overwhelmingly the usual suspects, namely, malaria, communicable diseases and complications in childbirth, whereby the latter often claim both mother and child.

The first step is to try to establish whether the disease environment is independent of the presence of an all-weather road. An important indicator of this environment is the relative incidence of the causes of death. Table 13 sets out the corresponding distributions of cases, where it should be noted that 8 of the 10 villages that had all-

Table 11: Distribution of deaths by age and year

Year	2006	2007	2008	2009	total
Age-group					
0 – 15	2	4	2	6	14
16 – 45	5	2	4	4	15
46 +	3	5	6	10	24
Total	10	11	12	20	53

Table 12: Distribution of deaths by age and cause, 2006-2009

Cause	malaria	pneu/TB	fever/flu	childbirth	other	total
Age-group						
0 – 15	4	3	2	4	1	14
16 – 45	4	3	0	4	4	15
46 +	7	5	6	0	6	24
Total	15	11	8	8	11	53

weather roads in July 2009 contributed to both rows, in virtue of having moved from one category to the other over the period 2006 – 2009. The null that the patterns are the same cannot be rejected (Fisher's exact test, $p = 0.227$).

All of the 53 deaths appeared to have involved acute causes, so that timely treatment was of the essence. In 49 of these cases, the respondents gave answers to the question, would the deceased have survived had there been more timely treatment? The respondents' answers ran as follows: in 2 cases, no; in 38 cases, yes; and in 9, don't know. In no fewer than 19 cases, no medical treatment was sought at all; and it was asserted that in 13 of these, the person would have survived with timely treatment. The same was asserted for no fewer than 25 of the 30 individuals who did get treated. Thirty-five deaths occurred in villages not then served by a road; in 29 of these, it was asserted that timely treatment would have made all the difference. Of the 14 deaths in villages so served, the corresponding number was 9. There is no great difference here.

Table 13: Distribution of deaths by presence of all-weather road and cause, 2006-2009

Cause	malaria	pneu/TB	fever/flu	childbirth	other	total
No road	12	8	8	5	6	39
Road	3	3	0	3	5	14
Total	15	11	8	8	11	53

A second question had to do with the quality of treatment. The respondents were of the opinion that all but one of the 30 deceased who were actually treated would have survived had their treatment been better, whereby the answers to the timeliness and quality of treatment are highly correlated.

A third question concerned transportation problems. In 23 of the total of 53 cases, no treatment was sought. Twenty-one of the 23 occurred in villages not served at the time by an all-weather road: put differently, just over one half of the 39 who died when there was no road received no treatment. The respondents claimed that in 13 of these 21 cases, transportation problems made it impossible to get the patient treated, either at a facility or at home by a visiting physician. Only two of the 14 who died in villages then served by an all-weather road went untreated, and in one of these two cases, transportation problems were cited as the reason. Some of the 30 who did receive treatment but died nonetheless may, of course, have been greatly delayed on the way, so adding to the toll exacted by poor transportation.

In order to investigate the effects of the presence of an all-weather road on mortality, allowance must be made for possible differences in age-structure and variations in general mortality from year to year. We therefore ran a Poisson regression, beginning with dummy variables for the road and age-group (reference group $0 - 15$), and pooling the years together. The null that the provision of a road had no effect on mortality is in no danger of rejection ($|z| = 0.08$), nor was there a significant difference in mortality between the two younger age-groups; but the rate for those older than 45 was 2.66 times higher than for those younger than 16 ($z = 2.90$). This failure to find any effect of an all-weather road on mortality is somewhat at odds with the finding that such a road made it much more likely that a person in need was actually treated. Perhaps the treatment really was rather poor or, despite the road, not timely enough. Then again, with so few cases, it might be just due to sampling fluctuation. During the household interviews, many respondents seemed to have had no doubts that some deaths had been avoided, or would have been, had there been an all-weather road.

5.3 The focus group interviews

The focus group interviews yielded, once more, both some striking uniformities and a few differences in the roads' effects, as is clear from Table 14. In all villages, children and the chronically sick receive more regular care, and treatment has become more timely, thereby reducing long-term *sequelae*. In five villages, doctors are also readier to make house-calls to treat those too sick to be transported to a hospital by an ordinary vehicle – though this raises questions about the quality of ambulance services, which exist precisely to deal with such cases. Despite these improvements in access, the respondents in three villages named the quality of care in the facilities themselves as the main problem, and those in two further villages were unclear on this point. Yet whatever their misgivings about the facilities on this score, the respondents in these five villages reported that people had largely ceased to rely on traditional healers. This revealed preference points to an improvement in welfare, but the respondents' expressed opinions to unexploited complementarity in the provision of public services.

Whatever be the failings on this latter front, there was no doubt in the respondents' minds that their new road had reduced mortality, which is surely a, if not the, leading outcome where evaluating its effects on health is concerned. Since this indicator is also measurable, the groups were asked how many of their fellow villagers had died due to untimely treatment in the year before their road became operational and how many in the crop year 2009-10. In communities wherein people know so much about their neighbors' doings, such estimates should be fairly reliable. Averaging over the villages, the mean number fell from 3.25 to 0.75 annually. Taking the individual differences to rid the data of any village fixed effects, the corresponding value of $|t|$ is 5.00: with 7 d.f., this is an overwhelming rejection of the null. This quantitative finding stands in stark contrast to that yielded by the household data, and it lends support to the suspicion that the failure to find any effect in the latter can be put down to sampling fluctuation – with just 8 households per village.

6 Ranking the Benefits in the Three Domains

Both the household survey and the focus group interviews provide strong support for the contention that the benefits in the domains of education and health are likely to

Table 14: Changes in health care and mortality in villages with new all-weather roads

Question	1	2	3	4	5	6
Village						
1	yes	yes	yes	yes	yes	yes
2	yes	yes	yes	yes	yes	yes
3	yes	yes	yes	yes	yes	no
11	yes	yes	yes	d.k.	yes	d.k.
18	yes	yes	yes	no	yes	yes
19	yes	yes	yes	yes	yes	yes
26	yes	yes	yes	d.k.	yes	d.k.
29	yes	yes	yes	no	yes	no
30	yes	yes	yes	yes	yes	no

Q1: Are children taken more regularly to health facilities for check-ups and immunisations?
Q2: Do the chronically sick receive better and more regular treatment?
Q3: Do villagers receive more timely treatment and thereby suffer fewer long-term problems?
Q4: Do doctors come to the village more readily to treat those who are too sick to be transported?
Q5: Has mortality fallen as a result of better access to health facilities?
Q6: In emergencies, is the poor quality of treatment or absenteeism among doctors still the main problem?
d.k.: don't know.

be substantial relative to the 'commercial' ones. It should be remarked at the outset that whereas the great majority of the respondents in the household survey were male, both sexes were strongly represented in the focus groups.

Beginning with the individual households, the respondents in those nine villages that had received an all-weather road at any time after January 2007 were asked to rank the three domains according to the size of the corresponding benefits they had enjoyed from the new road thus far. The commercial and health domains were ranked roughly equally (with 31 and 29 first, and 23 and 28 second ranks, respectively), whereas education lagged far behind. It is possible that the latter reflects the fact that 28 of the 30 villages have their own primary school, but only two have a secondary school, whereby these poor families – or perhaps their male respondents – may place little value on secondary education. At all events, the null hypothesis that the rankings are independent of the domains is resoundingly rejected ($\chi^2(4) = 13.28, p = 0.000$). The respondents were also asked to rank the benefits stemming from the commercial domain against those from education and health combined: 24 ranked the former first, 18 put them on a par, 28 ranked the latter first, and one expressed no opinion. The null that these rankings are independent of the (two) domains cannot be rejected at conventional levels ($\chi^2(3) = 4.34, \chi^2_{0.10} = 6.25$). These findings suggest that in the respondents' eyes at least, the benefits in the domains of education and health are roughly as large as those in the commercial domain.

These results are largely borne out by the respondents' rankings in the focus group interviews, though the men and women present, while all having definite opinions, took a rather different view of things, as can be seen at a glance from Table 15. In six villages, the men put commercial benefits first; in no village did the women agree, splitting instead 5 to 4 narrowly in favour of education over health. In seven villages, men ranked health second, and in five villages, education merely third. This apparent subsidiary ranking may be related to the male respondents' ages: if older, their children would have largely finished with school, so that getting to the clinic in good time to have their own various ailments attended to would take precedence over schooling. (Bell listened to just such a discussion in one Oriya village.) In all but one village, the women ranked the commercial benefits last.

Table 15: Focus groups' ranking of benefits according to domain, by sex

	men			women		
Rank:	1	2	3	1	2	3
Domain						
commercial	6	1	2	0	1	8
education	3	1	5	5	4	0
health	0	7	2	4	4	1
total	9	9	9	9	9	9

It is reassuring, where consistency is concerned, that when asked to *combine* the benefits in the spheres of education and health, the women in all nine villages reckoned them to be greater than those in the commercial sphere. In five villages, the men agreed with them, presumably with access to treatment on their minds. Of the four villages wherein there was no unanimity, the men put the commercial sphere first in three and conceded just parity in the other. There seems to be a pattern here: unanimity ruled in the poorer, less commercialized villages, but not in those producing a substantial marketed surplus or otherwise better integrated into the market economy. The men, who enjoy much more extensive economic opportunities than their womenfolk, know where their immediate interests lie.

7 Summary and Conclusions

Replacing one km of *kutcha* track by one km of PMGSY road yields an estimated increase in the net price obtained for paddy of Rs. 7.95 per quintal. Given a typical stretch of 5 km to reach the next level of the road network, a household selling one tonne would therefore realize an increase in net revenue of almost Rs. 400, or about 5 percent of the price ruling in the main markets in *kharif* 2009. To this gain must be added those arising from the marketing of other crops, especially cotton and vegetables, the estimated reductions in whose unit transport costs are, on average, larger than that of paddy. There are also the reductions in the farm gate prices of bought-in inputs such as fertilizers and agro-chemicals. Our measure of the net price relates to the village's place in the road and marketing network, whatever be the actual location of the villagers' transactions. Although rather noisy owing to the small number of observations in each village, it is conservative, in that the nearest alternative location to the farm gate is chosen when the sale is actually at the gate. The focus group interviews suggest that an all-weather connection leads to sharper competition among marketing intermediaries and more joint marketing by farmers to sell in their main market. We therefore suspect that the changes in behavior reported in the focus group interviews imply larger gains than those yielded by the cross-section econometric analysis.

All but two villages have their own primary school, and given that a village does so, the absence of an all-weather road will do little to hinder primary school children from getting to the school itself, even if its hamlets are a bit scattered. What its absence can do, however, is to prevent the teachers from doing so, especially during the monsoon; for they usually live elsewhere. This is confirmed by the survey data: in *kharif* 2009, primary school children in villages with an all-weather road each lost, on average, 1.9 days involuntarily, in those without, 8.6 days, a difference that is not only substantial, but also statistically highly significant. In contrast, only one of the 30 villages has a secondary or high school, so that the connection will normally affect the attendance of pupils and teachers alike. The corresponding average numbers of days lost involuntarily were 2.9 and 9.4, respectively, a difference that is not only statistically highly significant, but also leads to the suspicion that it is the teachers' attendance, at all levels, that is most furthered by an all-weather road. Secondary and high school pupils enjoyed virtually no savings in time making the daily round trip according to the cross-section comparisons, but between 17 and 30 minutes a day (depending on the definition of the cohort) in 'before' and 'after' comparisons in the villages receiving a PMGSY road after January 2007. The respondents in the focus groups gave replies to qualitative questions that are almost wholly consistent with these quantitative estimates of improved attendance and savings of time. In one matter, however, they tell another story: the household data reveal no improvement in completing grades, but the respondents in most villages were adamant that their new road had made dropping out of secondary school a rarity, even among girls.

Turning to the effects of all-weather roads on health, the quantitative household data reveal none where both morbidity and mortality are concerned, though the time elapsed since the provision of the PMGSY roads was far too short for long-term effects to make themselves felt. The provision of such roads did, however, affect the choice of facility for treatment: the ensuing switch from PHCs to hospitals is both substantial and involves longer travel times, both induced by higher average speeds. Such an effect on behavior is a clear indication that there was an improvement in welfare in this domain. The survey respondents' replies to the qualitative questions and the participants' in the focus group interviews leave no doubt on this matter. In particular, the latter were of the firm opinion that their roads had brought about a definite fall in mortality: the average of the estimate was 2.5 deaths a year in the nine villages.

We close with two remarks. First, whereas the traditional method of estimating the benefits arising in the 'commercial' domain is well-established and relatively easy to implement in practice, the task of estimating those arising in the domains of education and health is altogether more difficult. Since the respondents ranked the combined benefits in the domains of education and health at least as highly as those in the commercial one, simply doubling the latter yields a conservative estimate of the total (money-metric) benefits, provided this restricted view of consumer sovereignty be accepted. Second, as expected, the before and after comparisons yield sharper results than their cross-section counterparts. Obtaining more precise estimates of the effects of providing villages with all-weather roads therefore demands a more systematic and larger panel survey design, and one of longer duration.

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